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2010
AAEP
CONVENTION
WRAP-UP

A supplement to *The Horse*

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2010 AAEP CONVENTION WRAP-UP

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COURTESY CHARLES FAZIO/AAEP

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THE HORSE'S PARTNERS IN EQUINE HEALTH



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VIDEOS

NEUROAXONAL DYSTROPHY IN QUARTER HORSES: CASE SERIES

Dr. Carrie Finno of the University of California, Davis, uses several case videos to describe the neurologic disease neuroaxonal dystrophy (also called equine degenerative myeloencephalopathy) in horses. Also see the related story on page 37.

Videos sponsored by Intervet Schering-Plough Animal Health



COURTESY DR. CARRIE FINNO

MORE VIDEOS:

- Neurology/Ophthalmology
- Equine Welfare
- Reproduction: Short Presentations
- Lameness: Soft Tissue Problems
- *Rhodococcus equi* Pneumonia in Foals
- Farriery Program
- In-Depth: Reproduction
- Society for the Protection of Animals Abroad: 2010 Lavin Cup Honoree
- And many more ...



COURTESY DR. IAN MCKINLAY

MORE FROM THE CONVENTION

COMPLETE COVERAGE

- More than 100 articles on the latest news in equine veterinary medicine, including many more than you see in these pages.
- Take-home messages from nearly all presentations, described in video interviews with session moderators.
- Downloadable convention coverage reports. *Sponsored by OCD*

Highlights and Awards

BY ERICA LARSON

When the American Association of Equine Practitioners (AAEP) Convention returned to the Mid-Atlantic region Dec. 4-8, 2010, for the first time since 1998, it attracted more than 5,500 veterinarians, veterinary technicians, veterinary students, and other attendees to Baltimore, Md., to take part in continuing education opportunities, business sessions, and celebrations, all focused around equine medicine.

“The AAEP has many members who practice in the Mid-Atlantic states and the Northeast, which made Baltimore a very accessible convention location,” said David Foley, AAEP executive director, in a

press release. “We have been thrilled with the positive response we’ve received from members about the quality and practicality of the program this year.”

New Officers and Board Members

Each year at the convention, new officers and board members are inducted for the upcoming year. This year, Bill Moyer, DVM, and Ann E. Dwyer, DVM, were sworn in as president and vice president, respectively, during the President’s Luncheon.

Also at the President’s Luncheon, several new members of the Board of Directors were inducted. These representatives

are Brad Jackman, DVM, MS, Dipl. ACVS; Benjamin Espy, DVM, Dipl. ACT; Eric Peterson, DVM; and Emma Read, DVM.

Annual Awards

The 2010 Lavin Cup (an equine welfare award given annually by the AAEP) was presented to The Society for the Protection of Animals Abroad (SPANNA), a U.K.-based charity that works to alleviate human poverty by ensuring the welfare of working animals in developing countries.

The organization has permanent service centers in eight developing countries and responds to animal welfare



The AAEP 2011 Executive Committee pictured from left to right: David Foley, AAEP executive director; Jeffrey T. Berk, VMD, treasurer; Ann E. Dwyer, DVM, vice president; William A. Moyer, DVM, president; Nathaniel A. White II, DVM, immediate past president; John S. Mitchell, DVM, president-elect.

COURTESY AAEP/CHARLES FAZIO



emergencies around the world. The group educates impoverished communities about proper horse care and provides medical treatment for horses and other equids in need. Additionally, SPANA teaches equid owners about the basics of equid husbandry, feeding, and the proper use of tack. (For more information see TheHorse.com/17352.)

Jerry B. Black, DVM, was presented with the 2010 Distinguished Life Member Award for his more than 35 years of service to AAEP and the equine veterinary profession. During his time with the AAEP Black has served on several different task forces, forums, and committees, including the Student Relations, Public Policy, Foundation Advisory, and Equine Welfare committees.

Charles Raker, VMD, Dipl. ACVS, was presented with the Sage O. Kester "Beyond the Call" award. The 90-year-old veterinarian is only the second person to receive this prestigious award, which is the AAEP's highest honor. It is presented

“Dr. Raker’s surgical expertise led to the development of many medical and surgical procedures that improved the quality of life for his patient, the horse.”

THE AAEP

to members that have helped shape the practice of equine veterinary medicine.

“Recognized as one of the most respected educators in the equine veterinary community, Raker has profoundly influenced the careers of his students and veterinary colleagues,” the AAEP said in a statement. “Raker’s surgical expertise led to the development of many medical and surgical procedures that improved the quality of life for his patient, the horse.”

Tips of the Hat

Each year the Kester News Hour (see TheHorse.com/17777, TheHorse.com/17778, and TheHorse.com/17779) includes several “tips of the hat” to recognize equine veterinarians and others who have made significant horse health contributions.

The individuals who organized a series of student wet labs at Texas A&M University received a tip of the hat for developing a program that attracts more than 200 veterinary students from 24 schools annually.

The organizers of the Opportunities in Equine Practice Seminar, held annually for North American veterinary students to promote equine practice as a viable and rewarding career option, also received a tip of the hat. 🐾

MORE ONLINE See TheHorse.com/AAEP2010
Watch the SPANA: Lavin Cup Honoree video, TheHorse.com/Video.aspx?vID=482.

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Milne: Eye Surface Failure

BY NANCY S. LOVING, DVM

The soft, expressive equine eye holds a great fascination for horse lovers. And although it's normally a resilient structure, it's not immune from injury. Dennis Brooks, DVM, PhD, Dipl. ACVO, a professor of ophthalmology at the University of Florida's College of Veterinary Medicine, gave this year's Frank J. Milne State-of-the-Art Lecture on catastrophic ocular surface failure (OSF) in the horse, a condition that is most commonly caused by corneal ulceration. He began by describing how decades ago equine eye injuries were hopeless cases, but that this is no longer true. He proclaimed, "The horse's eye heals incredibly well, although not quickly, and our objective as veterinarians is to learn how to help it heal."

Brooks noted that disease pathogens attacking the equine eye are some of the strongest and most complicated in all of ophthalmology, comparatively with other species. These diseases aren't necessarily powerful because of the infections they cause, but they are enhanced because of the horse's specific neutrophil (a type of white blood cell) response to them.

The Ocular Surface and Response to Injury

An understanding of how the eye works is instrumental in effectively treating and managing ocular injury. Brooks explained features of the ocular surface, which includes all parts of the front of the eye:

- Conjunctiva lines the internal surface of the eyelids and contains lymphatic tissue.
- The precorneal tear film smooths the normally roughened corneal surface with an optical gel and tears that provide nutrition to the eye.
- The limbus, which is the transition nutritive zone between the cornea and sclera, is an area of weakness.
- Eyelids blink as many as 14 times per minute.
- The cornea is avascular (it has no blood supply), serves as a lens and a



COURTESY CHARLES FAZIO/AAEP

Brooks explained various ocular injury and disease treatment methods in the Milne Lecture.

windshield, and bends light entering the eye.

Most sensory nerves in the equine cornea are superficial, so even a slight abrasion by wind causes discomfort. The mucin layer of tears attaches the tear film to the corneal surface to provide an optically smooth surface for light to pass through to the retina. This is visible as a shiny layer on the cornea. Normal replacement rate for tears is seven minutes, as compared to four minutes in humans—therefore, if medicine doesn't stick to the cornea, it quickly flushes from the eye and (necessitating frequent treatment).

The innermost layer of the cornea, the endothelium, is one cell thick. Endothelium produces what's called the Descemet's

basement membrane, which covers the inner surface of the cornea. This membrane is only as thick as six red blood cells. Endothelial disease interrupts "pumping" of "water" out of the normally dehydrated cornea, leading to blue discoloration from edema (fluid swelling)—the foremost part of the cornea is rich in chondroitin 6-sulphate, which absorbs water (water moves in but must be actively removed or pumped out). Topical hyperosmotic agents (5% sodium chloride) draw out edema.

The horse is the only species for which it is known how fast corneal epithelial cells migrate for healing—0.6-1 mm/day. Healing begins at the corneal periphery and limbus, with healthy cells migrating across the ulcer site toward the center. Some drugs slow this down.

Brooks explained the limited ways an eye reacts to injury or disease with ocular surface failure:

- Neutrophils migrate quickly into an ulcer to form an abscess or necrotic area (dead tissue) to create white cellular infiltrates;
- Edema (fluid swelling) causes a blue hue; and
- Superficial or deep blood vessels appear red as they migrate 1 mm/day—this is necessary for healing, but might impact the horse's vision.

He reminded vets in attendance that high-dose systemic NSAIDs (non-steroidal anti-inflammatory drugs given intravenously, intramuscularly, or orally) slow vascularization (blood supply) and, thus, can slow healing. Using topical plasma or serum hastens healing and can mean a shorter wait for blood vessel migration.

Treating OSF involves a multifold approach. Brooks stressed the importance of eliminating infection as well as reducing protease enzyme activity (indicative of ulcers) in the tear film—an ulcer won't heal until protease activity returns to baseline. In addition, damaged or missing cornea must be replaced and tear film rejuvenated—something the body does on



its own. Also minimize inflammation of the cornea (keratitis) and iris.

As a corneal ulcer heals, epithelial cells at the ulcer edges push inward at a rate of 0.6 mm/day. It takes six weeks for epithelial cells to attach and adhere to corneal stroma (the connective tissue framework). Books said veterinarians should avoid irritating these healthy cells—some antibiotics such as ciprofloxacin are irritants. Brooks recommended waiting as long as possible to begin topical corticosteroid treatment.

A veterinarian can use fluorescein dye to detect defects in corneal epithelium, such as abrasions, erosions, or ulcers; cobalt blue filters in ophthalmoscopes aid visibility of fluorescein. Tear film (which is normally continuous; blinking maintains this continuity) normally breaks up in about 22 seconds if the eye is held open—this process is visualized by staining with nondiluted fluorescein, holding the eyelid open, and timing breakup of the tear film. If the break up occurs too quickly, this



A deep anterior lamellar keratoplasty (LK, a corneal transplant technique) and amnion transplant.

indicates the tear film is abnormal, which can slow healing. Rose Bengal dye stains for tear film instability, testing positive for virus, fungi, immune-mediated keratitis (a painful corneal disease), granulation or scar tissue, wind abrasion, or edema.

Seidel's test screens for leaks of anterior chamber fluid through full thickness corneal ulcers or holes. The vet stains an eye with fluorescein and observes for leaking



Fluorescein dye can be used to detect corneal ulcers, as shown above.

aqueous humor that dilutes the tear film. This is especially helpful when evaluating trauma or integrity of corneal sutures.

Microbial Infection

The equine cornea is constantly exposed to microbes. It was previously thought that cornea had to be damaged before bacteria or fungi could colonize, but in fact Brooks reported that microorganisms don't

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require physical corneal damage to set up infection. Another suggested source of infection might be inoculation of microbes through a micropuncture (a traumatic injection of a microbe or foreign body).

Ocular surface barriers generally protect the eye from infection; however, Brooks noted that something in horse tears attracts neutrophils to sites of corneal injury, rendering these barriers ineffective. Neutrophils move in quickly, about 8 mm/day, and when these neutrophils die, they release enzymes that create adverse reactions in the eye (observable as an ulcer). An ulcerated equine eye has high tear protease levels, and it can be difficult to combat these enzymes in the face of infection. Bacteria and fungi also might repopulate during topical drug administration, complicating treatment.

Bacteria or fungi form a protective extracellular substance called biofilm around themselves, which makes them difficult to kill and culture, despite active infection in an injured eye. Once organisms rupture from the biofilm, Brooks said they seem more pathogenic (able to cause disease) than before. Debriding an ulcer interrupts the biofilm layer while removing necrotic tissue and is important to healing. Topical EDTA (ethylenediaminetetraacetate) is also useful to break up biofilm, so Brooks recommended combining EDTA and serum for treatment. Serum, usually taken from the eye-injured horse, might be more effective if obtained from a normal horse.

As mentioned before, neutrophils pose a major problem in equine corneal disease resolution by eliciting and releasing destructive enzymes. Metalloproteinase (MMP) enzymes are present in the cornea, specifically MMP-2; this particular MMP is important for growth and for repair related to wear and tear. Bacteria and microbes don't produce MMPs; these enzymes are present in relatively inactive forms in the eye until an injury occurs. Corneal damage induces activity of MMP-9, which digests collagen. Neutrophil elastase (a serine protease, or proteinases) has active role in collagen destruction as well, but veterinarians aren't sure what it is at this time; it might impede the inhibitors of MMP-9, creating a vicious cycle (i.e., the cornea is damaged, MMP-9 is released at higher levels than NE, but the inhibitor of MMP-9 makes the NE more

active). Interestingly, Brooks noted that proteases increases are evident in tears of both eyes of a horse with an ulcer in only one eye.

Corneal Ulcer Treatment

A vet can prescribe a single oral dose (10 mg/kg) of doxycycline (an antibiotic) to provide anti-protease activity for three days. Plasma, EDTA, and serum (blood plasma minus the clotting factor) also inhibit MMP activity. Another treatment Brooks prefers involves using amnion (placental membrane) to cover the cornea (via suture or bioadhesive) so that enzymes attack amnion rather than cornea as the ulcer heals. Amnion has strong anti-inflammatory properties that combat fibroblasts (connective tissue cells) that would otherwise scar. Brooks remarked that amnion gives Mother Nature time for the cornea to heal on its own. Other methods of corneal protection include contact lenses, collagen shields, third eyelid flaps, or temporary tarsorrhaphies (sewing the eyelids together).

Methods of corneal protection include contact lenses, collagen shields, third eyelid flaps, or temporary tarsorrhaphies (sewing the eyelids together).

Ulceration might progress in spite of effective antibiotic treatment. Vets often use medication "cocktails" to treat difficult ulcers. Brooks described a combination of an antifungal drug (natamycin) and antibiotic (tobramycin and cefazolin) with serum. Diluting serum with these other drugs reduces anti-protease activity, but this cocktail is more effective against microbes than any of the drugs used alone. Indwelling lavage systems are an excellent way to infuse treatment, he said, noting that upper lid lavage treatment systems deliver greater concentration of medication to corneal lesions than lower lid lavage systems.

"It is rarely true that severe corneal disease results in anterior uveitis (inflammation of uvea including iris tissues)," he pointed out. Brooks stressed that horses

are able to compartmentalize ocular inflammation, containing it to the front of the eye most of the time.

Medical treatment of ulcers includes attacking infectious microbes, decreasing tear protease activity, and treating concurrent anterior uveitis (inflammation of the iris and ciliary body—the circular muscle located behind the iris) when present. The latter could potentially lead to cataracts due to fibrin (a protein in the blood that forms an essential part of blood clots) adhesions (synechia) to the lens. Brooks noted that corneal ulcer disease severity cannot be equated directly with severe uveitis severity. Nonetheless, it is important to dilate the pupil promptly in a painful eye with uveitis because synechia can occur in seconds. One drop of atropine in a normal horse's eye dilates the pupil (to prevent blindness) for two weeks. Brooks stressed that veterinarians exercise caution recommending topical atropine treatment since applying atropine to the eye four times a day for three days can decrease gastrointestinal motility. Combining atropine with phenylephrine achieves dilation that is safer to the GI tract. Often there is unnecessary concern that a horse with a dilated pupil will suffer retinal damage. This won't occur unless the horse stares at the sun for an hour, which as Brooks pointed out, a horse isn't likely to do.

Fungal Keratitis

In most cases, Brooks noted that mild fungal keratitis (corneal inflammation) resolves on its. However, in cases of trauma with plant material or subsequent to treatment with topical corticosteroids or antibiotics, fungi might take hold. Fungal plaques inhibit healing and destabilize the tear film. The corneal surface often appears dry in these horses, lacking its normal glistening luster. Brooks explained that fungi attacking the equine cornea produce an as yet unidentified chemical that inhibits blood vessel growth for ulcer repair. The more proteases present, the deeper fungi can invade.

Brooks described a stromal abscess as an infection within the corneal stroma beneath the eye surface. The more superficial the abscess, the more likely it's bacterial rather than fungal. Deep abscesses cannot be drained because they usually contain solid material related to fungal



infection, trauma, or ocular manifestation of systemic disease (OMSD, a disease in the body other than the eye that can cause illness in the eye).

Treating Deep Eye Injury

A descemetocoele (herniation of Descemet's membrane) nearing rupture doesn't stain with fluorescein, and lack of nerves in that location might prevent the eye from appearing painful. For deep ulcers such as this, surgical treatment is often necessary. A third eyelid flap only provides physical support to such an ulcer while it's healing, while a conjunctival pedicle flap (conjunctiva pulled across the ulcer and sutured in place) also provides continual plasma lavage as anti-protease treatment. Conjunctiva is only able to stick to ulcerated cornea, so this prevents any untoward adhesions elsewhere in the eye. Fibroblasts move in quickly and leave a significant scar that obscures a horse's vision—Brooks said he finds this unacceptable so he looks to other methods of repair.

A prolapsed iris is an example of an eye trying to heal itself by plugging the hole with its own tissue and fibrin. Brooks said this isn't a hopeless condition, yet only 40% of affected eyes retain vision following conjunctival flap treatment. A corneal transplant increases chance of vision to 68%. An iris that has prolapsed secondary to a corneal ulcer has a poorer prognosis—only 30% retain vision. To determine if a horse has the potential for sight in a seriously damaged eye, Brooks said to aim a bright light at the eye to see if the horse squints.

Penetrating keratoplasty (PK) and lamellar keratoplasty (LK) are corneal transplant techniques: PK is a full-thickness transplant of ocular structures; LK uses split-thickness tissues. Veterinarians remove the diseased tissue of an iris prolapse or deep corneal stromal abscess and replace it with a PK or LK graft. With these surgeries the veterinarian attempts to prevent enucleation (eye removal), but full vision might not be restored because

many equine ocular disease processes deteriorate vision. Brooks achieves 80-92% success in retaining the eye when treating catastrophic eye injuries with these methods.

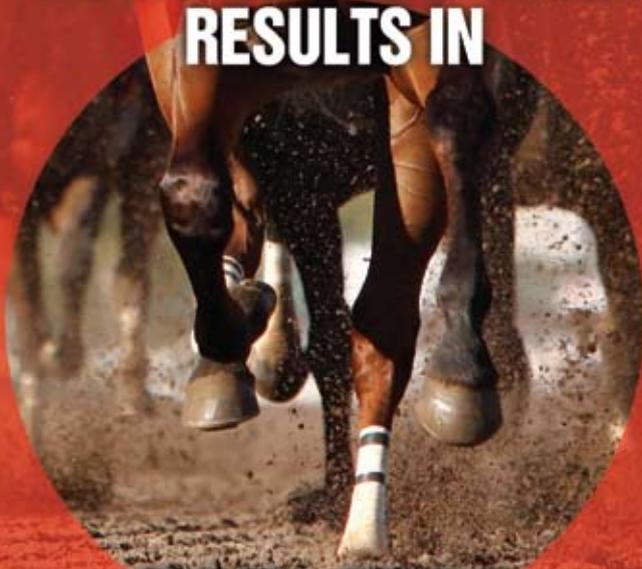
Brooks said targeted corneal tissue replacement might be a more logical surgical approach, using only epithelium, epithelial stem cells, stroma, or Descemet's membrane, depending on which tissue requires replacement. He appealed to horse owners to help save horses' sight by donating corneal tissue from a horse that is dying from a condition other than ocular disease.

He emphasized throughout his presentation that the horse eye wants to heal and that current knowledge, techniques, and expertise are available to help equine eyes achieve this goal. 🐾

MORE ONLINE See TheHorse.com/AAEP2010

■ Watch the Ocular Surface Failure in Horses video, TheHorse.com/Video.aspx?VID=474.

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2010's Top Equine Studies

BY CHRISTY WEST

What would be your pick for the most groundbreaking news in equine veterinary medicine for 2010? Not sure? Find out what three top equine veterinarians deemed the most important news in equine reproduction, lameness, surgery, and medicine in 2010.

These three veterinarians presented the popular Kester News Hour session:

- Margo L. Macpherson, DVM, MS, Dipl. ACT, associate professor/section chief in Reproduction at the University of Florida, and past president of the American College of Theriogenologists;
- Scott E. Palmer, VMD, Dipl. ABVP (Equine Practice), hospital director and a staff surgeon of the New Jersey Equine Clinic in Clarksburg, N.J., and past president of the AAEP and American Board of Veterinary Practitioners; and
- Steve Reed, DVM, Dipl. ACVIM, Rood & Riddle Equine Hospital, Lexington, Ky.

Top Reproduction Studies

Oviductal Patency In a study Macpherson termed “attention-getting,” researchers inserted tiny colored fluorescent beads into mares’ oviducts, then performed uterine lavage one and two days later, to assess whether the oviducts were patent (open, or allowing the beads to pass along the oviduct to the uterus). Beads were only recovered from 40% of mares, suggesting blockage of one or both oviducts was present in the other 60% of mares (which averaged 8 years of age compared to 4 years for the patent mares).

“While this isn’t a first line of defense for the barren mare, this novel approach could provide answers for mares with long-standing, unexplained infertility,” Macpherson commented. “Similar studies have also shown that oviductal flushing can sometimes resolve obstruction and result in future pregnancy.”

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Arnold CE & Love CC Laparoscopic evaluation of oviductal patency in the standing mare. *Animal Reproduction Science* 121, 86 (2010).



Drs. Macpherson, Palmer, and Reed (left to right) discussed more than 80 studies.

Endometritis “Work from several investigators in the past five years has suggested that clinical diagnosis of a uterine infection can vary depending on the organism involved,” said Macpherson. In other words, different bacteria cause different levels of inflammation in the uterus (endometritis), causing veterinarians to diagnose them differently. She described an *Animal Reproduction Science* (ARS) study in which researchers reported that *Streptococcus zooepidemicus* bacteria caused significantly more inflammation than *Escherichia coli* in susceptible mares (those that tend to get uterine inflammation/infection more easily than others).

Also, resistant mares (those that do not get uterine infections as easily) did not have any bacteria recovered from their uteri, meaning they were able to clear the infection on their own. However, their susceptible counterparts yielded *Strep* after infection with that bacterium, but generally did not have *E. coli* cultured even after infection with that bacterium.

Researchers on two more studies (in the

Journal of Equine Veterinary Science, *JEVS*, and *ARS*) also evaluated uterine infections; both reinforced the findings of more positive culture results with *Streptococcus* compared to *E. coli*. Also, endometrial biopsy samples were found to be better for cytology and culture testing than guarded swab samples. “All uterine infections are not created equally,” said Macpherson. “*E. coli* infections may be more insidious in nature and require more aggressive diagnostic procedures to detect.”

In a related study researchers from Colorado State University validated a polymerase chain reaction (PCR) test for detecting bacteria in the uterus. This is a “highly sensitive tool” that identified bacteria in 33% of mares with endometritis, whereas standard culture identified bacteria in only 22% of cases.

“PCR has great potential as an adjunct tool for mares with a long-standing history of infertility,” Macpherson commented. Also, she added, “Preliminary data from a PCR test used to detect fungal DNA from uterine samples shows great promise for difficult-to-detect fungal organisms.”



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Placentitis/Mare Management One group of scientists researched treating placentitis (placental infection/inflammation, a leading cause of foal loss). Veterinarians treated mares with clinical signs of induced placentitis using a combination of trimethoprim sulfamethoxazole, pentoxifylline, and altrenogest at standard doses. Treatment continued from the onset of clinical signs until foals were born or aborted.

According to Macpherson, 83% of the treated mares delivered live foals compared to zero control mares. Ten of 12 live foals of treated mares had no bacteria in their bloodstreams, whereas all of the aborted foals had bacteria in at least one of the following locations: Blood, stomach contents, and/or chest fluids.

"The workers attributed the rapid and aggressive treatment, within 96 hours of infection, to the successful delivery of live foals in treated mares," said Macpherson.

Another group of researchers tested several drugs against induced placentitis, using antibiotics alone (such as trimethoprim sulfamethoxazole) or in combination with immunomodulators (in this case, immune system boosters) such as the corticosteroid dexamethasone, aspirin, and progestins (synthetic hormones similar to progesterone). Treatment was initiated with onset of clinical signs (within 48 hours of infection), and two-thirds of the mares delivered viable foals regardless of which treatment they received.

"These findings beg the question of whether drug choice is the determining factor in successful treatment of bacterial placentitis, or (if it is) early detection

of disease and rapid initiation of treatment," Macpherson said. She also noted that treated mares delivered about 10 days earlier than healthy mares, suggesting that accelerated foal maturation occurred with the disease.

Lastly, she discussed an Australian study in *ARS* which mares were classified as being at "high-risk" of placentitis if they had less than a 50% live foal rate within the last three years. High-risk mares were monitored with ultrasound and visual observation starting at five months of gestation, and treated with antibiotics and altrenogest if they showed any signs of placentitis. More persistent cases also got anti-inflammatory medications.

With this treatment protocol, more than 80% of high-risk mares delivered live foals, compared to only about 25% before the study.

"Monitor mares at risk for premature delivery to ensure prompt diagnosis," recommended Macpherson. "Initiate treatment early, treat aggressively and for the duration of pregnancy. To ensure continued reproductive health for the mare, she should also be treated in the postpartum period—clean those mares up!"

Another mare management study (in *Theriogenology*) involved evaluating the effects of Regu-Mate (altrenogest, a progesterone hormone product). "Many of us use Regu-Mate, liberally at times, for support of pregnancy," Macpherson said.

Researchers found no difference in pregnancy rates with Regu-Mate, but they did find that older mares (which had smaller embryos at all time points) that were given the product had significantly larger embryos from Days 30-45 of gestation compared to older mares that didn't get Regu-Mate. Also, some mares then produced more equine chorionic gonadotropin hormone (which also helps support pregnancy).

"Early treatment (no later than Days 5-6) of pregnant mares, particularly aged ones, with altrenogest may have a positive effect on embryo and placental development," Macpherson noted.

Macpherson also reported that an injectable, sustained-release deslorelin product (for managing estrus in mares, using the same primary ingredient as the product Ovuplant, which has been off the market for some time) gained Food and Drug Administration approval in the week before

the convention, and was expected to be available by January 18, 2011. The product, called SucroMate, is being distributed by Bioniche Life Sciences.

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Broodmares and Financial Return In the financial arena, Macpherson reported that the general economic downturn has not spared the Florida horse production industry, which saw a "staggering drop in Thoroughbred production," nearly a 30% reduction in foal crops was noted from 2009 to 2010.

"I am guessing that few of us in this room are prepared to give up breeding mares, racing horses, or being equine veterinarians," she commented. "Instead, we need to make better decisions about what we do and how we do it. A first start is evaluating our breeding practices."

In that vein, Macpherson described a recent production data study in *Equine Veterinary Journal (EVJ)* in which researchers evaluated mare value and productivity, with an eye toward helping breeders maximize returns and mare productivity.

Most mares' foaling dates tend to drift later in the year with subsequent seasons, often resulting in a missed or barren season, she noted. Of the 1,176 mares in the study, 63% failed to produce a registered foal every season within the seven-year study period. For those mares, the average time to a barren season was 3.4 years.

Factors including increasing mare age, foaling after April 1, requiring multiple breedings in a season, and producing fewer foals in previous years were associated with reduced foal production during the study. Additionally, the researchers found that a mare must produce a live foal in at least six out of seven years to recoup



the breeder's investment in her, and that higher-value mares yield better financial gains.

"Mares are long-term investments," concluded the study authors. "Improving our understanding of mare, stallion, and management factors that affect the likelihood of producing a live foal is critical to ensuring a positive financial return."

Also, Macpherson reported that breeding earlier in the year yielded higher pregnancy rates, and that early breeding was especially important for maiden and barren mares. Foal heat breeding was also effective in reproductively healthy mares in one study, but not in another.

On the stallion side of things, some stallions were found to be more fertile than others in one study, and reinforcement breeding was again found to improve pregnancy rates when used in a natural cover program. Later covers in the day were associated with decreased pregnancy rates, as was the presence of neutrophils (a type of immune cell) in the dismount sample (possibly indicating uterine inflammation in the mare). Tranquilizers given to mares also had a detrimental effect (it was not clear whether that was because mares were not ready for breeding or because of a pharmacologic effect of the tranquilizer drug).

"The majority of factors associated with variation of fertility in this study, both positive and negative, were attributable to the mare," said Macpherson.

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Stallion Vocalizations for Teasing? Could farm managers tease mares to assess estrus by simply playing tape recordings of stallion vocalizations? The results of a recent study confirm the effectiveness of this practice, which could be used by some

breeding farms.

Researchers on an ARS study played taped stallion vocalizations to broodmares and were thereby able to identify estrous behavior. The effectiveness of this practice was improved when the mares were also presented with stallion scent, with a successful estrus detection rate of over 80%.

"This tactic might provide a less threatening environment for mares, which could be especially important for maiden or timid mares or on small farms with no stallions," Macpherson added. "Further, if physical findings of the reproductive tract were combined with behavioral responses, as is typical in practice, one would expect the sensitivity of this tool to be even better."

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Semen Processing Stallion semen is generally centrifuged, or spun at high speeds, during processing for extending/shipment so sperm are concentrated. However, this procedure can crush some sperm depending on the technique used, so researchers often evaluate techniques to reduce this sperm loss, such as by using a cushion medium in the tube.

Macpherson discussed one study in which researchers modified cushioned centrifugation procedures to use less cushion medium (1 mL instead of 3.5) and larger sperm samples (3 billion instead of 1), and found that sperm recovery rates were still higher than 90% regardless of cushion volume or sperm number. Sperm characteristics were also unaffected even after cooling for 24 hours.

"More sperm and less cushion means less tubes to process, which can increase efficiency and reduce costs," explained Macpherson.

Another study she was "particularly excited about" looked at increasing the concentrations of sperm in cooled, shipped semen from 25 million sperm per milliliter of shipped semen to 250 million sperm/mL. No negative impact on sperm characteristics was noted with this protocol.

"So we can ship more sperm, perhaps even up to 20 billion sperm," Macpherson noted. "This could be useful for providing more sperm for traditional artificial

insemination (AI) or for low-dose AI. The one qualifier for both of these studies is that these protocol changes have not been tested for fertility."

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Contagious Equine Metritis Macpherson also discussed a study of contagious equine metritis (CEM), a highly contagious bacterial infection that causes acute endometritis in mares and subsequently impacts fertility. The disease caused significant consternation recently in the U.S. breeding industry (see "CEM Investigation: 23 Positive Stallions," TheHorse.com/16078). For this study, researchers evaluated whether mixing antibiotics with semen extender would prevent transmission of the bacterium that causes CEM, *Taylorella equigenitalis*, from infected stallions to mares. They found that growth of the bacterium was "significantly inhibited" by the antibiotics and that mares bred with this semen did not become ill, whereas all mares bred with raw (not extended), infected semen developed CEM.

"The risk of transmission of CEM can be significantly reduced by mixing semen with extenders containing antibiotics," summarized Macpherson.

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Embryo Biopsy "Exciting advances in embryo biopsy techniques for diagnosing genetic diseases were revealed in 2010," said Macpherson. In humans, she added, this technique is commonly used to screen for genetic disease before implanting embryos created by *in vitro* fertilization.

Texas A&M University researchers have found good success with biopsying equine embryos that were 6-8 days old, then transferring the embryos into mares or freezing them for later use. Fresh, shipped embryos still yielded better than 75% pregnancy rates.

Diseases detected in the biopsied cells



included hyperkalemic periodic paralysis (HYPP) and hereditary equine regional dermal asthenia (HERDA). Embryo sex was also determined.

“This laboratory is working hard to perfect gene amplification procedures to allow for diagnosis of additional diseases,” Macpherson said. (For more information, see “Assisted Reproduction in Horses: Practical Usage,” TheHorse.com/17738)

Another study, this one from the University of Kentucky, also looked at vitrification (freezing) of biopsied embryos.

“In this groundbreaking study, transfer of frozen/thawed embryos subjected to biopsy resulted in a 75% pregnancy rate at Day 14,” reported Macpherson. “Three live foals were born from these biopsied embryos, including the first reported live foal following these procedures. Successful embryo biopsy for pre-implantation genetic diagnosis of equine diseases may revolutionize the way we manage genetic diseases in horses.”

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Early breeding is especially important for maiden and barren mares to give them optimal earlier foaling dates and reduce the chances they'll miss a season.

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Top Lameness/Surgery Studies

Diagnostic Techniques Veterinarians are always looking for improved diagnostic methods. Palmer discussed several studies on diagnostic techniques, including one study from *Equine Veterinary Journal (EVJ)* in which researchers compared different culture techniques for growing bacteria from synovial (joint) fluid. They found that use of enriched blood culture media increased the likelihood of obtaining a positive culture, which can help veterinarians be more successful in treating joint infections.

The second study correlated bacterial cultures from synovial fluid to survival rates of horses with joint infection. “Twenty-one percent of horses with positive cultures (containing bacteria) were euthanized vs. 1.4% of controls,” commented Palmer. He also noted that horses with *Staphylococcus aureus* cultured from their joints did not fare as well as those without.

Another *EVJ* study evaluated the potential use of biomarkers found in a horse's serum for predicting musculoskeletal injury. “Biomarkers have the potential to be used

as a screening aid prior to musculoskeletal injury,” wrote the authors. The researchers found seven markers that often correlated with injury, and that were deemed “promising but still not ready for prime time” according to Palmer.

Another potential screening tool was discussed in an *American Journal of Veterinary Research (AJVR)* study where researchers investigated whether fragments of certain types of collagen (a structural protein) found in synovial (joint) fluid and/or serum might indicate joint injury in that horse. The investigators determined that levels of these collagen fragments in serum and synovial fluid, along with the ratio between them, “could be used to detect horses with joint injury,” wrote the authors.

Palmer also discussed a study of diagnostic analgesia (nerve blocks) in horses, specifically the low four-point block used to numb structures at and below the fetlock joint. The researchers' goal was to determine if this block might also inadvertently anesthetize other structures higher in the limb, using contrast radiography to see where the anesthetic solution might spread after injection. They found that anesthetic from this block was unlikely to spread upward and anesthetize the upper cannon bone region. They also noted that the deep digital flexor tendon sheath was often inadvertently punctured when performing this block. “For this reason, it's extremely important to use aseptic



technique (when performing this block)," advised Palmer.

An *EVJ* study on flexion tests for localizing lameness to the fetlock joint found that pain in the fetlock joint itself was most likely to contribute to a positive test. The researchers found that flexion of the distal interphalangeal joints was unlikely to cause a positive flexion test in normal horses and urged veterinarians and horse owners to interpret positive fetlock flexion tests with caution during a pre-purchase examination.

However, Palmer commented, "Don't throw the baby out with the bathwater." In his experience, inflammation of the coffin joint can also result in a positive flexion test in some cases. Palmer felt that the flexion test remains an important part of the pre-purchase examination.

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Racing Topics

Palmer discussed a number of studies on racehorses, including one in the *AJVR* on the effects of early exercise on future soundness. "Moderate, controlled exercise can be safe at an early age (from 3 weeks to 18 months of age)," summarized Palmer. Indeed, the authors of this study suggested that early exercise might even help

protect joints from future injury (although more research is needed).

Another report presented during The Jockey Club Safety and Welfare Summit in 2010 (based on information in the Equine Injury Database) looked at racing surfaces (i.e., turf [grass] vs. dirt vs. synthetic). Palmer described four myths dispelled by this preliminary study:

Myth 1 Synthetic surfaces reduce fatal musculoskeletal injury (no difference was actually found)

Myth 2 Injuries occur when horses move from turf to other surfaces (the data disagree).

Myth 3 2-year-old horses are at greater risk of injury than older horses (the data say it's the other way around).

Myth 4 Fillies are at greater risk of injury than colts (again, the data say the opposite is true).

"One thing is for sure: Track maintenance is key," said Palmer.

Identifying horses at risk for fracture at the racetrack is a high priority. In the past

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year a number of papers compared diagnostic techniques for detection of changes in bone that might predispose a horse to fracture.

An *AJVR* study investigated proximal sesamoid bone fractures (behind the fetlock) and found that racehorses with these fractures had evidence of excessive remodeling and porosity of their sesamoid bones that likely predisposed these horses to complete fracture and catastrophic injury. The authors also suggested that detection of these focal areas of injury/remodeling could help to identify horses at risk for this type of fracture and prevent catastrophic injury (i.e., by not racing horses with this type of injury as they are more likely to break down).

Another study that evaluated early injury detection by use of scintigraphy (bone scan) in racehorses found increased radio-isotope uptake (indicating bone remodeling) in the lower joint surface of the cannon bone. Researchers on this study (published in *EVJ*) found that scintigraphy was good for detecting horses with this early bone injury, but it did not help veterinarians determine which horses should safely continue in training and which ones should be taken out of training to prevent further injury.

Yet another study focusing on the early detection of bone damage in the fetlock joint compared digital radiography, magnetic resonance imaging and computed tomography as screening techniques to identify changes in the cannon bone that often lead to fracture. Researchers found that digital radiography underestimated such damage, while computed tomography (CT) and magnetic resonance imaging (MRI) were able to detect it. Unfortunately, CT and MRI with high-resolution capability require use of general anesthesia, which prevents them from being used as routine screening tools.

“Standing MRI may be a good tool [for identifying horses at risk for fracture], but it is very operator-dependent and false negative results are a significant concern,” Palmer commented.

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Musculoskeletal Therapy

Finding problems is important, and so is treating them properly. Palmer next discussed treatments for a number of musculoskeletal problems, starting with a review of literature on the use of corticosteroids for reducing joint inflammation in the horse (published in *EVJ*).

“Intra-articular corticosteroids (injected within the joint) are a hot button in practice,” Palmer commented. “Used in conjunction with disease-modifying medications like hyaluronic acid, they are extremely useful to reduce joint inflammation.”

Another study on corticosteroids (in *AJVR*) evaluated whether triamcinolone acetonide (TCA) injected into the coffin (distal interphalangeal) joint would diffuse into the navicular bursa (thus potentially medicating both areas). The researchers found that TCA did migrate into the navicular bursa of sound horses, even when hyaluronic acid was mixed with it. This strategy “can potentially be used for treatment of navicular syndrome, but further studies are needed,” wrote the researchers.

One such study was presented during the American College of Veterinary Surgeons (ACVS) symposium and evaluated the same question in horses with clinical navicular syndrome. The authors of this paper found that diffusion of TCA from the coffin joint to the navicular bursa worked in clinical cases as well as in normal horses.

The next study he discussed evaluated the use of intra-articular vs. intravenous morphine for experimentally induced synovitis (joint inflammation), and found that the intra-articular route was more effective in reducing lameness. “Intra-articular morphine treatment may be a useful adjunct to other pain management modes after a painful joint surgery,” Palmer noted.

Stem cells are a hot topic for treating

various injuries, and two studies focused on this area. One published in *EVJ* compared embryonic stem cells and mesenchymal stromal (bone marrow) cells in terms of their behavior when injected into an experimentally induced injury in the superficial digital flexor tendon. Researchers found that embryonic stem cells did not cause immune reactions in the 90-day study period, and they migrated to other areas of damage while mesenchymal stromal cells did not.

The second stem cell study also supported the use of embryonic stem cells for healing tendon injuries, noted Palmer.

The final study he discussed evaluated the use of biophosphonates in horses; this class of drug is used to prevent bone loss (for example, to prevent or combat osteoporosis in older women). In horses, it has been used to treat navicular syndrome, subchondral bone cysts, osteoarthritis, stress remodeling and other lameness conditions. This study, published in the *ACVS Proceedings*, evaluated the use of zoledronic acid for treatment of 23 horses with a variety of lameness conditions and reported that 16 of them returned to their original use.

“Zoledronic acid may be useful to treat certain lameness conditions, but controlled studies are warranted,” noted Palmer. “We don’t know a lot about this medication. It’s being used to treat a variety of conditions in horses in the belief that it will decrease osteolytic (bone-destroying) processes that may contribute to lameness problems in horses, some of which may play a role in catastrophic injury.”

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Additional Topics

Palmer also discussed a few surgical techniques and other studies as follows:

One study in *AJVR* on common wound flushing techniques found that the ideal fluid pressure for flushing joints was best achieved by use of a one-liter bag and pressurized cuff. Use of syringes to flush wounds can produce high enough fluid pressures to damage tissues.

A *Journal of the American Veterinary Medical Association (JAVMA)* study on a technique for partial phallectomy (partial removal of the penis) found that linear urethrostomy followed by placement of a band tourniquet above the area of disease or injury, then removal of the part of the penis below the tourniquet, was an effective method. "This can be done in the standing horse, which is good for older or debilitated horses that can't undergo general anesthesia," said Palmer.

Mitomycin C was found to be effective for combating squamous cell carcinomas near equine eyes in a *Veterinary Record* study, whether used alone or in conjunction with surgical removal of the lesion.

Researchers in one study published in *Veterinary Surgery* found that the interior of mares' abdomens could be easily and safely visualized by inserting an

endoscope through a small incision made in the vagina (thus creating no external incisions). Palmer reported that the technique provided good visibility of abdominal contents and the incisions healed without incident.

One study discussed a surgical technique for stitching together the ends of a severed tendon. This novel technique required patience to learn, said Palmer, but it showed superior strength to conventional suture patterns.

Lastly, Palmer referenced a study on cryotherapy (cold therapy) for treating laminitis. This study found that ice bags and water boots each cooled blood within the blood vessels of the foot by 20 degrees (F) for a two-hour period. The study was also discussed during the AAEP's Joints and Foot Lameness session.

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Top Equine Medicine Studies

Metabolic Syndrome, Equine Cushing's Disease, and Laminitis Metabolic syndrome is a widespread problem in horses, as is the laminitis that's often associated with it.

"Laminitis is one of the most important issues facing all of us in veterinary practice," said Reed. He discussed several studies and scientific communications related to metabolic syndrome and equine Cushing's disease, starting with a consensus statement from the American College of Veterinary Internal Medicine (published in the *Journal of Veterinary Internal Medicine, JVIM*) covering characteristics, diagnosis, and management of equine metabolic syndrome (EMS).

"Equine metabolic syndrome is characterized by regional adiposity (fat deposits), insulin resistance, and a predisposition to developing laminitis," summarized Reed. "Insulin resistance is characterized by hyperinsulinemia (high levels of insulin in the blood) and abnormal response to glucose/insulin testing. These horses have hyperinsulinemia in the absence of stress, pain, or recent feeding; sometimes the blood samples even look different grossly (to the naked eye). Dietary management includes reducing the energy provided in the diet, feeding lower levels of nonstructural carbohydrates (NSC), limiting access to pasture grass. Increasing physical activity is critical."

Veterinarians on a *JVIM* study compared the composition of fat in different places on EMS-affected horses' bodies, and they found that fat in the nuchal ligament (in the neck) had higher levels of pro-inflammatory cytokines (mediators of inflammation) than fat in other locations,



Horses with large crests of fat on their necks were at higher risk for insulin resistance, and this area of the horse seems to adopt an inflammatory state more quickly than other areas.

CHRISTY WEST



and that these levels seemed unaffected by the horse's systemic (body-wide) level of insulin resistance. Reed commented that horses with large crests of fat on their necks were at higher risk for insulin resistance, and that this area of the horse seems to adopt an inflammatory state more quickly than other areas.

One issue with studying metabolic syndrome is that it can be hard to differentiate from pituitary pars intermedia dysfunction (also called equine Cushing's disease), noted Reed. While discussing two JVIM studies on hormone testing in horses presumed to have Cushing's disease, he commented that Cushing's disease often affects older horses than EMS does, and diagnosis can be difficult due to seasonal variations in the hormone levels used for diagnosis. However, insulin levels did not vary by season, so high levels "should raise suspicion of EMS, ECD, or both," wrote the study authors.

Cushing's horses "have cresty necks, long coats that fail to shed properly, polyuria (excessive urination) and polydipsia (excessive thirst), ravenous appetites, are prone to laminitis, and may or may not be obese," Reed noted.

Back to insulin resistance, another study in this area (in *AJVR*) found that pre-treatment of horses at risk for endotoxemia (such as those with colic or carbohydrate overload) with levothyroxine could inhibit laminitis caused by endotoxemia-induced insulin resistance. "Figuring out ways to prevent secondary laminitis is critical," Reed commented.

Metformin is one medication that's sometimes recommended for treating insulin resistance. However, researchers on a study published in *AJVR* reported that metformin has low bioavailability in horses, which could be why it sometimes garners poor long-term results.

Investigators completing an *AJVR* study on the effects of weight gain on hormone profiles found, unsurprisingly, that feeding horses double the calories recommended resulted in increased insulin resistance that was compensated for by increased insulin secretion (hyperinsulinemia). Hyperleptinemia (high levels of leptin hormone, which reduces appetite) was also observed.

"Preventing obesity is a potential strategy to help avoid insulin resistance, hyperinsulinemia, and hyperleptinemia in

horses," wrote the study authors.

Finally, Reed touched on a paper published in *EVJ* regarding equine clinical genomics, or study of the horse's genetic code and inherited diseases. "Several groups are using the horse's genetic sequence to study diseases such as hyperkalemic periodic paralysis, and people are also interested in using this to investigate EMS," said Reed. "We can submit blood samples to Dr. Molly McCue at Minnesota for horses that have the characteristic EMS phenotype, so perhaps they can identify a genetic marker for the disease."

All three presenters acknowledged the difficulty in managing and feeding horses with EMS. Palmer commented, "Owner compliance can be a real problem; they might say, 'Doc, he only gets a handful of this or that, so how do you restrict them further?'"

“Even pasture is not always your horse's friend, because grass at certain times of the year can be a big predisposing factor to developing laminitis.”

DR. STEVE REED

"It's very difficult," admitted Reed. "Owners need to be aware that you're not being kind to these horses when you put them outside at certain times of the year. Even pasture is not always your horse's friend, because grass at certain times of the year can be a big predisposing factor to developing laminitis."

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INFECTIOUS DISEASE

Equine Herpesvirus Equine herpesvirus (EHV) can cause respiratory disease, neurologic disease, or abortion. It can become dormant in the horse's body but recrudescence (reactivate) when the horse is stressed, which has been suspected to cause outbreaks of associated disease. In one JVIM study, investigators infected horses with EHV, then stressed them four months later with dexamethasone (a corticosteroid, which reduces immune function and can be used to treat allergic reactions and other inflammatory conditions). The virus reactivated and subsequently was detected in blood and nasal secretions of all horses, and one developed a fever, but uninfected horses placed in contact with those horses did not become ill.

Another JVIM study on EHV highlighted the extremely contagious nature of the virus in the context of a nosocomial (hospital-acquired) outbreak of the disease at a university equine hospital following admission of an infected horse. The index case was handled with "strict infection control procedures," yet six other horses became infected and two caused outbreaks at their home farms afterward.

"We must have preplanned infection control programs and the virus may still move from horse to horse, so early detection and isolation with a strict protocol is essential," Reed commented.

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Lawsonia intracellularis *Lawsonia intracellularis* can cause weight loss, loose feces, edema, and hypoproteinemia (low



protein levels) in foals. Reed discussed a JVIM study that confirmed foals could acquire the disease from ingesting feces or food contaminated with feces from infected foals. The infected foals began shedding *L. intracellularis* in their feces 12-18 days after infection and shedding lasted for seven to 21 days.

"At least this disease is treatable with simple antibiotics, usually oxytetracycline," Reed commented.

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Salmonella Authors of another hospital infection report described an outbreak of *Salmonella* Newport that affected 61 animals in a veterinary teaching hospital, killing 36% of them and necessitating closure of the hospital for thorough decontamination and remediation of biosecurity. Study authors estimated the costs of the outbreak at \$4.12 million.

"The biggest benefits of rigorous infection control and surveillance strategies are earlier detection (of highly infectious organisms like *Salmonella*), earlier cessation (shorter outbreaks), and improved ability for aggressive intervention," said Reed.

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Equine Piroplasmiasis Piroplasmiasis, caused by the organisms *Babesia caballi* and *Theileria equi*, is a disease found worldwide that causes anorexia, anemia, fever, malaise, and icterus (jaundice) in horses. "This disease recently re-emerged in the United States; it's a persistent infection but often clinical signs are nonspecific," said Reed. Following discussion of a Parasitology Research paper, he added, "Serologic tests are useful for detecting latent infection."

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Antibiotic-Resistant *Rhodococcus equi* *Rhodococcus equi* causes sometimes-fatal pneumonia in foals, and is a "big problem in foals three weeks to five months of age," said Reed. In this study (published in *JAVMA*, researchers found that while infection with antibiotic-resistant *R. equi* was not common (3.7% of submitted *R. equi* samples), 63.2% of those resistant isolates were resistant to more than one antimicrobial, and foals infected with those strains were nearly seven times more likely to die from their infections. The study authors emphasized the value of culturing the causative organism in foal pneumonia cases, and determining susceptibility of the organism to antibiotics to treat the disease successfully.

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Heart Problems in Racehorses

Reed discussed three studies on cardiac (heart) function in racehorses, starting with one *JVIM* article in which veterinarians sought to investigate heartbeat variations in healthy racing Standardbreds. The researchers found that "arrhythmias occur frequently in racing Standardbreds during cardiac deceleration (when slowing down after a race). ... Circumstances imposing unusual demand and racing at the trot appear to predispose (horses to arrhythmia). These findings provide insight into possible mechanisms of sudden death."

Researchers on a second *JVIM* study with a similar goal used a sophisticated treadmill evaluation along with echocardiography, Doppler imaging, and speckle tracking to investigate left ventricular function (activity of the left lower chamber of the heart) in healthy horses. "This is important because if we could learn about stress echocardiography in horses, we could target certain diseases and investigate medications that are important in management and performance issues," explained Reed.

Lastly, investigators on an *AJVR* study evaluated the use of a horse-side analyzer for cardiac troponin I, a protein involved in heart muscle contraction. The authors found that the horse-side analyzer

compared well against a laboratory test, but Reed commented that it took significant induced cardiac disease to detect differences in cardiac troponin I levels.

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Respiratory Disease

To study treatments for a disease, one must be able to first induce the disease. Reed described one study from *AJVR* in which researchers found that a combination of certain fungal spores, lipopolysaccharide, and silica microspheres worsened recurrent airway obstruction (RAO) in susceptible horses.

"This appears to provide a useful model for future research," he commented.

A research team on another RAO study, this article from *JVIM*, reported an association between RAO and increased parasite resistance. A third study (from *EVJ*) was the first to show improvement in RAO-affected horses with oral prednisolone medication, and also found that low-dose oral dexamethasone was effective (even more so than prednisolone).

Researchers also investigated genetic markers for a form of RAO known as summer pasture-associated obstructive pulmonary disease (striking horses on summer pasture rather than those in dusty barn environments), and reported that the disease was a "multifactorial, complex form" with several genes involved."

Lastly, Reed discussed an *EVJ* study in which veterinarians compared horse owner-assessed respiratory signs (RAO-affected horses' clinical signs graded by owners on a scale of 1-4) with thorough veterinary examination of the lower respiratory tract. The researchers reported that horse owners' assessment of their horses' respiratory disease correlated well with the veterinary evaluation.

"Listen to owners—they know their horses," commented Reed.



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Neurologic Diseases

"I couldn't be here without talking a little about neurologic problems," said Reed—known for his interest in neurologic disease—with a smile as he began his final Kester News Hour segment. First, he described an *EVJ* study in which researchers described in detail the anatomy of the articular process joints in the neck, which had not previously been described. This has bearing on evaluation of horses with neurologic problems that could be attributed to compression of the spinal cord in the neck.

"By taking variations of straight lateral and angled radiographs of the neck, one could see bone changes (potential joint problems) and identify which side of the neck they were on," explained Reed.

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Equine Protozoal Myeloencephalitis Testing

Reed also discussed equine protozoal myeloencephalitis (EPM), which commonly affects horses yet is not easy to definitively diagnose in living animals. Researchers on a *JVIM* study compared two diagnostic tests for the disease in living horses, and they found that the immunofluorescent antibody test (IFAT, or Western



ANNE M. EBERHARDT

The anatomy of the articular process joints in the horse's neck has bearing on the evaluation of horses with neurologic problems.

blot) was more sensitive for detecting the disease than the enzyme-linked immunosorbent assay (ELISA).

Also in the realm of EPM testing, a report in *Veterinary Parasitology* described a modification of the ELISA test to detect more surface proteins characteristic of the causative organism *Sarcocystis neurona*, thus making the test able to account for slight genetic variations of the organism (and, thus, more sensitive for detecting the organism).

Yet another study (from *JVIM*) involved testing for antibodies to EPM rather than the causative organism itself, and researchers on the paper reported good results with this method. Additionally, this testing method was not compromised when a sample of cerebrospinal fluid (CSF, which surrounds the brain and spinal cord) was contaminated with blood by the sampling process.

Finally, Reed mentioned a study discussed at the 2010 American College of Veterinary Internal Medicine conference that showed a paired ELISA test developed at the University of Kentucky's Gluck Equine Research Center, designed to be run simultaneously on blood and cerebrospinal fluid, was effective at detecting EPM. Also, the researchers found that the ratio of antibodies in serum compared to CSF was an effective indicator of EPM.

"This study verified that analysis of both serum and CSF from horses suspected to have EPM is more beneficial than examination of serum alone," wrote the authors (including Reed).

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Kester Tips of the Hat

The Kester News Hour always features Tips of the Hat, which are salutes to outstanding veterinarians, programs, etc. This year the tips of the hat included Texas A&M University volunteers and students for supporting future veterinary students with wet labs for more than 200 students (these were "arguably the most comprehensive hands-on experience for students available," commented Reed). The labs are planned by a group of 18 veterinary students, and many university staff, private vets, and sponsors donate time and materials to educate these students at minimal cost to them.

The second Tip of the Hat went to the organizers and supporters of the Opportunities in Equine Practice seminar, held in Lexington, Ky. The seminar is organized by Bill Rood, DVM, co-owner of Rood & Riddle, with support from private practitioners and the AAEP Foundation, and more than 3,500 students have attended in its eight years of existence.

"It's the largest recruitment and career forum out there," said Reed. 🐾

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Keynote: Unwanted Horses

BY ERICA LARSON

Equine welfare and the growing population of horses needing homes are quickly becoming some of the major challenges veterinarians face on a daily basis, according to Tom Lenz, DVM, MS, Dipl. ACT, who delivered the keynote speech entitled “Horse Welfare Wars: When Emotion and Fact Collide” at the convention. Lenz reviewed how he believes the issue of unwanted horses arose, urging veterinarians to confront the issue and educate owners on how they can help combat it, while offering some suggestions on how the industry as a whole might greatly reduce the number of unwanted horses in America.

According to Lenz, the problem is not one that’s likely to be resolved quickly and easily: “The more you know about the unwanted horse issue, the more complicated the solutions become,” he noted.

Unwanted horses, said Lenz, are horses that are no longer wanted by their current owners because they are old, injured, sick, unmanageable, or simply fail to meet the owners’ expectations. “Welfare is defined as the physical and psychological state of the animal,” Lenz said. He added that good welfare is generally described as meeting the horse’s physiological, psychological, and safety needs.

Lenz believes the closing of American equine processing plants is one of several issues that led to the proliferation of unwanted horses and equine welfare situations. Others include the economic recession, which has decreased the market for horses, and irresponsible ownership that has resulted in overbreeding in some segments of the industry.

“We don’t eat horsemeat in America, but we had three plants that processed horses for human consumption (in other countries),” Lenz said, reflecting on the early days of the anti-slaughter movement in



Lenz defined unwanted horses as no longer wanted by their current owners because they are old, injured, sick, unmanageable, or simply fail to meet the owners’ expectations.

COURTESY/DR. JOE COLLINS

the United States. He explained that a nationwide controversy began as the public learned that these plants processed horsemeat for human consumption.

The issue is “complicated by a worldwide love affair with the horse,” he said. “Uninformed people with few to no ties to the equine industry care for horses and want to have a voice in how they are treated.”

The controversy led to some federal government officials introducing legislation that would close all the equine slaughter plants in the United States. After being approached by a government agency to provide an opinion on the situation, several AAEP veterinarians—including Lenz—traveled to Texas to evaluate the welfare conditions at the processing plants.

He said the team found that the horses awaiting processing were receiving good care, their welfare was not compromised at any time from arrival to time of slaughter, and that the horses were being euthanized in a humane manner under USDA veterinarian supervision.

Lenz admitted that transportation of horses to processing plants was an area of concern, however, as many horses were, and still are, transported in double-decker trailers meant for cattle. He reported that

there is currently legislation introduced in the House of Representatives to eliminate the use of double-decker trailers to transport horses anywhere in the United States.

“The AAEP’s position is not pro-slaughter—we support HR 305 (the Horse Transportation Safety Act of 2009) but oppose HR 503, which would outlaw the processing of horses for human consumption, because there are no provisions in the bill to provide for the care of unwanted horses, to designate an agency to enforce the law, or funding to support them,” Lenz said.

Despite the AAEP’s findings, the three equine processing plants closed due to state regulation in 2007 and according to Lenz, the number of unwanted horses in the United States began to rise shortly thereafter.

Years later, the negative effects of the closures are present more than ever, he said, noting that the action polarized the horse industry; the anti-slaughter contingency refused to reason with the pro-slaughter groups and vice versa. In addition, the average price for a mid- to low-end horse has plummeted due to the high numbers of them now available.

He also said that there has been a significant increase in abandoned and neglected horses because owners have few options if they are unable to sell, donate, or rehome their unwanted horses. As a direct result, about 70% of the United States’ rescue, retirement, and retraining facilities are at or near capacity, he explained, citing the 2009 Unwanted Horses survey conducted by the Unwanted Horse Coalition.

Another issue that arose during the processing plant controversy and the expansion of the unwanted horse issue was the increase in animal activist group activity. This, according to Lenz, has led to an increase in awareness among the public.



“Our views on animal welfare are conditioned by our personal knowledge base and life experiences,” Lenz said. The general public without a background in horses has only the knowledge they obtain from the activist groups; the activist viewpoint is usually fairly extremist, he added.

On the positive side, Lenz said, the amount of unwanted horses and the concerns about equine welfare have stimulated positive action in the horse industry. Rescue groups have taken in thousands of horses that have fallen into the unwanted category, and AAEP veterinarians have vaccinated thousands more horses cost-free to help the animals remain healthy as they begin new chapters in their lives.

Even with the support of equine rescues and groups like the AAEP, finding a solution for the unwanted and neglected horse problem remains a challenge for equine practitioners and the industry in general.

“There is no definitive answer,” Lenz said. “In a perfect world all welfare solutions would be based on science, such as

(the horses’) health and biological function (as opposed to emotion). In reality, though, science is often ignored if society believes something is wrong.” Lenz added that emotions often take over because society views animal welfare as a moral issue rather than a scientific issue, and people tend to be quick to blame when someone cares for animals differently than they would.

“We must learn to accept that there is a societal aspect to horse care and use, and also that different perspectives are valid,” he continued.

Lenz cited responsible ownership as one of the simplest solutions to the unwanted and neglected horse problem. He also suggested that although reopening the processing plants (with greater regulation over the transportation of the horses) might not be the ideal option for dealing with unwanted horses, it would aid greatly in controlling the number of unwanted horses in America until the industry can develop resources to eliminate the need.

Next, he suggested looking at the big

picture for a solution. Overemphasis on one point is counterproductive, he added. By dismantling a situation and analyzing each aspect of the animals’ welfare, he explained, a full understanding of whether the situation is truly unethical is easier to come by. For example, solely looking at the feed a horse is offered or the amount of time they are kept in—or outside of—a stall on a daily basis does not provide an accurate reading of whether a caretaker is infringing upon a horse’s welfare.

Finally, he suggested that the horse world come together and work for the ultimate goal: to stop horse neglect and control the unwanted horse population in America.

“We as veterinarians have to take a firm position in the middle, and be willing to make a change,” he concluded. 🐾

MORE ONLINE See TheHorse.com/AAEP2010
Watch an interview with Dr. Lenz, TheHorse.com/Video.aspx?vID=469.

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Equine Welfare

BY ERICA LARSON

Equine Welfare Issues: An Overview

One of the AAEP's ongoing goals is to address the welfare issues that many horses and their owners face. Midge Leitch, VMD, of Londonderry Equine Clinic in Pennsylvania and immediate past chair of the AAEP Welfare Committee, described three key steps the AAEP has taken—and continues to take—to improve equine welfare in the United States.

The Unwanted Horse: The Beginning She began by describing the phrase, “unwanted horse.” The first time that many Americans heard this was in 2005, when the AAEP hosted the first Unwanted Horse Summit, a one-day conference at which presenters and attendees addressed apparent welfare issues in the industry.

The Unwanted Horse Coalition (UHC) was born out of the summit. According to the UHC website, the group “represents a broad alliance of equine organizations that have united under the auspices of American Horse Council to educate the horse industry about the unwanted horse issue.”

The UHC has supported and continues to back the welfare mission through measures that include hosting low-cost gelding clinics, developing a welfare speaker series and launching/distributing a newsletter designed to educate readers about responsible ownership, including breeding practices and equine welfare.

Tennessee Walking Horse Issues Next on Leitch's agenda were the steps taken by the AAEP to improve the welfare of Tennessee Walking Horses, which are often the victims of soring (deliberate injury to a horse's legs to achieve an exaggerated “big lick” gait) and other illegal practices. She noted that many members of the Tennessee Walking Horse community have been operating in violation of the Horse Protection Act (HPA) of 1970 by continuing to practice soring techniques on their horses.

The AAEP Welfare Committee convened a task force to evaluate the problem in December 2007, she noted, and by July, 2008 the group had drafted a white paper



An “Equitarian” conducts a deworming clinic for horse owners in the developing world.

addressing the issues and recommending steps to bring an end to these inhumane practices. As a direct result of the white paper, the USDA introduced thermography as a screening process to detect inflammation or irritation of the lower legs during pre-competition examinations. In 2009 the task force addressed the more recently utilized soring technique of pressure shoeing—a method that makes a horse's forefeet tender and results in the same exaggerated gait known as the “big lick.”

She added that the USDA's Animal and Plant Health Inspection Service, in its efforts to enforce the HPA by inspecting horses at competitions for any signs of soring or pressure shoeing, has most recently implemented a protocol that sets minimum uniform penalties for soring, using foreign substances on horses or failing to pass equipment and shoeing inspections.

“It is gratifying to see that both the USDA and elements of the Tennessee Walking Horse industry have been receptive to the recommendations of this task force,” Leitch said.

Equine Welfare Committee The final aspect of equine welfare that Leitch discussed was goal-setting for the AAEP Welfare Committee.

“The AAEP Welfare Committee is member-driven,” Leitch said, explaining that the issues the committee explores are those that the membership considers top priority. A recent survey of the AAEP membership showed the top five concerns within the veterinary community to be unwanted horses, slaughter-related problems, racing issues (such as breakdowns, retirement and medication abuse), the soring of Tennessee Walking Horses and American Saddlebreds and wild horse management.

Leitch said that in May 2010 the Welfare Committee convened at a meeting to examine responses to the membership survey. Stemming from the discussions that took place, the committee agreed to begin:

- ☒ Drafting a position paper on principles of equine welfare;
- ☒ Examining nonracing performance horse medication, procedures, and treatments;
- ☒ Expanding media assistance programs, crisis communications, and emergency response;
- ☒ Responding to the BLM's (Bureau of Land Management) request to review the care and handling of animals within its Wild Horse and Burro Program;
- ☒ Pursuing federal legislation to strengthen



the HPA (a task that was referred to the AAEP Public Policy Committee);

- ☒ Providing education to AAEP members about abuse and neglect, rehabilitating malnourished horses and assisting rescue and retirement facilities;
- ☒ Engaging the horse industry as a whole in recognizing and prohibiting abusive training and treatment procedures; and
- ☒ Developing proactive programs for responding to current, as well as future (or new) welfare issues.

"It is our mission that all members recognize the importance of equine welfare in their daily personal and professional lives and advocate for its advancement throughout their careers," Leitch concluded. "Knowing the issues and understanding the facts, the perceptions and the actions provides all of us the ability to comment on and discuss the many concerns of our clients. If we—the collective horse world—do not lead, a poorly informed (non-equestrian) public will determine the outcome."

Responsible Horse Ownership and Racing Reform

Responsible ownership is one of the keys to addressing the country's equine welfare problems, said Scott Palmer, VMD, of the New Jersey Equine Clinic. He noted that racing is one segment of the horse industry that regularly is subject to public criticism, mostly due to catastrophic injuries sustained by race horses. Palmer described responsible horse ownership and the need for reform in some aspects of the racing industry at the meeting.

"Responsible horse ownership must first address the basic needs of the horse, including food, shelter, and health care," Palmer said. "Their well-being must be a priority, and we need to recognize that this stewardship represents significant time and financial commitment."

He described the basic needs of the horse, the financial hardships that some horse owners face, and the challenges that arise because understanding of equine welfare and definitions of appropriate standards of care vary among individuals and organizations.

"Both science and society have a role to play in deciding what constitutes an appropriate level of animal welfare," Palmer wrote in his study. "Whereas science can determine what type or degree of animal

welfare risk exists under specific circumstances, science cannot determine what type of risk is acceptable." In other words, defining appropriate welfare risk is subjective and innately complex.

Palmer explained that the ethics of horse racing, for example, has come under fire. Some organizations label racing as objectionable due to equine welfare concerns. At the same time, the American Veterinary Medical Association views the sport as acceptable. Such conundrums illustrate the complexity of equine welfare issues.

Palmer added that the racing industry has been working to improve the safety and welfare of the horses involved.

"The NTRA (National Thoroughbred Racing Association) created the Safety and Integrity Alliance in 2008 to address five major areas that were felt to be critical to the safety and integrity concerns of racing fans," Palmer said. The five areas the alliance opted to focus on were all veterinary-

and licensing, and transitioning racehorses into second careers, Palmer reported.

"The welfare and safety issues of racing, while extremely important, are only one segment of our larger responsibility to be good stewards of the horse," he said. "Recommendations by the AAEP Racing Committee are applicable to all performance horse disciplines. The fundamental assumption underlying AAEP Racing Committee recommendations is: What is good for the horse is good for the sport.

"This is the lens through which we must view the everyday welfare challenges of equestrian sport," he added. "Although winning is the obvious goal of competitive equine sporting events, we must remain focused upon the fundamental obligations inherent in our stewardship to the horse. To the degree that we lose sight of that focus, both the horse and the sport as a whole will suffer."

Equine Welfare: One European Perspective

The horse industry in the United States is not the only one dealing with an equine welfare problem. Some European countries are also facing challenges in assuring all horses have a good quality of life, according to Joe Collins, MVB, PhD, MRCVS, CertEP, CertVR, who recently conducted his PhD study at University College Dublin's Veterinary Sciences Center.

Collins and his colleagues visited specific locations where poor equine welfare was evident, including horse fairs and sale venues, horse farms and horse dealer premises, animal sanctuaries and rescue centers, and horse competition events. As in the United States, some horses were found to be malnourished, living in less-than-ideal conditions, or dead.

Additionally, Collins conducted an in-depth study of the number of horses processed and of the disposal of horses. Collins said that the recorded number of horses slaughtered in Ireland for human consumption abroad each year has been on the rise—from 614 slaughtered in 2005 to 3,163 in 2009. He added that it is unclear how many horses are exported to Great Britain for processing in government-approved plants there, as there is essentially free movement of horses between the two countries. Currently, five government-approved processing plants are open in Ireland, with a sixth scheduled

“The fundamental assumption underlying AAEP Racing Committee recommendations is: What is good for the horse is good for the sport.”

DR. SCOTT PALMER

related: medication and testing, injury reporting and prevention, safety research, creating a safer racing environment, and the care of retired racehorses.

The AAEP Racing Committee has drafted white papers on Thoroughbred, Quarter Horse, and Standardbred racing, which address welfare issues specific to these racehorses, he noted. The group also recently drafted "Clinical Guidelines for Veterinarians Practicing in a Pari-Mutuel Environment," a document designed to help vets who are making welfare and ethical decisions at the track that will support the health and welfare of the horse.

The Jockey Club and the Grayson-Jockey Club Research Foundation held a Safety and Welfare Summit recently that addressed topics such as racing equipment and safety, racetrack environment and training practices, continuing education



to open in mid-2011, Collins said.

In addition to observing the welfare situation in Ireland, Collins and his team conducted a survey of horse owners about the current state of equine welfare in their region. He said that respondents suggested additional regulation and enforcement was the best way to address poor equine welfare. He explained that respondents said a "lack of awareness, or the desire not to know (about the current welfare situation in their region)," was a recurring trend that likely adds to the equine welfare crisis.

Collins said that "there was a consensus among industry players in Ireland that welfare standards for horses ... should be raised, but there was little agreement on how and whether that could be achieved." He added that while work is ongoing to educate owners about responsible horse keeping, veterinarians must step up and use their voices to advocate for improved standards of equine welfare.

"The fundamental issue underpinning all horse health and welfare issues was the need to adopt and enforce a robust system of horse identification, ensuring that owners are legally linked to the horses in their care," Collins said.

Use and Abuse of Medications at Horse Shows

"The use of medication in horses competing at equestrian events is a very polarizing topic," said Marjorie W. Miller, DVM, an equine veterinarian from Bradenton, Fla., with 20 years experience in performance horse practice." Some people believe that medication has no place in equestrian sports, and others believe that the judicious use of medication is in the best interest of equine health and welfare."

Miller discussed medication rules from several equestrian governing bodies as well as the role of vets in equestrian sport.

National and International Rules Miller began by reviewing the United States Equestrian Federation (USEF) medication definitions. A forbidden substance is anything that "contains an ingredient or a drug that might affect the performance of a horse or pony by acting as a stimulant, depressant, tranquilizer, local anesthetic, or psychotropic (a mood- and/or behavior-altering substance), is potentially dangerous to the horse, or interferes with drug detection procedures." By definition, even products claiming to be nontestable at

USEF competitions are illegal by virtue of their claims to alter performance.

Restricted substances are medications allowed for use with quantitative (measurable) limits and "require a medication form to be completed and turned into the appropriate show official." These are the drugs with the greatest potential for misuse as owners, exhibitors, and trainers mistake "legal" with "safe." Restricted substances include certain non-steroidal anti-inflammatory drugs (NSAIDs), dexamethasone, and methocarbamol.

In addition to the national governing body's medication rules, Miller discussed how the Fédération Equestre Internationale (FEI) approved its 2011 Prohibited Substance List in early November 2010 at the organization's General Assembly in Chinese Taipei. The list does not allow the use of NSAIDs in competition, but the FEI agreed to provide a greater level of guidance regarding the detection times for the post-event usage of certain NSAIDs,

“A lame or sick horse should never be asked or allowed to compete.”

DR. MARJORIE MILLER

specifically phenylbutazone (Bute) and flunixin meglumine (Banamine), in commonly-used low dosages. The list also bans the use of salicylic acid (the root compound in aspirin) at events.

The Veterinarian's Role "Veterinarians have a primary role in protecting the health and welfare of the horse, and decisions regarding the dispensing or administration of therapeutic medications should be based upon the specific health concerns of each individual horse," Miller said. "All medication should be dispensed within the context of a valid client-patient relationship."

A valid client-patient relationship requires the veterinarian to take responsibility for medical and treatment judgments for the horse, the client to agree to follow the veterinarian's instructions, the veterinarian to have knowledge of the horse and its medical condition obtained by examination, and the veterinarian to be available for follow-up and have emergency coverage in the event of adverse reactions or failure of the therapy.

"Veterinarians have a responsibility to maintain the integrity of their profession and not dispense bottles of medications just because these medications are 'legal' at the horse show," Miller said.

Miller added that veterinarians are responsible for educating clients about the medications they prescribe and for helping clients understand when medication is safe for the horse to be used in competition.

She is adamant that "a lame or sick horse should never be asked or allowed to compete, and it is the responsibility of every individual involved in equestrian sport to preserve the health, safety, and welfare of the equine athletes."

The Equitarians' Vision for 2011 and the Future

More than 100 million horses, donkeys, and mules worldwide spend their days working for a living: not necessarily working on their sliding stops, tempi changes, or jumping technique, but working to provide their human families with a means of transportation and a source of livelihood. These equids represent not only the family horse but also an animal that is a major player in the global agriculture market.

Unfortunately, these animals don't always receive health care that meets the standards many veterinarians or horse owners would consider acceptable. But a group of veterinarians ("The Equitarians," led by Jay Merriam, DVM, of the Massachusetts Equine Clinic) has taken on the task of helping these working horses, mules, and donkeys. In turn, they're helping the animals' owners. Merriam described this movement and explained how veterinarians and equine enthusiasts in general can become involved in the mission.

With the support of the AAEP, The Donkey Sanctuary, Humane Society Veterinary Medical Association, and the University of Mexico (UNAM), a week-long Equitarian Workshop was held in Vera Cruz, Mexico, in October 2010. The purpose was to train practitioners to work in field conditions with actual communities where working equids are the source of work and survival. Twenty-six veterinarians from North America and an equal number from Mexico joined with the faculty of the UNAM veterinary school to teach and serve. Some key components of the session were learning to interact with indigenous



communities and to see, identify, and treat many health conditions unique to equines living in tropical conditions.

“A struggling horse owner in the developing world has to make a living and support his family on less than we spend on lattes,” Merriam said. “But he knows his animals and wants the best (for them).”

Merriam recalled one case in Samana, Dominican Republic, when a mule with a scrotal hernia the size of a volleyball was presented for surgery.

“The team assembled, and repaired (the mule) on the grass in the middle of the town square,” Merriam said. “As the animal recovered, the owner approached and said his thanks, and added ‘I am old, my family feeds me, and if I die, they will survive. But if the mule dies, we all die.’ The man had not been able to pick coconuts for several weeks, but was soon back to work.”

The Equitarians, in addition to providing health care for the working equids, aim to teach the owners about proper daily care for their horses and how to

provide basic health care. To do this, they are continuously looking for veterinarians to travel to Third World countries and assist with the effort. Additionally, Merriam said, time in the field is essential for local caretakers and veterinarians to develop and hone their veterinary care skills.

“The AAEP recently established a working equids initiative with the British Equine Veterinary Association that will become a central source for connecting member veterinarians with ongoing projects, as well as allow donors of supplies to direct them where they are needed,” Merriam explained. “They have also joined with six other organizations to support the Equitarian Workshop and similar educational endeavors on an annual basis.

“Clinical skills and expertise get better with practice and field training,” he added. “Organizations working in developing countries need skilled, practiced hands to both perform and teach required procedures,” and vets traveling to these areas can provide guidance to local caretakers.

Merriam credits some of the Equitarians’ success to the fact that they meet the specific needs of a community (rather than only providing one type of assistance on a global scale), and they take the time to develop trusting relationships with horse owners. He added that many equid owners return to the clinics each time the Equitarians visit their community. Some owners even travel miles—often by foot—to bring their horses to the clinics.

“There is a need for veterinary care, parasite control, and nutrition (for the 100 million working equids worldwide),” Merriam concluded. “Education of caregivers, veterinarians, and health care workers is the key to improving the lives of these animals and their families.”

MORE ONLINE See TheHorse.com/AAEP2010

- Equitarian Initiative Table Topic, TheHorse.com/17693
- Watch the Equine Welfare video, TheHorse.com/Video.aspx?VID=485

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Lameness: Soft Tissue

BY NANCY S. LOVING, DVM

Rehabilitating After Injury With Mobilization

Historically, when a horse sustained major musculoskeletal injury or underwent a major surgery, he had to be immobilized before he could begin to use the limb. Results were less than optimal as immobility often leads to loss of flexibility or range of motion (ROM), as well as loss in proprioception (awareness of posture, movement, balance, and location), muscle symmetry, and trunk stability. Sheila Schils, MS, PhD, described the benefits of early mobilization of equine musculoskeletal tissues within the initial days after injury.

Schils, who designs therapeutic equipment and treatment protocols in River Falls, Wisc., explained that early mobilization during acute healing phases increases blood and lymph flow and increases tissue tension to stimulate tissue repair and improve tissue alignment. Early mobilization produced a 60% improvement in tendon Type 1 collagen deposition (evidence of healing) along with a 20% improvement in both ROM and ability of the tendon to handle ground reaction forces. Mobilization limits fibrosis (scarring) of connective tissues, preserves joint ROM, and improves neuromuscular coordination.

In contrast, Schils reported that restricting mobilization of an injury often yields bulky scar tissue and adhesions, along with reduced tissue strength and persistent pain. She added, however, that immobilization is not all bad—for severe tears and fractures a short stabilization period is advised before mobilization.

Schils mentioned that research has shown that longer, slower rehabilitation doesn't necessarily improve the outcome, while early mobilization doesn't increase reinjury rate. Grading of each injury (Grade 1, 2, 3) according to severity helps the veterinarian determine how to proceed in the initial days: Schils recommends beginning ice, compression, elevation, weight-bearing exercises, controlled stretching, and functional



MARC MANNING

Schils recommends mounting a balanced rider on a horse recovering from musculoskeletal injury.

electrical stimulation immediately to improve flexibility, with gradual increases in intensity and repetition. Then she recommends adding strengthening exercises, although flexibility remains the major focus throughout rehabilitation.

Schils remarked that pain is not necessarily an appropriate guide to determine muscle flexion limitations—joint swelling or stiffness might limit flexibility, yet not be painful. She said to practice site-specific as well as site-complementary exercises such as evaluating gait mechanics and overall body symmetry. Tendon and ligament healing responses are best tracked with serial ultrasound exams.

Although a horse might appear painful at times during mobilization exercises, Schils stressed that rather than reducing the exercises, it's better to plateau and remain at the same level of exercise. She reminded her audience that rehabilitation is cyclical—a horse's mobility might improve for a bit, then lose some ground only to rebound shortly thereafter with improvement.

She also recommended mounting a balanced rider on the horse as soon as possible. When a horse is mounted with a rider the mobilization time will be longer, trunk stability exercises (such as transitions and lateral work) can be performed, and the



horse can be walked over varied terrain to activate proprioception. Schils also considers the psyche of a horse to be important and said that stall rest alone should be used as infrequently as possible.

Hyaluronic Acid-Based Biomaterial to Enhance Leg Wound Healing

Managing equine wounds—particularly on the legs—is often costly both in time and resources. Linda Dahlgren, DVM, PhD, Dipl. ACVS, assistant professor of large animal surgery at the Virginia-Maryland Regional College of Veterinary Medicine, spoke on the use of a hyaluronic acid-based biomaterial (CMHA) in several application methods to facilitate wound healing.

In her study Dahlgren and colleagues examined the use of the CMHA biomaterial to see if it could accelerate wound healing and decrease scar tissue formation in equine lower limb wounds. The investigators created full-thickness skin wounds on the front of all four cannon bones in eight horses. One randomized leg on each horse served as a control with no CMHA treatment, and then each of the other three limbs on each horse underwent one of three other treatments: a) CMHA gel applied once; b) CMHA gel applied multiple times at each bandage change; or c) CMHA film on a gauze backing applied multiple times at each bandage change. The gel and film are similar forms of hyaluronan cross-linked in a slightly different way.

The team performed bandage changes every four days for seven weeks. They trimmed exuberant granulation tissue (proud flesh) as needed to prevent it from inhibiting wound healing, and they weighed all trimmed tissue. At each bandage change wounds were photographed so wound size and epithelialization (migration of skin tissue) could be analyzed later.

While differences between treatment groups regarding number of times or amount of granulation tissue trimmed were not statistically significant, both frequency and amount were greater in the multiple-gel group, suggesting increased production of granulation tissue. All wounds retracted equally during the initial three to 11 days. Dahlgren reported that wounds treated with multiple applications of CMHA film were significantly smaller than controls on Days 19 and 31,

and these returned more quickly to half the original wound size compared to the other two treatment groups or the control. By Day 47, wounds in the multiple-film group were covered with smooth, adherent epithelium. These also had a flatter profile than the other groups, consistent with less inflammation and less scar tissue formation.

In summary, Dahlgren reported that wounds treated with CMHA films healed faster and with higher quality and less fragile epithelium, compared to the other treatment groups or controls. She noted that repeated applications of CMHA gel stimulated granulation tissue formation, which could help in handling deep injuries where it is advantageous for granulation tissue to quickly fill in a wound defect.

How to Diagnose and Treat Back Pain in the Sport Horse

“Back problems can be performance-limiting in the horse due to pain and reduced range of motion and flexibility,” reported Kent Allen, DVM, owner of Virginia Equine Imaging, as he discussed equine back pain.

Allen reminded the veterinarians in attendance that many myths circulate regarding causes and treatments for back pain. A common assumption is that back pain is due to hock lameness problems; blame is also placed on poor saddle fit or behavioral issues. A common, yet fallacious, approach to equine back pain is to rest the horse without forced exercise, which, as Allen pointed out, might exacerbate a back problem since rest contributes to wasting of the epaxial muscles along the spine.

Allen agreed that a primary limb lameness that creates an asymmetrical gait can lead to secondary back muscle soreness. Yet, he also noted other causes of back pain: primary muscle or ligament soreness, spinous process impingement (kissing spines), degenerative arthritis of the articular facets between vertebrae, spondylosis (ossification, or bone formation, of vertebral joints), or fracture of bony structures in the spine.

He encouraged diligently pursuing an accurate diagnosis through a comprehensive physical and lameness exam followed by appropriate diagnostic imaging. He stressed that back problems cannot always be predicted relative to

conformation—horses with good conformation might develop problems, while those with less-than-ideal conformational characteristics might not. Visual inspection is important to ascertain physical changes related to atrophy, swelling, or asymmetrical alignment. The veterinarian should palpate each spinal vertebra and the epaxial muscles on each side of the spine to determine if bone and/or soft tissue are causing pain. The veterinarian should assess the horse's degree of flexibility and back mobilization, then perform dynamic evaluation by watching the horse move on a straight line, in longeing circles, and under saddle. Allen has had excellent success using a 50-pound weighted surcingle that mimics the weight of a rider and allows observation for signs of discomfort during girthing up and while the horse is longed. After carefully assessing these parameters, the veterinarian might order radiographs and possibly nuclear scintigraphy (bone scan).

Treatment suggestions by Allen are multifold. The primary lameness problem must be addressed, and saddle fit must be corrected as necessary. Other options directed locally to the back include ultrasound-guided injection of articular and/or spinous processes, extracorporeal shock wave therapy for kissing spines, acupuncture, chiropractic, therapeutic ultrasound, and tiludronate therapy (which is not currently widely available in the United States for use on horses, although some veterinary practices have provisional licenses to use it). Pain control with mesotherapy blocks sensory pain fibers pulsing through the skin in the epaxial area; this can lengthen pain relief following shock wave therapy or corticosteroid injections.

A successful approach to back issues addresses pain control and spasm while keeping a horse active during the rehabilitation process—back muscles must be regained to achieve results. Allen noted that in his hands, 80% of back pain horses returned to their previous level of exercise when diagnosed properly and treated aggressively.

Pigeon Fever as a Lameness Cause

The soil-borne bacterium *Corynebacterium pseudotuberculosis* can infect horses and cause a condition commonly known as pigeon fever, in which the infected horses often have pectoral (chest) swelling,



resembling a pigeon's breast. Other clinical signs include fever, lethargy, and lameness. Cases are predominantly found in the western United States; however, the bug is steadily extending eastward, according to Nora Nogradi, DVM, a resident in equine internal medicine at the University of California, Davis, veterinary school, who presented a retrospective study on the outcome of 35 equine cases featuring lameness attributable to *C. pseudotuberculosis*.

Cases appear seasonally because they're correlated with fly activity, so pigeon fever diagnoses usually are made in the late summer and early autumn months. Flies inject these bacteria into the ventral (underside of the) abdomen, where lymphatic flow picks up the infection and spreads it to other areas of the body. While most *C. pseudotuberculosis* infections localize in the pectoral muscles, Nogradi noted that 8% of abscesses localize internally in the liver, spleen, or kidney, and 1% cause ulcerative lymphangitis with profound hind limb swelling. A smaller subgroup of cases with external abscess formation will develop abscesses in the limbs, causing a confusing lameness. Since the abscesses develop slowly, so does the lameness, and a veterinarian's involvement might be delayed for this reason. Most affected horses in the study were Grade 4 (out of 5) lame, which means lameness is noticeable at a walk. Most presented with a mild fever around 102°F, and complete blood count data was consistent with bacterial infection. In nearly all of the horses culturing an abscess yielded a positive diagnosis, and serology titers confirmed this as well.

Of the 35 horses, Nogradi noted that 71% had developed abscesses in the axillary (armpit) and triceps region of the forelimb; abscesses in these areas are the most common source of lameness in pigeon fever cases. Ten horses had no visible swelling, but veterinarians could detect lameness as a decreased cranial (forward) phase of the stride because of discomfort created with limb extension. Ultrasound examination allowed veterinarians to identify an encapsulated abscess beneath the triceps musculature in all cases. Nogradi remarked that the size of abscess did not correlate with a horse's degree of lameness. The depth of these abscesses caused them to take weeks to develop into a systemic illness with fever and blood count changes.

Nogradi mentioned four horses that

developed ulcerative lymphangitis during the study period, which persisted as a markedly swollen leg (lymphedema) in each of the horses. The study also included a couple of horses with *C. pseudotuberculosis* abscesses around the stifle joint, two bone infections requiring surgery, and one other with primary septic arthritis (infection of joints).

To treat *C. pseudotuberculosis* in the limbs, the vet must localize the abscesses and drain them via ultrasound-guided needle puncture (to avoid inadvertent puncture of vital structures). Timely intervention is the key to preventing secondary complications such as osteomyelitis (bone infection) or support limb laminitis. After

**According to Haussler,
(spinal) manipulation has
been shown to increase
flexibility, improve
performance, and decrease
pain and muscle spasm.**

establishing drainage, antibiotic treatment with appropriate antimicrobial drugs is important. Non-steroidal anti-inflammatory drugs ease comfort once the abscess is drained. Nogradi noted that all of the cases resolved over 21 to 120 days.

In summary, *C. pseudotuberculosis* infection of musculoskeletal structures should be considered in horses presenting with severe lameness and signs of systemic illness during the fall months in regions where *C. pseudotuberculosis* is prevalent. Although diagnosis is challenging, cases with proper and timely treatment carry a good prognosis for recovery.

**Researchers Examine Spinal
Mobilization vs. Manipulation**

Equine back pain can often cause a horse to move with a stiff trunk, asymmetrical spinal motion, and lameness. Horse owners often turn to chiropractic care as a technique to improve their horses' performance and comfort. Kevin Haussler, DVM, DC, PhD, assistant professor in the Department of Clinical Sciences at Colorado State University's veterinary school, discussed a study in which he and colleagues measured the effects of two different

types of chiropractic techniques: spinal manipulation and spinal mobilization.

Spinal mobilization describes using cyclic and rhythmic forces to induce selective displacement along the spine—this is achieved by applying firm downward pressure and releases repetitively along the length of the spine. Spinal manipulation (SMT) is achieved with a high-velocity, low-amplitude thrust. According to Haussler, manipulation has been shown to increase flexibility, improve performance, and decrease pain and muscle spasm.

In the study, Haussler and his team treated 24 actively ridden horses with SMT over five thoracolumbar sites (in the saddle region, in front of the pelvis) once weekly for three weeks. Haussler explained that 70% of flexion-extension of the trunk occurs at the lumbosacral junction—the joint between the lumbar vertebrae and the sacrum, just in front of the croup. Investigators measured peak vertical movement, applied force, and stiffness at these five intervertebral sites.

The results of the study demonstrated that manipulation and mobilization both increased spinal mobility. According to Haussler, SMT causes the spine to move beyond its normal limit in range of motion, while mobilization usually is only effective within the normal range of joint motion. While mobilization produced consistent delayed increases in spinal mobility or flexibility between treatment sessions, SMT achieved immediate therapeutic effects. Such SMT displacement effects lasted between treatment sessions, whereas mobilization effects did not.

Haussler explained that mobilization is a more conservative and less forceful technique, making it useful for treating acute pain without overstretching or injuring soft tissues. Manipulation is a more aggressive approach with notable benefits for chronic neck and back pain. He suggested that additional treatment sessions might be necessary to achieve longer-term effects than those seen after each of the three spinal manipulation treatments used in this study.

Enostosislike Lesions

When new bone forms within long bones, enostosislike lesions (ELs) can develop—an uncommon but concerning problem. At present, the exact cause of this phenomenon is unknown, but veterinarians



can diagnose it using nuclear scintigraphy (bone scan): an ELL is visible as one or more focal areas of radiopharmaceutical uptake in the medullary (central) cavity of one or more long bones. These focal areas are sometimes referred to as “hot spots” on bone scans. Benjamin Ahern, BVSc, a resident in large animal surgery at the University of Pennsylvania, presented a retrospective study of 79 horses affected with ELLs over a period from 1997 to 2009.

Of nearly 5,000 scintigraphic studies performed at the University of Pennsylvania’s George. D. Widener Hospital for Large Animals during the 12-year period, veterinarians identified 85 cases of enostosislike lesions (1.7%) in 79 horses at 157 sites; four of the 79 horses had multiple, separate ELL bouts. Slightly more than half the 79 horses had a single ELL, 28% had two lesions, and 21% had three or more within a single scintigraphic study. A single ELL site didn’t significantly affect a horse’s racing career, but Ahern commented that racing careers were shortened in

horses diagnosed with two or more lesions. On discharge from the clinic following diagnosis, veterinarians recommended racing Thoroughbreds rest for 12 weeks and Warmbloods or nonracing breeds rest for eight weeks. This recommendation varied depending on severity of lameness.

Interestingly, Ahern noted a marked increase in ELL occurrence in 2008 and 2009, yet ELL incidence in 2010 returned to pre-2008 levels. Ahern said attempts were made to correlate the increased incidence with hyperbaric treatment, various track surfaces, or corticosteroid use, but researchers weren’t able to make any conclusive associations.

Enostosislike lesions were identified more often in Thoroughbred horses than other breeds, and older horses (of any breed) were more likely affected. ELLs occurred most frequently in the tibia (the bone above the hock) or the radius (the bone above the knee). However, lameness, which occurred in nearly half of affected horses, was most often related to lesions

in the humerus (shoulder bone) or femur (the long upper bone of the hind leg, above the tibia). It is noteworthy that, statistically speaking, a horse’s lameness score correlated with the intensity of radiopharmaceutical uptake on scintigraphy. Ahern stressed the importance of differentiating ELL from stress fractures due to differences in management strategies.

In conclusion, ELLs should be considered as a cause of wandering lameness, especially in older horses and Thoroughbreds. The severity of lameness caused by ELLs is associated with the anatomic location of the lesion and the intensity of radiopharmaceutical uptake on scintigraphic examination. Enostosislike lesions often cause variable lameness that most horses can recover from with conservative treatment. 🐾

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 ■ Watch the Lameness: Soft Tissue Problems video at TheHorse.com/Video.aspx?vID=489.

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Lameness: Joints

BY NANCY S. LOVING, DVM; STACEY OKE, DVM, MSC; AND CHRISTY WEST

Stem Cells Improve Cartilage Repair for Arthritic Horses

Osteoarthritis (sometimes called degenerative joint disease) is the most common cause of lameness in horses and currently there is no cure. However, researchers continue to improve available treatment methods. Wayne McIlwraith, BVSc, PhD, DSc, FRCVS, Dipl. ACVS, director of the Orthopaedic Research Center at Colorado State University, presented the results of a study evaluating the use of bone marrow-derived stem cells in conjunction with microfracture for healing cartilage defects in horses.

Cartilage, a smooth layer of tough tissue covering the ends of bone at joints, allows the bones to move smoothly past each other as the joint moves. However, in osteoarthritis, that cartilage becomes thinned, roughened, or even worn completely away in spots by typical wear and tear, trauma, joint chips/debris, etc. Varying degrees of pain and lameness result.

Unfortunately, cartilage doesn't spontaneously regenerate, but various treatments can help repair it to a degree. For the current study McIlwraith and colleagues used an experimental model of cartilage damage and a proven treatment of microfracture (punching small holes in the subchondral bone beneath the cartilage defect to stimulate cartilage growth). They then treated each lesion one month later with hyaluronan alone or hyaluronan with bone marrow-derived stem cells. Each horse also underwent a standardized daily treadmill exercise regimen from four to 12 months after the start of the study.

He reported that using bone marrow-derived stem cells in addition to microfracture offered superior healing compared to microfracture alone. The repaired tissue was significantly firmer and had higher levels of aggrecan, a molecule that provides compressive stiffness to the cartilage.

"We've shown consistently better repair (of cartilage defects) with microfracture, and this is one step beyond that," said McIlwraith.



Bone marrow-derived stem cells (being collected above) and hyaluronan in conjunction with microfracture are useful for healing cartilage defects in horses, according to a recent study.

IRAP-II Joint Disease Treatment for Horses Beats IRAP in Lab Study

To combat joint disease or osteoarthritis in horses, many veterinarians have used autologous conditioned serum (ACS), also called by the product name IRAP (for the interleukin-1 receptor antagonist protein it contains), since the first scientific publication appeared on the subject in 2003. Since that time, a new kid on the block—a similar product sharing many characteristics with the original, and, indeed, named IRAP II—has arrived on the market. David Frisbie, DVM, PhD, Dipl. ACVS, associate professor of clinical sciences at Colorado State University, presented a study comparing the two products.

Frisbie said, "The future brings more

choices (for treatment of health problems), and we are always left wondering which to use. That is the impetus of this study."

The molecule interleukin-1 is one of the major mediators of joint disease, explained Frisbie; the increased levels of interleukin-1 receptor antagonist (IL-1Ra) in IRAP products treat arthritis by blocking interleukin-1's destructive effects. Both IRAP products involve pulling blood from a horse, then incubating it for 24 hours with glass beads that stimulate production of anti-inflammatory proteins including IL-1Ra. Finally, a veterinarian injects the conditioned serum back into the arthritic joint to reduce inflammation and help heal the joint.

For the current study, Frisbie and



colleagues examined the composition of serum prepared using both IRAP I and IRAP II products. They found that both products yielded increased levels of IL-1Ra and insulinlike growth factor as compared with untreated serum, but IRAP II yielded more than twice the amount of IL-1Ra, which theoretically would magnify its beneficial effects. Also, using IRAP II resulted in lower production of tumor necrosis factor- α (alpha, another pro-inflammatory cytokine, or mediator of inflammation) than when IRAP I was used.

“ACS (IRAP) II, with an increased growth factor and anti-inflammatory cytokine profile and no significant increase in pro-inflammatory cytokines, showed a superior profile compared with ACS I,” Frisbie summarized.

Economic Impact of Osteoarthritis and Oral Joint Health Supplements

Osteoarthritis is expensive to manage, with estimated annual costs as high as \$10,000-15,000 per horse to diagnose, treat, and medicate, explained McIlwraith, who discussed the economic impact of osteoarthritis and oral joint-health supplements (OJHS). In his review of a paper that he co-authored with Stacey Oke, DVM, MSc, McIlwraith explained that the value of a horse affected by osteoarthritis also decreases substantially.

The veterinary nutritional supplement industry collectively earns \$2 billion per year, with more than half of that coming from the equine sector—34% of equine products are OJHS. McIlwraith remarked that 89% of these nutraceuticals are purchased from sources other than veterinarians.

Of note, McIlwraith pointed out that in many cases these horses are rarely receiving a specific diagnosis if the joint-health product is not received directly through the veterinarian. Often, a horse presented to a veterinarian for lameness evaluation has received OJHS for months, with or without an accurate diagnosis. These OJHS are often used to manage osteoarthritis and navicular syndrome, and to control post-traumatic and post-surgical inflammation. And, despite a lack of objective data, many products are given prophylactically (preventively) to at-risk athletic horses, he said.

Recent studies in humans continue to yield contradictory results. Oral glucosamine and chondroitin sulfate

supplements have not demonstrated a proven benefit for managing osteoarthritis despite years of favorable anecdotal reports. In light of this, McIlwraith stressed the need for validating products with *in vivo* (in the live horse) data and that drug manufacturers should be encouraged to do this. At this time there appears to be little incentive for drug companies to perform such studies, he explained.

Owners should be aware that poor product quality is possible—OJHS might not contain the type or amount of ingredients listed on the label, thereby leading to the administration of subtherapeutic doses. Contamination with heavy metals, toxic substances, and/or insecticides is also possible. Some individual horses might experience hypersensitivity reactions, gastrointestinal upset, or drug-herbal interactions with adverse effects. McIlwraith recommends using the ACCLAIM system developed by Oke: **A** name you recognize; **C**linical experience; **C**ontents; **L**abel claims; **A**dministration recommendations; **I**ngredients; and **M**anufacturer information. (For more information on the ACCLAIM system, see TheHorse.com/11958.)

The nutritional supplement industry continues to grow despite the economic downturn, McIlwraith noted. Poor-quality and potentially harmful supplements are continually available to unsuspecting consumers. The American Veterinary Medical Association and AAEP advocate that veterinary use of these products remains within the bounds of an active, valid veterinarian-client-patient relationship and that veterinarians stock the best-quality products for use in their equine patients.

Equine TMJ Disease: Why So Rare?

A resurgence of interest in the equine temporomandibular joint (TMJ) (which allows for opening and closing of the mouth) led James Carmalt, MA, VetMB, MVetSc, FRCVS, Dipl. ACVS, ABVP, of the University of Saskatchewan's Western College of Veterinary Medicine, to discuss the relationship of TMJ disease to weight loss or behavioral changes in horses. Carmalt reviewed his study on how the TMJ responds to short-term inflammation as compared to the load-bearing fetlock joint.

Carmalt remarked that a horse grazes 18-21 hours per day, experiencing a staggering number of TMJ repetitive motions over time. Yet he said that the

incidence of published, true TMJ disease in the horse is negligible, whereas human TMJ disease is relatively common.

Tooth floating has not been shown to consistently improve weight gain in the horse, therefore more horses are referred for TMJ disease, he noted.

“The feeling is that either this is a rare disease or we are not picking it up,” said Carmalt. There are case reports of septic arthritis in the TMJ with secondary osteoarthritis or cases of post-traumatic inflammation, but there are no reports of primary equine TMJ disease; either horses are coping with the problem, horse owners and veterinarians are missing the condition, or it is not a real problem, according to Carmalt.

The nutritional supplement industry continues to grow despite the economic downturn, McIlwraith noted. Poor-quality and potentially harmful supplements are continually available to unsuspecting consumers.

Previously published Japanese studies using mice challenged with medications to induce osteoarthritis demonstrated that mouse TMJ responds with less inflammation and cellular changes than what occurs in the mouse hock or stifle joints. Carmalt's study compared the equine TMJ response to short-term inflammation to that of the equine fetlock joint, looking to see if the TMJ has a different response than a joint that is routinely affected by osteoarthritis.

Investigators conducted thorough clinical, oral, and lameness exams in seven horses aged 5-10, along with taking radiographs of the fetlock joints. Then they injected lipopolysaccharide (LPS) into one TMJ and one forelimb fetlock of each horse to induce inflammation; the opposite of each joint was injected only with saline to serve as a control. Synovial fluid samples were taken over the next 24 hours and evaluated for inflammatory enzymes.

All joints injected with LPS were effusive (swollen), warm, and resistant to palpation, whereas only two control joints showed signs of inflammation. Interestingly, feeding behavior and chewing movements did not change—subjectively there appeared to be no effect of TMJ inflammation on eating. However lameness from the LPS-injected fetlock joints increased within several hours of injection (returning to normal by the end of the study). Carmalt suggested that despite probable TMJ pain, the horses kept eating. Carmalt concluded that inflammation appears to subside more quickly in the TMJ than in the fetlock joint.

Carmalt summarized saying, “The study suggests that TMJ disease may be rare in the horse and that rapid control of intra-articular inflammation within this joint may play a role (in its relative obscurity).”

Ethyl Alcohol Pastern Joint Fusion

Any lameness can be tough for a veterinarian to treat and resolve, but pastern joint lameness caused by osteoarthritis can be especially problematic. Stephanie Caston, DVM, Dipl. ACVS, an equine surgeon at Iowa State University, discussed possible options for managing pastern osteoarthritis. Chemical joint fusion using ethyl alcohol was one treatment she and colleagues examined in a recent study.

In low-motion joints, sometimes the solution to lameness troubles is physiologic fusion (fixation of the joint so it can't move) called ankylosis, to relieve pain and discomfort. Ankylosis occurs naturally in some joints, but Caston noted that ongoing joint disease in itself is unlikely to result in complete ankylosis. Typically, veterinarians manage such low-motion joints using arthrodesis (surgical fusion) with a variety of approaches ranging from lag screws and plates to drilling away the cartilage to laser surgery or chemical injections with irritating substances (to induce fusion). Many of these orthopedic solutions are expensive and fraught with long recovery periods.

Caston presented an alternative chemical approach to surgical arthrodesis, injecting sterilized 75% ethyl alcohol into an osteoarthritis-affected pastern joint. She and her colleagues selected horses for the study based on a lameness exam,



Radiograph of a pastern joint with a needle (circled) in place in preparation for ethyl alcohol injection.

COURTESY DR. STEPHANIE CASTON

diagnostic nerve blocks, and radiographs scored as to severity of pastern osteoarthritis. They considered treatment successful based on whether the horse was able to return to its previous performance level and on the satisfaction of the owner regarding the horse's use.

Following joint injection with ethyl alcohol, each horse was allowed free-choice turnout. All pastern joints were reinjected with ethyl alcohol one month later. The study included 21 horses and 23 joints with a mean duration of lameness of 13 months; duration of lameness ranged from two months to four years. Of 21 horses, 19 returned to some level of use following treatment. Caston reported that 13 horses returned to their previous level of work or use, five to lighter use, and one returned to work but was euthanized for an unrelated orthopedic injury. Two horses did not respond well to treatment, with one owner opting for surgical arthrodesis after six months and the other electing euthanasia.

The research team noted few complications with this procedure. They observed transient lameness in two individuals and one developed cellulitis (a bacterial infection of the skin and associated tissues) due to suspected septic arthritis.

Caston noted that owners of seven horses with other concurrent orthopedic concerns had elected not to pursue surgical arthrodesis of a single joint, preferring ethyl alcohol injection. She commented that the decision to pursue ethyl alcohol

arthrodesis was driven by economics—this procedure is easily performed in a standing horse in a manner similar to standard intra-articular injections. It is also possible to treat two joints concurrently (the veterinarian doesn't have to treat one joint for a while, wait, then treat the other). The period of convalescence before a horse returns to use is shorter than with other surgical options, making ethyl alcohol arthrodesis an attractive alternative procedure, she said.

In some cases Caston noted an immediate and rapid onset of improved comfort. Return to soundness is slower than achieved by some surgical options, requiring a mean duration of eight months. However, this recovery is achieved with a markedly reduced expense. For all horses, Caston remarked that in the horses that were able to return to work, the cosmetic outcome was acceptable.

Stifle Abnormalities in Cutting Horses: Not So Bad, Says Study

Radiographs of a horse's limb joints are an important part of the pre-purchase examination for any performance prospect; the goal is to find any problems that might cause lameness down the road. However, it appears that in cutting horses at least, certain lesions seen on radiographs of the stifle joint just don't hurt a horse's performance as much as many have thought. Myra Barrett, DVM, MS, Dipl. ACVR, a clinical instructor in the radiology department at Colorado State University, discussed the results of a study examining sale repository radiographs and performance records of 432 yearling and 2-year-old cutting horses.

“Radiograph repository studies exist for Thoroughbreds, but results in Thoroughbreds aren't necessarily comparable to Quarter Horses,” she began. “Different breeds and disciplines can have distinct orthopedic problems, and the stresses on the horses vary with individual Western performance disciplines.”

This study examined the radiographic characteristics of 432 horses sold for cutting as yearlings and 2-year-olds, specifically focusing on the medial femoral condyle (inner joint surface at the lower end of the femur). Shape and quality of the condyle were graded from 0 (normal) to 4 (lucent



lesion extending into the weight-bearing portion of the bone) for the medial femoral condyle (MFC) in each horse's stifle joint.

The study also evaluated performance and earnings data on these horses through their 4-year-old years, and found that surprisingly, no grade of MFC defect significantly reduced performance or earnings. There was a trend between Grade 4 defects and a lower likelihood that the horse would compete, but it was not a statistically significant finding.

Researchers considered whether horses with more severe stifle lesions were weeded out for other uses than cutting, and perhaps this was why their lesions appeared to have no effect on performance. However, they found that only 25% of horses with more severe lesions were used for other purposes, "which seems to show they aren't just being used for other things," Barrett commented.

Interestingly, she reported that the published data in the convention proceedings were no longer accurate by the time of the convention. As the study continued, the size of the study group doubled and previously statistically significant findings of MFC defects affecting performance became insignificant.

"This shows how important it is to make sure we have enough horses in our studies, and carefully examine our own and other studies to make sure we have enough horses for significance," said Barrett.

Future study directions for this population might include evaluating lameness, not just performance data, as an outcome of MFC joint pathology.

"Flattening of the medial femoral condyle gets dinged a lot (in purchase evaluations); we know stifles get torn up in cutting horses, but often it's soft tissue damage," commented McIlwraith following the presentation. "We pretty easily excluded flattening as a knock on a horse (with this study). A lot of changes (bone lesions noted in the current study) are insignificant relative to what horses do to their stifles and injuries they acquire later."

Bone Spavin: Alcohol Joint Fusion Effective

Bone spavin in horses, or osteoarthritis of the distal tarsal (lower hock) joints, is a "common cause of equine lameness, resulting in lost training days and limiting affected horses' careers," says Carmalt. He

discussed results of a recent small study on fusing those painful lower hock joints.

"Usually these horses are managed with non-steroidal anti-inflammatory drugs (such as phenylbutazone, or Bute) initially, and/or corticosteroids," Carmalt said. "But there comes a time when medical management is no longer working and you need to think about doing something more permanent or retiring the horse completely."

Often when a joint is arthritic and painful, fusing that joint (stopping its movement entirely) will also stop the pain. In the small lower hock joints, which have very little movement, fusion usually does not even affect the horse's gait. Surgical fusion with hardware could be effective, but Carmalt and colleagues investigated the value of injecting common ethyl alcohol into the lower hock joints of horses with clinically apparent bone spavin to induce fusion (this approach was found effective

Embryonic stem cells have improved growth potential and are pluripotent, meaning they can form any tissue type to produce optimal healing.

in normal, or non-affected, horses in another study). The researchers were very careful to inject only lower hock joints that did not communicate (share fluid with) other joints, to avoid fusing more joints than intended.

Investigators placed 3 mL of 70% ethyl alcohol placed in the sore lower hock joints of 11 horses for the study, and they re-examined the animals every three months for one year. During this time the horses went right back to work and no arthritis medications or anti-inflammatory drugs were permitted. After that year, 10 of the 11 (91%) were sound and the remaining horse had lameness graded 0.5 of 5 (on the AAEP lameness grading scale). Ten more horses were treated in this manner by owner request, and seven of those went sound (two remained Grade 1 lame, one with upward fixation of the patella; and one was lost to follow-up).

"Rapid, sustained reduction in lameness" and collapse of the joint space

(fusion) occurred throughout the yearlong follow-up period, and Carmalt reported no injection complications, no need for reinjection in any horses, and no white hairs/scarring at the injection site. He also noted that in one horse followed to three years, there was still no lameness. The team plans to recheck the horses at five years post-injection.

Embryonic Stem Cells and Tendonitis Repair

Fifteen percent of racehorse musculoskeletal injuries are related to tendons, with half of these occurring in the forelimb, and 75% of the forelimb tendon injuries affecting the superficial digital flexor tendon. In eventing horses, 50% of injuries involve a tendon or ligament. Unfortunately, there is a high recurrence rate in affected animals, with 50% of horses reinjuring their tendons within two years. This is likely because tendons heal by repair through scar tissue formation rather than regeneration of tendon tissue. Ashlee Watts, DVM, Dipl. ACVS, described a new approach for regenerative therapy using fetal-derived "embryonic-like" stem cells for tendon repair.

Historically, regenerative therapy has involved the use of active molecules in the horse's own blood such as those found in platelet-rich plasma (PRP), with its high concentration of trophic (nutritional) constituents and growth factors, and stem cells derived from the horse's own bone marrow, or fat. These adult-derived stem cells can form tissues from a single germ line, the mesoderm (the embryonic origin of all musculoskeletal tissues, including tendon). Although targeting the germ line responsible for tendon development seems beneficial, it is possible that a stem cell with greater potency, or ability to form all three developmental germ layers, could lead to improved outcomes.

Embryonic stem cells (ESCs, cells derived from embryos or generated using genetic means) have improved growth potential and are pluripotent, meaning they can form any tissue type to produce optimal healing. Unlike stem cells derived from an adult horse, ESC sources are available off the shelf, or over the counter, with improved uniformity in the product. This is in contrast to cells isolated from the horse's own bone marrow or fat, where the horse's age and health status can affect the ability



of the stem cells to repair injury. Embryonic stem cells are homogeneous (the same throughout) and, according to Watts, their greater potency might better contribute to repair and self-renewal for stronger tendon healing with less scar tissue.

Because of the difficulty in isolation of equine ESCs, Watts and colleagues used a cell line derived from fetal tissue. Traditionally classified as an adult stem cell, fetal-derived stem cells are embryonic-like in that they can be induced to express genes and proteins of pluripotency, essentially making them act like an ESC. Because of these similarities to ESCs, fetal-derived embryonic stem cells (fdESCs) have a lower stage of differentiation (are less committed to a single embryonic germ layer) and a greater self-renewal and expansion potential compared to adult stem cells from bone marrow or fat. FdESCs might also share beneficial characteristics with the adult derived stem cell, such as immune privilege, allowing 'non-self' cells to be safely used without risk of immune rejection.

Scientists isolate cell lines of fdESC from early fetal tissue, specifically the brain. In their study, Watts and colleagues injected male fdESCs into tendon lesions of Thoroughbred and Thoroughbred-cross mares—this enabled tracking of fdESCs. Horses in the study were trained or raced animals that were treated one week after inducing tendonitis.

The team members performed sequential ultrasound examinations at regular two-week intervals until the study horses were euthanized at eight weeks after treatment injection. Ultrasound at four weeks revealed that tendon lesions had already reduced in size compared to placebo control treated tendons, but were not yet different in their accumulation of more normal fiber patterns. By eight weeks, there were significant improvements in fiber pattern and architecture in addition to reduced tendon and lesion size in the fdESC treated tendons, indicating improved healing as compared to control tendons. Post-mortem MRI

exams on tendonitis samples demonstrated reduced size of the lesions and more normal tissue patterns compared to the placebo control group.

Treatment with fdESC did not cause post-injection inflammation, and investigators did not note any adverse reactions in the treated horses. New tendon cells were evident at eight weeks along with improved tendon architecture, as evidenced by better cell shape and orientation, filling in of tendon lesions, and correct fiber alignment. Watts stressed that fdESC treatment might elicit tendon regeneration rather than repair with connective scar tissue but that longer-term studies are required to confirm this finding.

Relevant to the equine athlete, she explained, better tendon healing could lead to reduced reinjury rates. 🐾

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Gastrointestinal Tract

BY ERICA LARSON; NANCY S. LOVING, DVM; AND STACEY OKE, DVM, MSC

Colic Surgery: Sutures or Staples?

Customarily, veterinarians close the intestinal wall following colic surgery in horses using either sutures or staples. But which is best? According to Julie Rosser, DVM, it's a tie: Staples are just as effective as the traditional method of hand-sewing the intestine closed with suture material in one common colic surgery procedure.

"Incising into the intestines at the part of the gastrointestinal tract called the pelvic flexure is a fairly routine procedure performed during exploratory surgeries in colicky horses," said Rosser, of the University of Wisconsin-Madison. "Traditionally, surgeons sewed the intestinal incision closed in two layers using an absorbable suture material."

Over the past few decades, surgical staplers have become increasingly popular because they make a surgeon's job easier and decrease tissue trauma and surgery time. Despite the fact that they've been embraced by veterinary surgeons worldwide, their efficacy for closing the equine pelvic flexure had not been studied.

Rosser reviewed the medical records of 84 horses who underwent a pelvic flexure enterotomy (i.e., their intestines were incised). Surgeons had stapled closed 70 horses' intestinal incisions and sutured the remaining 14. Key findings included:

- Both groups of horses had similar rates of postoperative complications; and
- In total, 77 of the 84 horses survived to discharge from the hospital. There was no difference in survival rates between the staple and the suture groups.

"Stapling closed the pelvic flexure during colic surgery is as safe as hand-sewing the intestine closed," concluded Rosser.

Fenbendazole & Resistant Ascarids

Foal owners need to be especially mindful of *Parascaris equorum*, commonly known as ascarids, the most dangerous worms found in these youngsters, according to D. Craig Barnett, DVM, senior equine technical services veterinarian for



Studies show that closing the pelvic flexure (a common colic surgery procedure) by stapling it is just as effective as hand-sewing it with suture material.

Intervet-Schering Plough Animal Health (ISPAH). He reported that ascarid populations at several breeding farms have developed resistance to ivermectin and moxidectin, drugs which are commonly used to treat these worms, and researchers are trying to determine the best way to deal with the problem. (*Note: Moxidectin is not approved in the United States for use in foals less than 6 months of age.*)

Fenbendazole, he said, might be the answer researchers have been looking for. He discussed the results of a recent study carried out by Craig R. Reinemeyer, DVM, PhD, president of East Tennessee Clinical Research; colleague Julio C. Prado, DVM; and Wendy E. Vaala, VMD, Dipl. ACVIM, equine technical services specialist for ISPAH. Reinemeyer and his team inoculated 16 foals with an ivermectin- and moxidectin-resistant strain of ascarids and divided the foals into two groups, then treated one group with fenbendazole paste (10 mg/kg) on Days 11 through 15 post-infection, and the other with ivermectin on Day 15.

After two and a half months, when the ascarids had matured and begun to lay eggs, the researchers performed fecal egg count reduction tests and total worm counts to compare the two regimens.

They found that the foals treated with a five-day fenbendazole regimen had significantly lower egg counts than ivermectin-treated foals. Ivermectin exhibited minimal efficacy against the resistant population (as expected), whereas fenbendazole reduced the egg counts by 99.5%. The number of adult ascarids in the foals treated with fenbendazole was also significantly lower; there was a 96.3% reduction of adult worms compared to the foals treated with ivermectin.

According to the researchers, a 5-day regimen of fenbendazole (10 mg/kg) has proven to be "highly effective" against ivermectin-resistant ascarids.

The team noted that the 5-day course of fenbendazole "is not recommended as the sole approach to routine ascarid management, but is an effective tool in the face of ivermectin-resistant ascarids."



Reinemeyer added, "Another important application of this regimen is that it is larvicidal, meaning that it kills ascarids while they're still migrating through the liver and lungs. Larval infections cannot be detected by any known tests, and this is probably the stage at which foals transmit infections from one farm to another."

This poses a particular problem for breeding farms where the mares are transported to another premise for breeding: "Their foals-at-side can pick up a resistant strain of ascarids at the breeding farm, and then take it back home. Even if they are treated with ivermectin upon their return, it will have no effect on the developing infection because that strain is ivermectin-resistant. Once those worms mature and begin to lay eggs—which is around 75 days post-infection—the new farm will be contaminated with a resistant strain."

The fenbendazole treatment provides a way to prevent introduction of resistant strains to previously naive farms, Reinemeyer added.

Heart Disease Blood Test in Horses: Effective and Useful

If a veterinarian suspects heart disease in a horse, running a cardiac troponin I (cTnI) blood test can expedite a diagnosis, according to a team of Cornell University veterinary researchers.

Cardiac troponin I is an excellent marker for injury to human heart muscle tissue, but "until recently, it was not known if measuring cTnI using the same blood analyzer (the i-STAT1) as in human medicine is either useful or feasible in horses with cardiac disease," relayed Thomas J. Divers, DVM, Dipl. ACVIM, ACVECC, professor and chief of large animal medicine at Cornell, who presented results of research on this testing method.

He and colleagues measured cTnI levels in 83 healthy horses to establish normal ranges for the analyte (a substance or chemical constituent that is determined in an analytical procedure). Subsequently, they tested horses that received the cardiotoxic drug monensin (sometimes pinpointed in cases of horse feed contamination with the cattle drug); those with a history of poor performance and chronic intermittent rhabdomyolysis (the breakdown of muscle fibers resulting in the release of muscle fiber contents into the bloodstream); and horses with primary cardiac

diseases such as myocarditis (inflammation of the heart muscle, pericarditis (inflammation of the heart's outer sac), and endocarditis (inflammation of the inside lining of the heart chambers and valves) or other systemic illnesses.

Divers et al. found:

- Normal ranges for cTnI levels in healthy horses are 0 to 0.06 ng/mL;
- cTnI levels are elevated in horses with acute monensin toxicity, but normal in horses with chronic intermittent rhabdomyolysis;
- Horses with colic requiring surgery have elevated blood levels (high levels of cTnI might suggest a poorer outcome); and
- Blood cTnI levels are elevated in horses with myocarditis (inflammation of the heart muscle) and those with severe hypoxia (oxygen deprivation) or systemic inflammation.

"These data indicate that cTnI is a useful test in a wide variety of cases, not just in horses with suspected heart diseases," said Divers. "Not only are cTnI levels measured at the time of hospital admission, but also the changes in the cTnI levels after treatment can be equally or even more useful."

Colic Prognosis

Monitoring lactate levels in samples of peritoneal fluid, the fluid surrounding and lubricating the abdominal organs, can help a veterinarian predict which colicky horses require surgery. John G. Peloso, DVM, MS, Dipl. ACVS, an owner/partner at the Equine Medical Center of Ocala in Florida, presented a study on peritoneal lactate levels and colic prognoses.

Tissues use glucose as their energy source. When the supply of oxygen to tissues is plentiful, glucose is converted to water and carbon dioxide (aerobic metabolism). When the supply of oxygen is lacking (anaerobic metabolism), glucose is converted to lactate. When lactate levels are high, it is inferred that oxygen levels are low. Recognizing that tissues need oxygen to survive, a high lactate level tells veterinarians that tissues are not receiving oxygen. In other words, if they hear "high" lactate, they should think "low" (no) oxygen.

"In human medicine, blood lactate levels are routinely measured in patients to determine if there is an adequate supply of oxygen to the tissues. While blood lactate levels are also used routinely in horses to

determine if tissues are being adequately oxygenated, peritoneal fluid lactate levels give us an earlier indication of poor oxygen delivery to the intestines," explained Peloso.

Veterinarians need an accurate and rapid method of diagnosing intestinal lesions that cut off the blood supply to the intestine in colicking horses. Thus, to determine if serial measurements of lactate levels in abdominal fluid would help fill this void, Peloso and Noah D. Cohen, VMD, MPH, PhD, Dipl. ACVIM, from Texas A&M's College of Veterinary Medicine, reviewed the medical records of 95 Ocala horses that presented with colic signs and had a second peritoneal fluid lactate sample measurement 1 to 6 hours after the first measurement.

Peloso and Cohen found that an increase in peritoneal fluid lactate levels in abdominal fluid samples (sample 2 – sample 1 > 0.5) was significantly associated with the presence of a strangulating lesion. "In other words, if the lactate levels increase from one sample to the next, then the underlying cause of the horse's colic is likely due to the blood flow to part of the intestinal tract being cut off and surgery is likely indicated," summarized Peloso.

In these 95 Ocala horses, using an increasing lactate level over time as a guide, veterinarians were able to correctly identify horses with strangulated bowel 88% of time (showing sensitivity of the method) and correctly identified horses that did not have strangulated bowel 79% of the time (specificity). Thus, lactate levels may be important because they can help a veterinarian detect surgical lesions early, which will ultimately improve a horse's chance of survival.

Practitioners, don't run and grab your lactate analyzer too quickly. Peloso and Cohen identified that these results are based on a population of Ocala horses. "A repeat of this study at different referral hospitals around the U.S. and Canada would substantiate these results," Peloso concluded.

Assessing Abdominal Abscesses

A variety of equine conditions can present with clinical signs that include colic pain, fever, decreased appetite, and weight loss. Similar signs occur with abdominal abscesses, making them challenging to diagnose. Carolyn Arnold, DVM, Dipl. ACVS,

clinical assistant professor of veterinary medicine at Texas A&M University, discussed data from a retrospective study of 61 cases of abdominal abscesses in adult horses.

Arnold defined an abdominal abscess as an encapsulated structure within the abdominal cavity that contains an exudate (pus). Veterinarians diagnosed the abscesses on ultrasound, during surgery, or at necropsy. Horses in the study ranged from 1-23 years old, and there was roughly equal distribution between male and female. The predominant clinical signs detected in association with these abdominal abscesses were abdominal pain (67%), depression (57%), lack of appetite (51%), fever (46%), rapid heart rate (46%), and weight loss (30%).

Precipitating events in these cases included recent castration, a penetrating wound, previous abdominal surgery, or exposure to *Streptococcus equi* bacteria. One affected mare had suffered a vaginal laceration subsequent to foaling. Twenty-five percent presented with acute clinical signs, such as colic, whereas 75% displayed chronic clinical signs despite ongoing treatment by referring veterinarians.

Veterinarians identified a mass on rectal exam in one quarter of the affected horses. Ultrasound via rectal scan or external scan along the abdomen identified an abscess in 56% or an abnormal amount of abdominal fluid (ascites) in 45%. Most horses (47) had a single abscess; the rest had two or more abscesses present.

Surgery confirmed the diagnosis in half the cases and provided access to remove the abscess. Arnold reported finding a gastrointestinal foreign body in 15 horses—wire was the predominant material, which the horses likely consumed when eating wire-baled hay. Three-quarters of the 61 horses were euthanized because of poor prognosis related to peritonitis (abdominal infection), adhesions, or an owner's financial constraints. Of the 18 horses that continued treatment, veterinarians administered antimicrobials, with length of treatment dependent on infection severity and number of bacteria isolated from abscesses. A variety of pathogens were cultured from three-quarters of these horses under treatment. Fifteen of the 18 horses survived and were discharged from the hospital.

Arnold concluded that helpful diagnostic information in abdominal abscess cases



ANNE M. EBERHARDT

Basing a deworming program on fecal eggs counts (shown) allows each horse an individualized deworming schedule and reduces the possibility of developing anthelmintic-resistant parasites.

can be obtained through ultrasound and rectal exam, cytology of abdominal fluid, and abdominal exploratory surgery.

Fecal Egg Counts and Internal Parasite Control Programs

Most horse owners are diligent about deworming their horses on a regular schedule. But there might be a more efficient deworming program that both horses and their owners can benefit from. According to Claudia K. True, DVM, a practitioner with Woodside Equine Clinic in Ashland, Va., basing a deworming program on fecal egg counts allows each horse an individualized deworming schedule and reduces the possibility of developing anthelmintic-resistant parasites.

"The use of routine fecal egg counts allows veterinarians to decide which horses to deworm and when to deworm them," True said. "Our practice implemented routine fecal egg counts in horses over one year of age as part of our wellness program to encourage our clients to adopt responsible anthelmintic use."

Although Woodside's clients initially responded to the program's introduction with mixed opinions, True relayed that the overall response was very positive once the clients understood the process and how it benefited their horses and their bank accounts.

The clinic team divided the horses they examined into two classes: high shedders and low shedders. High shedders' fecal

exams contained 300 eggs or more per gram of feces, while low shedders' feces contained less than 300 eggs per gram.

The basic program she and her colleagues outlined for low shedders (which accounts for the majority of the population, True said) includes deworming twice a year: once in December with moxidectin and praziquantel, and once in June with ivermectin and praziquantel. The specific dewormers used will likely vary in different parts of the country, she added.

The program the veterinarians recommended for high shedders includes five dewormer administrations per year. Moxidectin and praziquantel are used semiannually (in February and October). Oxibendazole, ivermectin and praziquantel, and pyrantel are used annually in May, June, and January, respectively. Again, the types of dewormers used should be appropriate for the region of the country.

About 10 to 14 days post-deworming, True added, it's important to do a follow-up fecal egg count to ensure the amount of parasites present in the horse was reduced.

The veterinarians in the practice place foals on a specialized deworming program, according to True. In her program foals are first dewormed with oxibendazole when they're 6 to 8 weeks old, and they don't analyze a fecal sample before the first deworming. After the foal's first fecal sample is taken at 14 to 16 weeks, the foal is dewormed with pyrantel. Oxibendazole is used again at 22 to 24 weeks of age



(again with no fecal sample). Finally, at 30 to 32 weeks, pyrantel is administered after a fecal examination. True recommends that the foal be put on a regular adult horse deworming schedule at 38 weeks.

True cautions not to use moxidectin to deworm foals less than 1 year old, as reports of death have surfaced due to accidental overdoses.

She said that the program Woodside established focuses on the parasites found in the Mid-Atlantic region (the clinic's location), and other areas of the country (or world) might have different parasite deworming requirements. Before creating such a program she suggests veterinarians develop a deworming schedule specific to their geographic location, and also that they analyze which types of dewormer should be used throughout the year in their region of the country.

Also, she cautioned that this program is not possible without appropriate staffing and time at the clinic to implement and process all the fecal samples.

By scheduling routine fecal exams for their horses, owners can feel confident they're following a personalized deworming program that meets their horse's individual needs. Additionally, True noted, some owners will save money by reducing the amount of dewormer they must purchase annually, which is a positive in the current economy.

Antimicrobial-Associated Diarrhea

Veterinarians commonly treat many equine infections with antimicrobial drugs to achieve resolution. However, in some cases, the antimicrobials themselves induce gastrointestinal disturbances with subsequent diarrhea. "This unfortunate side effect of antibiotics may prolong the time of hospitalization, increase the cost of treatment, and increase the risk of mortality," explained Bonnie Barr, VMD, Dipl. ACVIM, of Rood & Riddle Equine Hospital in Lexington, Ky. She presented her study in which she examined antimicrobial-associated diarrhea cases (AAD) from three referral practices (in Florida, Kentucky, and New Jersey).

In the study she and colleagues reviewed nonhospitalized horses older than weanling age that developed diarrhea during treatment with antibiotics for non-gastrointestinal problems. Subsequently, these 32 cases were admitted to a referral

hospital. Fecal samples were tested for enteropathogens such as *Clostridium difficile*, *Clostridium perfringens*, and *Salmonella* spp. Ages of the horses, mostly Thoroughbreds, ranged from 4 months to 28 years. Of these horses, 18 had received a single antimicrobial drug, while 14 had received a combination of two antibiotics. The target of the original antibiotic treatment in most cases was respiratory problems.

Barr pointed out one noteworthy finding from the AAD submission data to three referral practices: There was a regional difference in AAD incidence. She suggested that this might be attributable to differences in diet and management that affect intestinal flora and the presence of intestinal pathogens. The equine referral hospital in New Jersey had 2.8% incidence of AAD, compared to Kentucky (0.7% incidence) and Florida (0.3% incidence).

“ This unfortunate side effect of antibiotics (diarrhea) may prolong the time of hospitalization, increase the cost of treatment, and increase the risk of mortality. ”

DR. BONNIE BARR

In comparison, when Barr reviewed records of 5,251 horses on antimicrobial therapy from the three practices combined she identified an overall 0.6% incidence of AAD. The most commonly administered antimicrobial was oxytetracycline (1,243 cases), with no associated diarrhea cases. She expected enrofloxacin to be not as likely to cause diarrhea due to its poor anaerobic activity, but it actually resulted in eight cases of diarrhea. Use of single antimicrobials such as trimethoprim-sulfa, doxycycline, ceftiofur, or oxytetracycline was associated with low numbers of AAD cases despite previously reported figures of a higher incidence.

According to Barr, combination treatments, with their broad-spectrum activity, are more likely to disrupt intestinal flora and subsequently increase AAD incidence.

Twenty-two percent of horses presenting

with AAD tested positive for an enteropathogen, namely *C. difficile* or *Salmonella*. Of these, 19% died, confirming that antibiotics can result in disruption of the normal flora and, if severe enough, can have a negative outcome.

Barr summarized that veterinarians must use antimicrobials at the recommended dose, with considerations regarding efficacy, ability to reach the infection site, route of administration, whether the drug is labeled for equine use, and the potential for side effects. Veterinarians should only use these drugs off-label when no approved or commonly accepted drug or dose is available. Barr's study confirmed that almost all antimicrobials can be associated with diarrhea, but the overall incidence is low.

Equine Proliferative Enteropathy: Developing a Challenge Model

It isn't every day that a new disease or ailment is discovered, as many of the most common equine health problems have been around for several decades, if not centuries. But within the past decade a new disease has emerged that appears most frequently in weanlings. The disease is equine proliferative enteropathy (EPE), a gastrointestinal disease that causes excessive weight loss and stunted growth in foals.

Because veterinarians only recently discovered EPE, little research has been completed on it. But Allen E. Page, DVM, of the University of Kentucky, has developed a challenge model for EPE.

The bacterium *Lawsonia intracellularis* is the causative bacterial agent for EPE, which is characterized by diarrhea, depression, fever, inappetence (anorexia), weight loss, edema (fluid accumulation in the skin) of the throatlatch, ventral abdomen, or lower limbs, a poor hair coat, and intermittent colic (due to thickening of the mucosal lining in the small intestine). Most of the knowledge that equine veterinarians possess about this disease is from the research that has been done in swine, in which *L. intracellularis* was noted long before it appeared in horses.

The disease typically is not fatal, providing that a diagnosis is made early and the foal receives proper medical treatment. Even then, however, the foal likely will have suffered severe weight loss and stunted growth; affected foals might have a smaller overall stature than unaffected

ones, although research into this aspect of EPE is lacking.

In order to study EPE in a controlled manner, Page designed the challenge model whereby he administered *L. intracellularis*, isolated from a previous case of EPE, to six weanlings through a nasogastric tube. The challenged weanlings were monitored daily for signs of EPE with samples (fecal and blood) collected for analysis at regular intervals. The team also performed weekly ultrasounds to check for thickening of the intestinal walls, and they weighed the foals on a weekly basis. At the end of the study Page and colleagues performed a necropsy on each of the weanlings, examining the small intestine for signs of *L. intracellularis* infection since this is where the bacteria typically infect the horse.

Of the six weanlings that were challenged with *L. intracellularis*, four contracted forms of EPE based on analysis of all of the data that was collected during the study. Page added that one of the foals was affected subclinically (the horse did not show any outward clinical signs of disease). The remaining two weanlings showed no signs of EPE, which is consistent with real-world cases where weanlings are exposed to the *L. intracellularis*, but never develop EPE.

Page added that larger challenge studies are needed to help further researchers' understanding of EPE and the bacterium that causes it.

Colic Surgery and Intestinal Lubricants

Colicky horses that undergo exploratory surgery and are ultimately diagnosed with an ileal impaction appear to benefit from a single injection of carboxymethylcellulose (CMC) into the ileum to resolve the problem, according to veterinarians from Auburn University's College of Veterinary Medicine.

"Impactions of the ileum, the last part of the small intestine, are a relatively common occurrence in certain geographic regions and are associated with the ingestion of Coastal Bermudagrass hay," explained Christopher G. Alford, DVM, who with R. Reid Hanson, DVM, Dipl. ACVS, ACVECC (emergency and critical care), reviewed the use of CMC in ileal impactions.

He noted that many horses presenting with ileal impactions can be managed medically, but sometimes surgery is performed



Finding alternate ways to break down an ileal impaction other than cutting into the ileum would decrease postoperative complications and increase horses' chances for survival.

to resolve the impaction—surgery that has its own associated risks. "A large variety of complications can occur in horses undergoing abdominal surgery, especially if the intestines are cut into or a section of intestine is removed," noted Alford.

Finding alternate ways to break down the impaction other than cutting into the ileum would decrease the postoperative complications and increase the horse's chance for survival, he noted. "Using the 'lubricant' CMC is a simple way to reduce the impaction with a minimal effect on the small intestine," he said. "CMC penetrates and rehydrates the impaction, but its primary mechanism of action is lubricating the impaction, making it easier (for the ingesta) to pass into the cecum."

In their prospective study, after completely exploring the abdomen and diagnosing an ileal impaction, Alford and Hanson injected approximately 1 L of 1% CMC into the ileum. Then they massaged the ileum and broke down the impaction.

CMC has been previously studied in abdominal surgery and has shown to have beneficial effects when placed in the abdomen by preventing postoperative adhesions and increasing overall survival rates from colic surgery. It has not been studied in regards to injection within the gastrointestinal tract itself, however Alford noted that CMC is often used as an additive and thickener in the food industry and is safe for ingestion. The ability of CMC to

penetrate the impaction and facilitate its reduction, while also lubricating and protecting the outer serosal surface of the intestine, makes it an ideal substance to aid in resolution of surgical ileal impactions.

Alford noted, "In our hands, this technique has been safe and effective. No immediate intraoperative or postoperative complications attributable specifically to the injection of CMC were noted."

Battling Dehydration in Horses with Hypertonic Saline

When horses have hemorrhaged or have experienced fluid losses from dehydration, they can end up in a dangerous state of low blood volume, called hypovolemia. Veterinarians use hypertonic saline to restore blood pressure while administering additional fluids, plasma, or blood to restore fluid volume. Langdon Fielding, DVM, Dipl. ACVECC, of Loomis Basin Equine Medical Center, in Loomis, Calif., reviewed the use of hypertonic saline for multiple equine conditions.

Fielding explained that in a Robin Hood-like effect, tissues rich in fluid are forced to redistribute to areas poor in fluid. This creates dual effects—fluid loss in tissue means excess edema (fluid swelling) is eliminated while spaces gaining physiologic "water" restore rapidly along with improved blood pressure. A horse in need of fluid restoration shows specific clinical signs: rapid heart rate, weak pulse, pale

COURTESY AAEP/DR. CHRISTOPHER G. ALFORD



mucous membranes, delayed capillary refill time, slow jugular vein refill, cold extremities, and reduced urine output.

For blood loss, moderate dehydration, or shock, Fielding recommends administering two liters of hypertonic saline (per average 500-kg, or 1,100-lb. horse) followed immediately by administering intravenous (IV) isotonic fluids and perhaps additional oral fluids. Fielding pointed out a few things veterinarians should consider before reaching for hypertonic saline: If the hemorrhage has not been well-controlled, then raising blood pressure with hypertonic saline might exacerbate bleeding and, therefore, might not be the best choice of therapy. Also, for marked dehydration, he cautioned veterinarians about using hypertonic saline as there might not be sufficient tissue fluid to “steal” to restore the extracellular space—in these cases, such as with dehydrated endurance horses, concurrent restoration with isotonic IV fluids and oral supplementation of water are extremely important strategies.

Fielding also suggested using hypertonic saline (1/2 liter given three to four times a day per 500-kg horse) to combat edema formation subsequent to traumatic injury to the central nervous system, particularly as a substitute for mannitol (often used

Veterinarians use hypertonic saline to restore blood pressure while administering additional fluids, plasma, or blood to restore fluid volume.

to reduce brain swelling). Horses with gastrointestinal disease that has caused large fluid losses through diarrhea benefit from restoration with hypertonic saline. New research suggests that hypertonic saline might mitigate effects of intestinal

shutdown (ileus) in colic by reducing bowel edema severity. And, by boosting blood pressure, hypertonic saline provides a rapid rescue treatment for refractory hypotension (low blood pressure of unapparent cause) that can occur during anesthesia.

Severe electrolyte derangements complicate use of hypertonic saline administration, and veterinarians must take care when treating horses with kidney or other organ dysfunction using this method.

Fielding said he is impressed by the growing number of practical uses for hypertonic saline, the ability to administer this therapy rapidly in minutes rather than hours, and also by how easily a veterinarian can store this relatively inexpensive product on an ambulatory veterinary truck without it taking up much space. 🐾

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Compounding

BY NANCY S. LOVING, DVM

Risks of Veterinary Compounding

More than 12,000 compounding pharmacies operate in the United States, and each year compounded product sales reach \$300 million—25% of that is spent in the animal pharmaceutical industry alone. The Food & Drug Administration (FDA) has developed regulations to provide assurances for safety and efficacy of drugs and devices, to ensure food supply safety, and to regulate food chain supplies and animal foods; so how do these apply to compounding? Scott Stanley, PhD, professor of Equine Analytical Chemistry at the University of California, Davis, discussed FDA's ongoing attempts to ensure safety of drugs produced by compounding pharmacies (that provide individualized medications that are prescribed, but unavailable through normal means).

He described a study conducted by the FDA in which scientists analyzed 29 samples from 12 compounders. Stanley noted that 10 of the samples failed to meet the FDA standard for quality testing (which for potency is $\pm 10\%$ of the labeled concentration), yielding a 34% failure rate compared to the typical 2% failure rate seen among the entire pharmaceutical industry in general. More than half of the failed samples contained less than 70% of the labeled potency.

Equine practitioners must evaluate the integrity of compounding pharmacies as well as the quality and consistency of drugs produced. Stanley remarked that many practitioners express concerns about the efficacy of products that different pharmacies compound, noting that just because a pharmacy prepares a product doesn't mean that it's efficacious—what an owner might perceive as a legitimate, reliable source of medication might not always be. In addition, veterinarians must consider the quality (potency, purity, and stability) and consistency of drugs as well as their liabilities for using that particular product.



STEPHANIE L. CHURCH

The FDA is working to ensure compounded animal pharmaceuticals are safe.

Stanley explained that the FDA does not permit compounding, but rather uses "enforcement discretion," meaning that if a product cannot be obtained to control a life-threatening disease process or to control suffering, then the use of a compounded product is permitted.

The Animal Medicinal Drug Use Clarification Act (AMDUCA) allows manufacturing, preparation, propagation, processing, and compounding of drugs as long as a product is not already commercially available. In addition, there must be a valid veterinarian-client-patient relationship to dispense these drugs. Three categories of drugs are

available for use:

- FDA-approved "pioneer" drugs: These are studied through clinical trials that show efficacy, safety, and quality; it often costs \$30 million to get a drug through the FDA-approval process;
- Generic drugs: These are subjected to an abbreviated process for verifying efficacy—companies must demonstrate that a generic drug is a drug's biologic and/or chemical equivalent, and it must meet label claims for the product; and
- Compounded drugs.

Compounding a drug is a form of adulteration, according to Stanley, since it



includes any manipulation of a drug formulation to produce a dosing form different from label requirements. He said pharmacies should not provide drugs that are commercially available or those slightly altered by flavoring or by small changes in drug strength.

There is little external oversight; compounding pharmacies are mostly self-regulated. A compounded product cannot be called a generic equivalent and cannot be substituted for an available FDA-approved product. A compounder may reformulate an approved animal or human drug to change its delivery, for example, turning powder into paste, or if a formerly FDA-approved drug is no longer available. In addition, only a 72-hour supply should be kept on-hand at the pharmacy for dispensing. In every compounding case there must be a valid veterinarian-client-patient relationship. Label instructions include specific details on how it is to be used.

Before choosing a compounding pharmacy, Stanley recommends researching information about the pharmacy, asking if it is accredited by the Pharmacy Compounding Accreditation Board (PCAB), if the pharmacist has obtained appropriate training, and if the pharmacy has liability insurance. He also recommends finding out if the product you're seeking is prepared using pharmaceutical or chemical (bulk) grade materials and where these were obtained.

He noted red flags that are causes for concern, such as an overly long expiration date—by law the longest expiration date on a compounded product can only be six months. Other red flags include statements of sterility, marketing materials presenting the product as cheaper than an available FDA-approved product, or AVMA or pharmaceutical complaints that have been filed. Clients should be concerned about websites that advertise compounded drugs, particularly when medications are available without necessary prescriptions.

Stanley described omeprazole as an example of compounding issues that arise. Two FDA-approved products (Gastrogard and Ulcergard) with demonstrated efficacy and stability are available. Any compounded formulation with omeprazole is currently considered pirated since Merial still owns the use patent. The pH

of omeprazole is very sensitive—pH less than 7.8 results in rapid deterioration. Compounded pirated omeprazole products showed low pH values as well as dosing inconsistencies—only one of six products met FDA potency requirements upon arrival at the test lab. Similar findings occurred with non-steroidal anti-inflammatory medications: Levels were only 68% of label-claimed potency in injectable flunixin meglumine (Banamine) and 72% potency in powdered phenylbutazone (Bute).

FDA regulations on medical devices are stringent—a medical device is defined as an external device that does not result in a chemical reaction within or on the body. There are several products FDA-approved as medical devices but used as drugs for intra-articular therapies; therefore, Stanley remarked that any injectable medical “device” is considered a drug. Should a practitioner choose to use a device as a pharmaceutical, he or she should be aware that these products have not been evaluated to determine their suitability for that usage by any regulatory agency.

Stanley also stressed that a client cannot consent to substandard care (per legal standards for medical malpractice). Clients might not understand that just because a product is formulated and prepared for resale doesn't mean it is therapeutic to achieve desired results. Stanley also emphasized the importance of client education, including counseling the client regarding potential adverse reactions and possible efficacy failure.

He summed up the possibilities of what can go wrong in compounding:

- Inadequate oversight of quality assurance and control, resulting in formulation error or drug used in an improper application;
- Inadequate storage—If the potency is low (deteriorated), the drug might not work (therapeutic failure). If the drug degrades into a toxic intermediate, the patient can become sick or die from it;
- Lack of product testing;
- Lack of recall procedures (if a product were to test as unsafe, sufficient structure might not exist to be able to recall the products, as there would be with an FDA-approved product);
- Inadequate processing facilities re-

garding cleanliness (resulting in a potentially contaminated product);

- Improper operation and maintenance of equipment; and
- Oversight by FDA and state pharmacy boards can be difficult/limited due to economic cutbacks.

AAEP now requires PCAB accreditation of compounding pharmacies with exhibits at their annual convention trade show to meet a minimum standard.

Compounded Pergolide

Systemic effects of equine Cushing's disease, a common malady in older horses, have been controlled well in many horses with daily administration of pergolide. Until 2007 this medication was available for off-label use—the human product was available for purchase. Then, the FDA-approved product was removed from the human pharmaceutical market. The product now has to be compounded in order to be available to

Clients should be concerned about websites that advertise compounded drugs, particularly when medications are available without necessary prescriptions.

the equine population, so quality control issues became a large concern. Stanley discussed efficacy, potency, and stability of compounded pergolide preparations.

In a recent study Stanley examined the potency and stability of three different compounded pergolide products—liquid suspensions, powders in bulk form, and powder-filled capsules—relative to storage duration and varied storage temperatures. In previous studies and reports, authors recommend that storage should not exceed 30 days and that pergolide products—particularly those in liquid suspension form—are best stored at 8°C (46° F).

Stanley began his discussion by addressing liquid suspensions, noting that three out of seven tested suspensions did test as having the target potency



prior to storage. However, after storage, potency decreased to 30-40%, even at 8°C (46°F). After 60 days, the potency of most products stored at 25°C (77°F) with exposure to light fell below 70% of the target potency and were inconsistent from lot to lot.

Storage temperature did not appear to affect powdered or capsulated forms of pergolide. Four out of seven products (each from different compounding pharmacies) started at levels above the target potency; however, active medication in each capsule varied by as much as 200%. Stanley concluded that potency testing at the compounding pharmacy that produced the compounded capsules that tested higher than 200% was lacking during preparation, and stability data (evaluations that are carried out to study the chemical and physical stability of formulations) was unavailable.

Stanley observed that many products fell far below labeled potency upon delivery to the test lab. Liquid prepara-

Stanley explained that density of the pergolide chemical is 15 times greater than the lactose that is mixed with it, and inadequate mixing, in this case, distributed pergolide unevenly throughout the mix.

tions were unstable, and potency decreased rapidly regardless of storage conditions, especially considering they were to be used within 30 days of manufacture. Powdered formulations (either in bulk form or in capsules) were less susceptible to degradation, but potency levels among capsules within a single

prescription bottle were erratic. Capsulated products degraded more slowly than suspension, but potency variability among capsules made it difficult to assess and interpret these products. Stanley explained that density of the pergolide chemical is 15 times greater than the lactose that is mixed with it, and inadequate mixing, in this case, distributed pergolide unevenly throughout the mix. Subsequently, some capsules were filled with too much active pergolide, while others contained too little.

The consequences of an excess or insufficient dose of pergolide are significant in terms of toxicity or efficacy. Stanley urged all practitioners to be critical when selecting a compounding pharmacy to prepare a pergolide product for their patients. 🐾

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Drugs and Anesthesia

BY NANCY S. LOVING, DVM, AND STACEY OKE, DVM, MSC

Treating Severe Forelimb Pain With a Continuous Nerve Blockade

Veterinarians can reduce a horse's severe forelimb pain by administering a continuous, low-dose infusion of the local anesthetic bupivacaine, but this method is not suitable for every case, according to researchers from Cornell University's College of Veterinary Medicine.

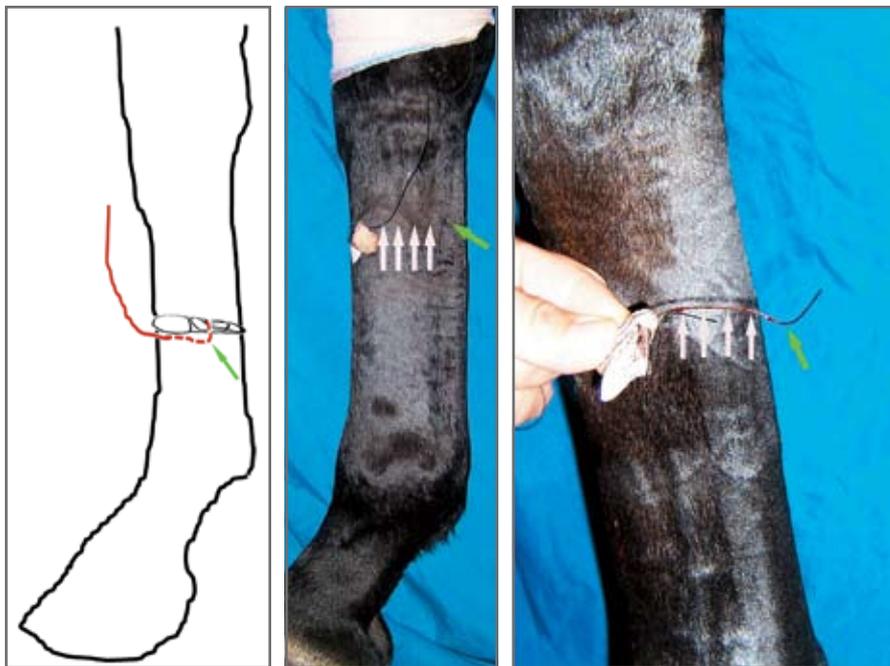
"Severe forelimb pain can occur with fractures, joint or tendon sheath infections, or traumatic injuries," explained Ashlee E. Watts, DVM, Dipl. ACVS, a graduate student pursuing a PhD and a part-time large animal surgeon, who presented a study on this subject. "In response to the reluctance to bear weight on a severely painful limb, increased weight bearing stresses are placed on the opposite forelimb, which can lead to support limb laminitis."

Veterinarians can administer epidural medications in the hind limb to drastically reduce pain. Since an epidural cannot be used for forelimb pain, Watts and colleagues assessed the use of a continuous peripheral nerve blockade (CPNB). This technique is performed by inserting a catheter in the mid-metacarpal (cannon bone) region between the suspensory ligament and the deep digital flexor tendon and continuously administering bupivacaine to the palmar nerves. These nerves are responsible for transmitting pain signals from the tissues of the distal cannon bone, fetlock, pastern, and foot to the spinal cord and brain.

Watts and colleagues compared the effect of administering bupivacaine via CPNB at a rate of 0.14 mL/hour to that of injecting bupivacaine only intermittently (0.85 mL every six hours). They studied 14 horses with experimentally induced forelimb pain over three days.

Key findings:

- CPNB can be performed using a single catheter and a low volume of bupivacaine that does not cause complete nerve block;



The diagram on the left shows placement of a catheter for continuous administration of bupivacaine to the palmar nerves that transmit pain signals. The middle photo shows the catheter prior to removal, and the photo at right shows the catheter immediately after removal. The solid red line (in diagram) represents the catheter; the dotted red line on the diagram/white arrows on the photos shows subcutaneous (beneath the skin) catheter placement. The green arrows show where the catheter transitions from subcutaneous to between the suspensory ligament and check ligament.

- Catheters were easily placed and did not dislodge with normal limb movements; and
- CPNB effectively decreased severe, short-term lameness compared to intermittent low-dose injections. No adverse effects of the injections were noted.

"One catheter did culture positive for *Staphylococcus aureus*, suggesting that although this technique can reduce lameness from short-term, severe forelimb pain, clinicians need to consider the risk of microbial contamination to the tissues when selecting cases in which to use this technique," concluded Watts.

Side Effects of Sedative Reversal

The idea of being able to "unsedate" or "reverse" a sedated horse after minor procedures is a great one, but veterinarians must select their cases carefully and be

vigilant about using these drugs properly.

"The alpha-2 adrenergic agonists xylazine, detomidine, and romifidine are all commonly used sedatives in equine practice," relayed David B. Scofield, DVM, of Colorado State University's College of Veterinary Medicine & Biomedical Sciences. "Their effects can be reversed by such drugs as tolazoline and yohimbine."

Tolazoline is FDA-approved for horses and has been deemed a safe pharmacologic product: "Yohimbine is approved for use in dogs, so there is no label claim for the horse. Tolazoline is specifically labeled for the horse, therefore it's deemed safe for use in the horse."

To document the side effects associated with tolazoline or yohimbine in horses, Scofield and colleagues collected data from case reports on the AAEP e-mail distribution list and Equine Clinician's

distribution list in early 2010.

“Thousands of doses of tolazoline and yohimbine are used successfully each year without incident,” he said. “This survey found only 18 adverse reactions that occurred without a pattern or predisposing factors.”

Of these 18 reports from veterinarians, seven horses were treated with tolazoline and 11 with yohimbine. Four and nine deaths occurred respectively following administration of these drugs.

Veterinarians are well aware that no drug is risk-free; however, Scofield et al. warned that adverse reactions to alpha-2 antagonist agents like tolazoline and yohimbine can occur unpredictably and without a predisposing factor.

In horses that exhibit a reaction to an alpha-2 antagonist, the study authors suggested providing cardiovascular support via intravenous fluid therapy and administering a vasoactive drug such as phenylephrine.

“As outlined in our paper included in the AAEP conference proceedings, veterinarians are encouraged to follow the dosage time frame and routes of administration to limit the potential for an adverse reaction and to carefully weigh the benefits of the use of these drugs for nonemergency situations,” Scofield concluded.

Horse Sedation with an Oral Gel

We’ve all heard about or witnessed horses that simply refuse to be restrained long enough for the veterinarian to administer a much-needed intravenous sedative. Authors of a recent study suggest that a sedative-containing gel might be just what the doctor ordered in these cases.

Detomidine is an alpha-2 adrenergic agonist and one of the more common drugs used to sedate horses. Usually, veterinarians administer detomidine intravenously, but they can inject it intramuscularly as well.

For those “hard to reach” horses, an oral formulation that can be administered by either a veterinarian or horse owner/trainer would be a valuable product, said Gary W. White, DVM, of Sallisaw Equine Clinic, in Oklahoma. White and colleagues tested the gel in 129 horses.

“The horses in the treatment group were sedated with a single, sublingual (beneath the tongue) dose of the gel prior



Above, a demand valve is being used to ventilate an anesthetized horse.

to performing such procedures as cleaning the prepuce (sheath), clipping hair, trimming feet, shoeing, manual rasping of teeth, radiography, and passing a stomach tube or endoscope,” said White.

“Hypoventilation in anesthetized horses is undesirable because reductions in breathing cause changes in the amount of oxygen that is delivered to the body ...”

DR. JOHN A. E. HUBBELL

The researchers included an additional 42 horses in a placebo group.

Key findings:

- Handlers were able to complete 76% of the procedures successfully in the treatment group;
- They were successful in completing only 7% of the procedures were in the placebo-treated horses; and
- The researchers did not note any significant side effects following administration of the detomidine gel.

“This study demonstrated that the gel is safe and effective for horses requiring sedation for routine procedures,” concluded White.

This was one of the studies required for U.S. approval of detomidine oral gel in the United States. The product is now approved and is available from Pfizer Animal Health as Dormosedan Gel.

Avoiding Respiratory Problems in Anesthetized Horses

Letting ‘sleeping horses lie’ may not be the best thing when they’re anesthetized, according to John A. E. Hubbell, DVM, MS, Dipl. ACVA (anesthesiology), professor of veterinary anesthesiology in the Department of Veterinary Clinical Sciences at The Ohio State University’s College of Veterinary Medicine. In fact, the horse might not get enough oxygen, so some kind of ventilation is preferred, particularly when anesthesia extends for 60 minutes or longer. Hubbell reviewed support ventilation techniques for the anesthetized horse.

Hypoventilation occurs when a horse’s lung ventilation is reduced or deficient. Hubbell explained, “Hypoventilation in anesthetized horses is undesirable because reductions in breathing cause changes in the amount of oxygen that is delivered to the body and changes in metabolism by altering the cellular



COURTESY DR. LORI BIDWELL/AAEP PROCEEDINGS

The musculature in the donkey's neck can make accessing the jugular vein more difficult in donkeys, which complicated the process of inserting a catheter for general anesthesia.

environment of various organs, including the heart, liver, and muscles.

“Even healthy horses hypoventilate under general anesthesia,” he continued. “This decrease in respiration and subsequent decrease in oxygenation of their tissues is caused by three main things: the drugs they are administered, being laid down on their sides or back, and the length of time they are anesthetized.” Most anesthetic procedures in the field last less than an hour, and horses kept under for that amount of time usually tolerate the hypoventilation well in most instances. Regardless, all anesthetized horses benefit from the administration of oxygen while they are recumbent, Hubbell noted.

A number of veterinary researchers have looked at ways veterinarians can minimize the degree of this “respiratory embarrassment” (i.e., respiratory depression, hypoventilation, and decreased oxygen delivery). He summarized these as follows.

During short procedures veterinarians should monitor anesthetized horses' ventilation and oxygenation by looking at their respiratory rate and the “pinkness” of their gums. During longer procedures, the best way to assess the adequacy of ventilation is to take a sample of arterial blood to measure pH and the blood gases (carbon dioxide and oxygen). Portable, “stall-side”

units allow veterinarians to assess ventilation even in remote locations. Arterial blood-gas analysis is the “gold standard” method of monitoring ventilation and oxygenation.

Veterinarians should enhance oxygenation by delivering oxygen (“insufflating”) via a compressed gas source through a delivery tube to the pharynx or trachea.

Veterinarians should support ventilation and oxygenation either manually (by compressing an air-filled bag that delivers air to the horse) or with a commercial ventilator. Larger breaths and lower respiratory rates are better. Excessively fast respiratory rates should be avoided because the distribution of ventilation is less optimal when they are used.

Any anesthetic procedure has the potential to significantly impair respiration and oxygenation in the horse, Hubbell added. Anesthesia of a short duration is relatively well tolerated, but horses anesthetized for longer procedures benefit from increased inspired oxygen levels and assisted ventilation.

Anesthesia for Donkeys vs. Horses

“Donkeys are becoming more common patients for equine veterinarians, and although it is tempting to treat a donkey like a horse, there are important differences regarding patient handling and

drug dosages,” said Lori Bidwell, DVM, of Lexington Equine Surgery and Sports Medicine in Kentucky. She discussed the key differences between anesthetizing donkeys and horses, listing several behavioral and physiologic differences between the two equids:

- Donkeys behave differently than horses (their behavior is often closer to that of cattle rather than horses);
- The musculature in the donkey's neck can make accessing the jugular vein more difficult in donkeys, which complicates the process of inserting a catheter for general anesthesia. A local anesthetic and surgical incision can help veterinarians place an intravenous catheter more easily;
- The angle of the larynx at the back of the throat (top of the trachea) is different than in horses, and donkeys have a pharyngeal diverticulum (pocket) in their throat, excess tissue in their pharynx, and elongated laryngeal sacculles (part of the airway that aids in vocalization). Together, these differences make placing an endotracheal tube through the mouth to the trachea more difficult; and

- Nasal intubation also is more challenging because donkeys have narrower nasal passages than horses.

Also, higher doses (typically 1.5 times the horse dose) of a number of drugs are needed in donkeys. “One notable exception is guaifenesin (a centrally acting muscle relaxant). Horse doses of this drug in donkeys can cause respiratory arrest,” she warned.

In general, all of the same types of drugs can be safely used in both horses and donkeys. This includes sedatives (e.g., xylazine and detomidine, used to sedate for standing surgeries), drugs used to induce or maintain general anesthesia (e.g., ketamine, diazepam), and drugs for pain management (e.g., butorphanol, morphine).

“Donkeys can be easy to work with if everyone appreciates that they are not horses,” concluded Bidwell.

Bute vs. Firocoxib Safety

The non-steroidal anti-inflammatory drug (NSAID) firocoxib had fewer side effects than phenylbutazone in horses after 42 days of treatment, according to scientists from Merial Limited who presented



comparative research results.

Phenylbutazone, or "Bute" as it is commonly called, is useful for controlling pain and/or inflammation in many equine veterinary cases, but its use is not without risk. Side effects such as gastric ulcer formation and kidney damage can occur.

Like phenylbutazone, firocoxib is also a non-steroidal anti-inflammatory drug. It is approved to control pain and inflammation associated with equine osteoarthritis at a dose of 0.1 mg/kg once daily for up to 14 days.

Bute, considered a "pioneer" NSAID, inhibits the production of pro-inflammatory molecules (called prostaglandins, produced from fatty acids) by blocking the action of an enzyme called cyclooxygenase (COX, which makes the prostaglandins from the fatty acids). Unfortunately, Bute blocks some "good" prostaglandins, such as those that protect the lining of the stomach. Newer NSAIDs such as firocoxib are more selective and mostly block the production of "bad" prostaglandins;

therefore, these are thought to have fewer untoward side effects.

The research team treated 42 horses with various dose levels of firocoxib and phenylbutazone once daily by mouth (orally) for 42 days. They found:

The non-steroidal anti-inflammatory drug (NSAID) firocoxib had fewer side effects than phenylbutazone after 42 days of treatment.

- There was an 88% increase in gastric ulceration in the horses treated with therapeutic levels of phenylbutazone (4.4 mg/kg), compared to only an 11% increase in horses in the control group and those treated with elevated levels of firocoxib (0.5 mg/kg);

- Microscopic damage to the gastrointestinal tract occurred following phenylbutazone, but investigators did not note any damage even after administering five times the therapeutic level of firocoxib; and

- The researchers noted microscopic damage to the kidneys following administration of therapeutic doses of phenylbutazone, but they noted similar damage only in the higher-dose firocoxib-treated horses.

The research team concluded that after 42 days of treatment at therapeutic levels, firocoxib was well-tolerated, whereas phenylbutazone was associated with gastrointestinal ulceration and tubulointerstitial nephropathy (a type of kidney damage that can lead to kidney failure). 🐾

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Racehorse Topics

BY ERICA LARSON AND STACEY OKE, DVM, MSC

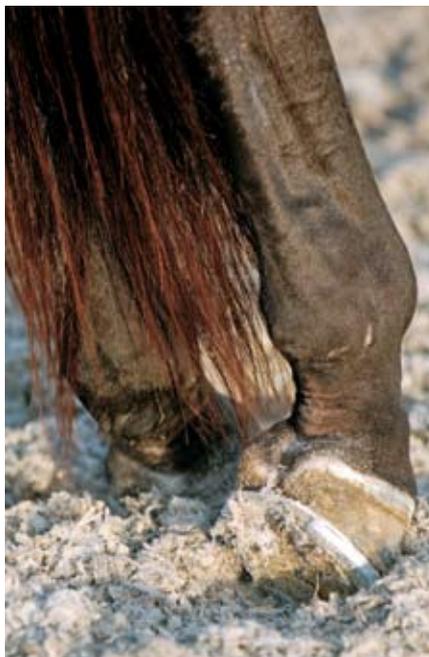
Fatality Rates and Track Surfaces

The horse racing industry is continuously working to make the sport safer for all parties involved, and in 2008, the California Horse Racing Board (CHRB) mandated the use of synthetic track in an attempt to reduce the number of catastrophic injuries that took place on California racing surfaces. To see if the switch was a success, Rick Arthur, DVM, the equine medical director of the California Horse Racing Board, undertook a retrospective study to compare the rates of catastrophic musculoskeletal injury (CMIs) on dirt, turf, and synthetic surfaces at the four major California racetracks (Hollywood Park, Del Mar, Santa Anita, and Golden Gate Fields) from Jan. 1, 2004 to Dec. 31, 2009.

After three years of racing in which California tracks saw a 40% increase in equine fatalities, the CHRB made the decision to mandate synthetic track surfaces for all tracks that featured more than 30 consecutive days of racing in one calendar year, effective Jan. 1, 2008. The decision came after Turfway Park in Florence, Ky., made the switch from dirt to synthetic in 2005 and saw an 85% reduction in the number of catastrophic injuries on the track.

According to Arthur, all horses that die within the racing enclosure at CHRB tracks must undergo a necropsy. He reviewed all of the necropsy reports over the six-year period to obtain his results. Arthur pointed out that he did not include several of the necropsy reports in his study, as they were not related to the track surface. The excluded fatalities were listed by track surface and included starting gate accidents, sudden deaths (such as cardiac events), and other accidents.

Hollywood Park was the first to install the synthetic track in late 2006; the other three tracks followed suit in 2007. From the beginning of the study until the synthetic surfaces were installed on the main tracks, California had a combined rate of 3.09 catastrophic injuries per 1,000 starts, or 181 fatalities out of 58,659 starts, on the dirt tracks.



Catastrophic injuries were shown to decrease when tracks switched to synthetic surfaces.

After the change from dirt to synthetic, the four major tracks in California had a combined fatality rate of 1.95 deaths per 1,000 starts, or 109 fatalities out of 56,031 starts.

The turf courses at the four tracks held a combined fatality rate of 2.44 catastrophic injuries per 1,000 starts, or 89 fatalities out of nearly 36,500 starts. There was no significance difference between 2004-2006 turf fatality rates (2.37 fatalities per 1,000 starts) when the main tracks were dirt and 2007-2009 (2.50 fatalities per 1,000 starts) when the main tracks were synthetic.

However, Arthur also discussed a general nationwide trend that after the change-over and initial reduction in catastrophic injuries sustained on the synthetic track, there tends to be a slight and gradual rise in the number of fatalities. He attributes this to the synthetic material wearing out very quickly and difficulty in maintaining synthetic tracks.

"This was a novel technology," he said. "It's very difficult and expensive to

maintain a synthetic surface, and it also sees a very high volume of horses working and training on the surface."

Arthur said that he would like continue studying the effects of racing surface on musculoskeletal injuries by finding more data on nonfatal racing injuries and also on injuries that occur in training. Also, he is hoping to make further correlations with a horse's veterinary history and past track performance, and weather, track composition, and track maintenance.

X Ray Abnormalities in 2-Year-Olds

In the first study of its kind performed on 2-year-old Thoroughbred racehorses, Daniel T. Meagher, DVM, MS, Dipl. ACVS, of Valley Equine Associates, in Ranson, W.Va., set out to determine the prevalence of radiographic lesions and their effect on race performance. A similar study was previously carried out on radiographic abnormalities in yearlings, but Meagher's study was the first to examine the prevalence of abnormalities in 2-year-olds and what effect those had on their racing careers.

Meagher presented the current study in which he and his colleagues examined carpal, fetlock, stifle, and hock radiographs associated with 2-year-olds in training sales from 1997 to 2001 in Barretts Equine Limited's repository. Barretts, a Thoroughbred auction company based in Pomona, Calif., gave Meagher access to these radiographs for the research.

Of the 953 sets of radiographs examined, 69% (654 horses) had no evidence of lesions and served as controls, and the remaining 31% (299 horses) with lesions were considered cases. Meagher noted that 63% of the case horses were male, and that 11 horses had lesions in more than one region (in both the knee and the fetlock, for example).

Meagher's findings revealed that the case horses were statistically less likely to start a race or earn money. "Eighty-six percent of (case) horses raced, while 91% of control horses raced," he said.



“Specific radiographic abnormalities were associated with lower race performance,” Meagher wrote. “However, none of the individual lesions prevented all affected horses from racing.”

The researchers revealed that lesions in the fetlock area were most common, with approximately 40% of the case studies (121 horses) showing such lesions. Meagher noted the most drastic difference in performance between case and control horses involved horses with a forelimb proximal P1 chip fracture (a chip in the upper portion of the long pastern bone)—a less commonly found, but still significant, lesion.

“A study examining the effects of arthroscopic removal of P1 chips in racehorses shows that the prognosis is favorable following removal,” he observed. “Therefore, the assumption is that proximal P1 chips are not a big deal on pre-sale radiographs, and this (information) may refute some of that dogma.

“However, caution must be taken in interpreting these results, as no knowledge of pre- or post-sale surgery was known,” he advised.

Catastrophic Injuries: Thoroughbreds vs. Quarter Horses

In the Midwest there are several racetracks—featuring both Thoroughbred and Quarter Horse racing—that sometimes slide under the radar of the mainstream racing community. But like all other tracks around the nation, these venues see wins, losses, and, unfortunately, catastrophic musculoskeletal injuries. Andrea L. Beisser, BA, of Iowa State University, and her colleagues analyzed the circumstances surrounding catastrophic musculoskeletal injury (CMI) at three tracks in these regions.

Beisser and her team evaluated a wide range of variables in order to obtain the most complete data set possible from Prairie Meadows in Iowa, The Woodlands in Kansas, and Remington Park in Oklahoma. She noted that the team was able to secure necropsy reports and race records on 130 Thoroughbred fatalities and 50 Quarter Horse fatalities.

They found that the average CMI rate of the three tracks was 1.46 fatalities per 1,000 starts. The average CMI count for Thoroughbreds was 1.48 per 1,000 starts, and Quarter Horses averaged 1.36 CMIs per 1,000 starts. Individually, all three tracks delivered similar results. Only dirt

tracks were used in the study.

Beisser’s team found that at the Midwestern tracks the highest frequency of Thoroughbred CMIs occurred in claiming races, while the majority of Quarter Horse CMIs happened in stakes or handicap races.

The average distance a Thoroughbred ran before sustaining a CMI was six furlongs, while the average distance a Quarter Horse ran was just 350 yards. Beisser explained that the difference in distance covered was likely due to the fact that Thoroughbreds generally run longer races than Quarter Horses do.

Additionally, the most common location of CMIs in Thoroughbreds was in the left forelimb, with nearly 57% of injuries occurring in that leg. Quarter Horses, however, saw 60% of CMIs in the right forelimb. Both Thoroughbreds and Quarter Horses travel the same direction during races.

“A study examining the effects of arthroscopic removal of P1 chips in racehorses show that the prognosis is favorable following removal.”

DR. DANIEL T. MEAGHER

The most common type of CMI reported in Thoroughbreds was a sesamoid (small bones behind the fetlock) fracture; such fractures were the cause of nearly 39% of the fatalities reported. Beisser added that humeral (forearm bone) fractures were overrepresented in Quarter Horses.

Beisser reported that when she and her colleagues compared 3- and 4-year-old Thoroughbreds, the 4-year-old Thoroughbreds were twice as likely to sustain a CMI. Additionally, she stated that the sex of the horse was not a significant factor in the study.

Beisser relayed that the Quarter Horse population of the study was small, so results should be interpreted with caution.

“The differences identified between Thoroughbred and Quarter Horse CMIs should allow regulatory veterinarians at mixed meets to focus the evaluations on horses and anatomical regions at greatest risk,” Beisser wrote in the study.

“Racing in smaller Midwest jurisdictions has similar injury rates to larger jurisdictions,” said Scott McClure, DVM, PhD, Dipl. ACVS, assistant professor in the department of clinical sciences at Iowa State and one of the co-authors on the study. “When we are pursuing further work in this area, we may want to consider the differences between Thoroughbreds and Quarter Horses.”

Humerus Stress and Track Surface

How much impact does a racing surface have on the horse’s body and which parts are stressed most during work? According to Abigail N. Dimock, DVM, MS, of the University of California, Davis, who in collaboration with Kurt Hoffman, DVM, and other colleagues completed a study on the subject recently, track surface has more of an impact on bone stress than was initially thought.

Dimock discussed the study in which the team examined nuclear scintigraphy images of 930 Thoroughbred racehorses in order to determine whether areas of remodeling in the humerus (the bone located between the shoulder and elbow joints) changed when dirt tracks in California were transitioned to synthetic surfaces. The horses raced at three California racetracks (Del Mar, Hollywood Park, and Santa Anita) and the images were collected from Sept. 1, 2005, to July 1, 2009. Although she has no definite history on the horses, Dimock presumes that the horses were scanned after being presented for lameness. The synthetic track was represented by 541 horses and dirt tracks were represented by 389.

In the study a reader (who had no knowledge of which surface the horses raced on) evaluated the scintigraphy scans, rating the severity of humerus lesions as mild, moderate, or severe, and also noting the location of each lesion.

In total, 166 horses from both groups had lesions (characterized by abnormal uptake in the scintigraphy images) in the humerus. Of those, 57 had bilateral abnormal uptake (areas of stress in both humeri). The blinded reader rated 138 of the lesions as mild, 62 as moderate, and 31 lesions as severe. Dimock noted that neither the injury rate nor lesion severity was significantly different between the two surfaces.

Dimock noted, however, that the locations of the lesions on the humerus



differed drastically between horses running on dirt and synthetic tracks. She found that horses that ran on synthetic surfaces had a much higher likelihood of developing a lesion in the distal (or lower) humerus, while the proximal (or upper) region was more common in horses that ran on dirt.

"The study confirmed that the lesion location changed with the change in track surface," Dimock said.

It is unclear why the location of lesions changed with the change in track surface, she added.

"Continued monitoring is necessary to determine whether this change is associated with a change in the configuration of stress remodeling in other bones or the incidence of catastrophic fractures," Dimock wrote.

Equine Scapular Fractures: Incidence in Racehorses

About 2% and 6% of all racetrack fatalities in Thoroughbreds and Quarter Horses, respectively, are the result of scapular (shoulder blade) fractures, according to Stuart A. Vallance, BVSc (Hons), who, with Susan Stover, DVM, PhD, Dipl. ACVS, and a research team at UC Davis' JD Wheat Veterinary Orthopedic Research Laboratory, has investigated the risk factors for this fracture so prevention strategies can be developed.

Vallance and his colleagues examined the necropsy reports of 73 Thoroughbreds and 28 Quarter Horses, as reported by the California Horse Racing Board postmortem program. These animals were euthanized after suffering scapula fractures on a racing surface between 1990 and 2008.

The team discovered, through visual and CT examinations, that fractured scapulas showed signs of stress fractures that resulted in a region of weakness within the bone. Such weakness can predispose the bone to complete fracture when a horse is racing or working at high speed.

They reported that when the exercise histories were compared to those of live matched control horses, Thoroughbreds and Quarter Horses sustaining scapula fractures had fewer races and works, fewer days in active training, less total distance schooled, and longer layup periods.

"We also found that females were underrepresented in this study," Vallance said, indicating that males were more

likely to sustain a scapula fracture. Additionally, Thoroughbred and Quarter Horse racehorses with scapular fractures were more likely to be 2 years old or 5 years old or more when compared to the racetrack population. The team also noted that the fractures occurred most commonly in the right forelimb.

Quarter Horses sustained most of their scapular fractures while racing, whereas Thoroughbreds sustained most of their fractures while training. The majority of the scapular fracture-related deaths during races occurred in claiming races, with many of them being the horse's first (maiden) race.

The team also reported that while Quarter Horses were more likely to sustain a scapular fracture than Thoroughbreds, the Quarter Horse racing population had a 50% lower incidence of musculoskeletal deaths when researchers considered all fracture types and fatalities.

Vallance believes that scapula fractures are a preventable hazard of racing that can be identified on lameness examination or via nuclear scintigraphy or ultrasound prior to catastrophic fracture.

"Unfortunately, we do not know at this stage why horses with a scapular fracture are not keeping up with the rest of the training cohort," Vallance said. "But it is interesting that the two breeds that have very different race distances are suffering the same fracture."

This study was supported by the Center for Equine Health through a gift from the Patterson Foundation of St. Paul, Minn., and the Dolly Green Foundation Endowment, and made possible by the California Horse Racing Board Postmortem Program conducted through the California Animal Health and Food Safety Laboratory System, UC Davis.

Bone Chips in the Knee and Racing Potential

Before purchasing a yearling it's important to review his health records to ensure he is healthy and sound enough for a successful racing career. Jennifer L. Higgins, DVM, gave potential buyers insight into specific lesions that could reduce a horse's career earnings when she presented a retrospective study on the subject.

Higgins, an associate veterinarian at Northern Lakes Veterinary Hospital in Ashland, N.H., completed the study with a

team from Rood & Riddle Equine Hospital in Lexington, Ky., when she was an ambulatory intern. The team reviewed more than 5,000 radiographs of Thoroughbred yearlings offered for public sale from 2004 to 2007. They examined bone fragments located in the backs of the horses' knees on the articular joint surfaces of the accessory carpal bone that were previously considered to be mild problems, hoping to determine whether these fragments affected racing prognosis.

The researchers narrowed their focus to 45 yearlings that met their inclusion criteria. Of these 45 case studies, 23 horses had lesions in the left knee, 19 in the right, and three had lesions in both knees. Due to the retrospective nature of the study, there was no way of knowing how or when the horses sustained the lesions.

They then pulled complete race records on the 45 horses, mainly focusing on the number of starts, earnings per start, and career earnings.

"We compared these records to those of (siblings on) their dam's side," Higgins said. The comparison with the maternal siblings allowed the researchers to have controls in the study.

Higgins and colleagues revealed that the lesions in the accessory carpal bones didn't have an effect on the number of starts the study horses made, but they had an appreciable effect on career earnings.

"Both the study horses and their siblings made it to race," Higgins said. "But the study horses made significantly less money per start than the siblings during their 2- and 3-year-old campaigns."

Higgins noted that the siblings made roughly, on average, \$1,500 more per start over their 2- and 3-year-old campaigns than did the case horses. Subsequently, the siblings had higher career earnings than the study horses.

Higgins did point out that the small study size may have impacted the results. She added that there was no way of knowing how long fragments had been in joints at the time the radiographs were taken, so it was unclear if fragment chronicity impacted the results.

"Racing is complex and outcomes are influenced by multiple factors," Higgins said. But, she added, in this study bone fragments of the accessory carpal bone had a significant negative impact on racing performance.



Surgical Methods of Correcting Angular Limb Deformities

Angular limb deformities (ALDs) of the carpus (knee) are a common problem in foals and yearlings, and researchers have narrowed the surgical treatment options down to the two that present the best results. Eric R. Carlson, DVM, an equine surgery resident at the University of Illinois' Veterinary Teaching Hospital, gave a presentation on these options.

"ALDs are important because they affect how weight bearing is transferred through the lower limb, and they can have negative effects on performance and on sale value," said Carlson.

When one side of the limb grows faster from the growth plate than the other, an ALD arises. If the lateral aspect (outside) of the limb grows faster than the medial aspect (inside), then the limb deviates inward and is called a varus deformity. In contrast, a valgus deformity is caused by the medial aspect of the limb growing faster, causing the limb to deviate outwards

away from the midline.

The two standout surgical correction techniques that Carlson discussed were the screw and wire or the single transphyseal screw (STS) technique.

"The screw and wire technique works by placing a screw above and below the growth plate that is growing too quickly and using a wire to tighten the growth plate to slow the rate of growth," said Carlson.

The STS technique uses a similar principle, but the screw is placed directly through the growth plate to slow the rate of growth and straighten the foal's limb.

To determine if one technique is better than the other, Carlson and colleagues reviewed the medical records of 568 Thoroughbred foals admitted to Rood & Riddle Equine Hospital, in Lexington, Ky., that were treated with either screws and wires (253 foals) or an STS (315 foals).

Key findings of the study:

- Lateral placement of the screws and/or wire for treatment of carpal varus was most common;

- Surgeons left STS in place for a shorter period of time than the screws and wire; and

- Complications such as inflammation of the growth plate (physitis) post-treatment and metaphyseal collapse (a collapse of the area between the growth plate and the shaft of the bone) were significantly more common in foals treated with STS than with screws and wires.

"Both treatment options are viable for management of ALDs in yearlings," noted Scott Hopper, DVM, MS, Dipl. ACVS, of Rood & Riddle, and co-author on the study. "The primary benefit to using the screw and wire method is the decreased chance of physitis or metaphyseal collapse postoperatively. The primary benefits to using the STS are the ease of implantation and the shorter duration to correction." 🐾

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Neurology

BY CHRISTY WEST

EHV-1: Minimizing Costs, Dispelling Myths

Equine herpesvirus-1 (EHV-1) disease is “one of the costliest equine diseases worldwide,” said Rebecca McConnico, DVM, PhD, Dipl. ACVIM, associate professor of veterinary medicine at Louisiana State University. She and Paul Lunn, BVSc, MS, PhD, Dipl. ACVIM, professor of equine medicine at Colorado State University, presented a discussion of controversial issues and myths surrounding the neurologic form of equine herpesvirus-1 (also called equine herpesvirus-1 myeloencephalitis, or EHM).

EHV-1 can cause a variety of problems including respiratory disease, abortion, and neurologic problems. The virus is highly contagious among horses, asymptomatic carriers can shed it readily, and the disease is endemic worldwide; the neurologic form was declared an emerging disease in the United States in 2007 based on increasing incidence of outbreaks. Cases in such neurologic outbreaks are often characterized by fever, weakness, ataxia (incoordination), difficulty urinating and moving the bowels, tail and anal-tone deficits, and a dog-sitting posture.

McConnico and Lunn first detailed several aspects of EHV-1 neurologic disease/infection and control as follows:

- There is no definitive test for EHV-1 related neurologic disease in live horses; diagnosis is generally based on a history of acute-onset myeloencephalopathy, an outbreak scenario, and the presence of EHV-1 in blood and/or nasal swab samples.
- The incubation period for the disease (time between exposure and clinically apparent illness) is one to 14 days.
- Infected horses usually will shed virus into the environment for seven days or less, but in some cases they can shed for two weeks or longer.
- Horses can be infected with EHV-1 without showing signs of disease, but they can still shed the virus and infect other



COURTESY DR. STEPHEN REED

EHV-1 can cause respiratory disease, abortion, and neurologic problems. The latter is seen here in this slinged patient.

horses (as asymptomatic carriers).

- Equine herpesvirus can become latent (inactive) in the horse's body, but reactivate in response to stress and cause disease at a later time.
- The disease can be treated successfully.

Minimizing economic losses associated with EHM outbreaks requires agreement among veterinarians and officials on disease/strain nomenclature, case definition, test interpretation, and appropriate biosecurity response, said McConnico and Lunn. They addressed several myths surrounding the disease and drove home the following points:

- Two strains of EHV-1 (D₇₅₂ and N₇₅₂) have been termed “neuropathogenic” and “non-neuropathogenic” in the past. The D₇₅₂ strain appears to be more commonly detected in neurologic disease outbreaks, causes higher levels of viremia (virus in the bloodstream), and appears to cause disease more readily than

the N₇₅₂ strain. However, both can cause neurologic disease and the response in outbreaks of each is the same (isolate and treat ill horses, quarantine ill and exposed horses, and monitor fevers every 12 hours for at least two weeks).

- Perform testing via polymerase chain reaction (PCR, preferably real-time) and viral isolation when possible to help diagnose disease and document which strain(s) are present.
- The D₇₅₂ strain has been more commonly isolated in recent years from Central Kentucky populations. Whether this means this strain's prevalence is increasing in the general EHV-1 viral pool is not yet clear.
- Neither strain is definitively considered to be a “wild-type” or original strain, and these viruses do not spontaneously mutate from one strain to the other.
- Since the virus is recovered from ill horses for up to 16 days after infection,



the AAEP recommends a 28-day quarantine period for ill/exposed animals. In some states, officials might allow a shortened quarantine period of 14 days if animals “test clean” via real-time PCR. However, it might be cheaper to simply continue to board horses at the quarantine location until 21 days have passed since the latest clinical case was identified or became asymptomatic (not testing if no new cases have presented).

“In conclusion, EHV-1 testing plays a vital role in managing equine neurologic disease,” said McConnico. “Outbreaks are manageable, and testing should be done to document which ... strain(s) are present; this could change the situation’s risk assessment.”

Neuroaxonal Dystrophy in Quarter Horses: Case Series

Neuroaxonal dystrophy, or NAD, is a neurologic disease that can affect horses as well as humans, sheep, cats, and dogs. The condition is not yet fully understood, although researchers believe there might be a genetic component. Carrie Finno, DVM, Dipl. ACVIM, a resident in large animal medicine at the University of California, Davis (UC Davis) discussed findings in a series of cases in Quarter Horses at a single cutting horse breeding farm.

“Neuroaxonal dystrophy is a degenerative disease of selected neurons and their axonal processes in the nervous system,” explained Finno. Clinical signs include:

- Symmetric ataxia (incoordination) that can appear much like wobbler syndrome,
- A base-wide stance at rest,
- Abnormal circling,
- Dull mentation,
- Often laterally odd foot placement (inappropriate proprioception, or the horse not knowing where his feet are),
- Toe stabbing when walking up inclines,
- Weakness behind when going downhill, and
- Trouble walking over curbs (such as those in parking areas/on road edges).

Mild cases can present with performance issues, said corresponding author John Madigan, DVM, MS, Dipl. ACVIM, a professor of veterinary medicine at UC Davis.

“This disease is clinically indistinguishable from equine degenerative myeloencephalopathy,” Finno noted. “The

lesions (in the nervous system) are the same, just distributed differently.”

The disease is not restricted to Quarter Horses, she added; she mentioned another study in which half of one farm’s Lusitano foal crop was affected with NAD.

The case series Finno described involved a cutting horse farm with 148 Quarter Horses from two months to 34 years of age (but mostly yearlings), 59% of which had ataxia of Grade 1 or greater on a five-point ataxia scale.

“These cases showed symmetric ataxia of all four limbs, with the pelvic (hind) limbs more severely affected than the thoracic (front) limbs,” she reported. “They also often had an inconsistent menace response (not always flinching from quick hand movement towards their eyes), dull mentation almost as if they were sedated, and we could induce this sleepiness by raising their heads for a short time.”

“Neuroaxonal dystrophy is an important rule-out for any breed of horse with proprioceptive deficits.”

DR. CARRIE FINNO

Also, many cases had low blood levels of vitamin E; Finno suggested that affected horses might have an underlying susceptibility to developing this disease if they don’t receive enough vitamin E.

“Why a cluster (of cases) in cutting horses?” commented Madigan. “Could it be that horses with the genetic mutation for NAD who get adequate vitamin E have an ability to be tolerant of extreme limb position relative to their body (away from the midline)? Are the exceptional movements of the cutting horse related to this trait and disease simply occurs when vitamin E is low? The future will tell. For the meantime, feed plenty of vitamin E beginning in early pregnancy and the first few years of life of at-risk horses.”

All three index (initial) cases from that farm that were euthanized showed characteristic NAD lesions in their nervous systems, strongly suggesting that the same process was at work in other affected horses. Lesions can be subtle and easy to miss when tissues are examined, Finno

commented. Additionally, she is working to determine the underlying genetic basis for the disease.

“This disease is probably an autosomal dominant trait,” she went on. “After genetic counseling (and breeding selection modification), 10% of this farm’s 2009 foals were affected (compared to the 59% found in 2007).

“Neuroaxonal dystrophy is an important rule-out for any breed of horse with proprioceptive deficits,” she concluded.

Vitamin E for Neurologic Disease

You might know that vitamin E is a powerful antioxidant that helps protect cell membranes and tissues from damage by reactive free radical molecules. You might even know that it’s been recommended to help treat several neurologic diseases in horses. But did you also know that just feeding vitamin E might not be enough, and that having the right source of that vitamin E is also key?

Ed Kane, PhD, a researcher and consultant in animal nutrition, presented a review of literature on vitamin E and its effects on horses with neurologic disease.

“Horses on pasture or those that have access to fresh green forage get enough vitamin E,” he began. “But most horses these days are fed stored forages and grains, and they might not get enough. Confined horses, or those on poor or winter pasture, often need vitamin E supplementation.

“All sources of vitamin E are not the same,” he went on. “Natural and synthetic forms have chemically different structures. Synthetic vitamin E contains equal amounts of eight stereoisomers (different chemical structures) of vitamin E, of which only one is identical to the natural RRR-isomer. The body preferentially transports and incorporates the natural isomer, thereby making the bioavailability of natural vitamin E greater than an equal quantity of synthetic vitamin E.”

Vitamin E deficiency has been linked to equine degenerative myeloencephalopathy (EDM) and equine motor neuron disease. Also, Kane noted that possibly due to underlying oxidant damage from their neurologic disease, affected horses might have greater need for vitamin E than unaffected horses. Thus, promoting high enough levels of alpha-tocopherol (a specific form of vitamin E) in a horse’s blood and cerebrospinal fluid (CSF, the fluid around



the brain and spinal cord) is important for preventing and treating these neurologic diseases and potentially others.

"It's highly recommended that young horses at risk for these neurologic diseases, or mature horses with neurologic disease, be supplemented with vitamin E," said Kane. "Supplementing stallions might help their foals, too." (This practice reduced EDM incidence by 75% in one study he referenced.)

He discussed two studies of water-soluble vitamin E supplementation in horses (completed at UC Davis); in the first study researchers found that giving horses 10,000 IU (international units) of natural micellized (processed for greater bioavailability) vitamin E compared to 1,000 IU unsurprisingly resulted in higher concentrations of vitamin E in both blood and cerebrospinal fluid. However, the 10x dose did not give 10 times the serum/CSF concentrations of vitamin E; the increase in E concentration in each horse was 1.3-3.4-fold across both groups.

In the second study investigators evaluated natural micellized vs. synthetic vitamin E use by comparing blood serum and CSF levels of α -tocopherol before and during 14 days of supplementation with 10,000 IU of natural vitamin E, 10,000 units of synthetic vitamin E, or 5,000 IU of natural vitamin E daily. The natural vitamin E came out on top, yielding higher levels of α -tocopherol in study horses' blood and CSF even when given at half the synthetic dose. Indeed, the synthetic form did not even significantly raise α -tocopherol levels in CSF above baseline at the 14-day mark.

"Supplementation of a water-soluble natural micellized α -tocopherol should be used instead of synthetic vitamin E when treating horses with neurologic disorders," Kane concluded. "Consider giving this to horses with neurologic disease at 5-10 IU/lb, to reach serum α -tocopherol levels greater than 6 μ g/mL."

EPM Incidence in Horses: Holding Steady

Some say the incidence of equine protozoal myeloencephalitis (EPM) is increasing, while others say it's decreasing. Who's right? Frank Andrews, DVM, MS, Dipl. ACVIM, director of the Louisiana State University Equine Health Studies Program, discussed a retrospective evaluation of 17 years' worth of horses' records from

15 university equine hospitals, coupled with an online survey of veterinarians.

The research team found that the incidence of EPM diagnosis (confirmed by positive test results for the protozoa) in those university hospitals' populations has not increased from 1990 to 2007 (despite a spike from 1995 to 1997, when the Western blot test first came into use). The proportional EPM morbidity rate, or rate of EPM cases within the hospital population, was found to be 0.88% over the study period.

The rate of EPM diagnosis "peaked in 1997 with a 1.95% incidence," commented Andrews. "This is very common in epidemiology, when the number of cases goes way up when a new test is found. Also, at least two pharmaceutical companies were working on products to treat EPM at that time, so more horses were potentially being enrolled in university studies of the disease.

“The most important aspect (of a neurologic exam) is to develop a system and use it consistently to avoid overlooking abnormalities.”

DR. AMY JOHNSON

"The actual incidence could be higher if you consider nonclinical or subclinical infection, or horses that have the disease but are not diagnosed," he added.

Andrews noted that Standardbreds, Thoroughbreds, Tennessee Walking Horses, and males were more likely to be diagnosed with the disease. Most of the affected horses in the study were 2-15 years old.

The second part of the study involved a recent survey of 221 veterinarians, 76% of whom felt that the incidence of EPM in their practices had decreased or stayed the same over the last two to four years. More than 43% of those veterinarians said they diagnose EPM without using laboratory testing, relying instead on neurologic exam results alone or in conjunction with the horse's response to EPM medication.

Andrews said the group's next goals are to document the incidence of EPM since

2007 and conduct a more thorough survey study of veterinarians on EPM incidence, diagnosis, and treatment.

How to Perform a Neurologic Exam in the Field

What does a veterinarian look for when evaluating a horse for neurologic disease? Hint: The neurologic exam starts with simple field tests, not sophisticated imaging equipment. Amy Johnson, DVM, Dipl. ACVIM-LAIM, lecturer in clinical studies at the University of Pennsylvania, discussed field neurologic examination of horses.

"Each clinician has his or her own method of performing a neurologic exam; the most important aspect (of the neurologic exam) is to develop a system and use it consistently to avoid overlooking abnormalities," she began.

She described four sections of the neurologic exam as follows:

- Evaluation of mental status;
- Cranial nerve examination;
- Spinal reflexes and muscle evaluation; and
- Gait and postural examination.

Under-saddle evaluation isn't required, and in fact Johnson recommended against this practice for safety reasons if a horse is showing neurologic signs.

Evaluating a Horse's Mental Status First, Johnson watches the horse in its stall or paddock to see any encephalopathic behavior such as head-pressing, compulsive circling, blindness, seizures, or changes in mental status (these are generally obvious without handling the horse). If any of these signs are present, this leads to suspicion of neurologic disease and further investigation to rule out other causes of the behavior (such as pain or systemic disease).

Handling the horse further will require additional caution and might also lead her to modify her exam for safety reasons, she noted. Additionally, if a symptomatic horse has not been vaccinated for rabies or its rabies vaccination history is unknown, she recommended using gloves and limiting contact with the horse.

Cranial Nerve Examination This phase of the exam evaluates the horse's cranial (head) nerves by looking at whether the horse has normal function of the head and related structures, such as head position, eye function, menace response (flinching



from quick hand movement toward the eye), normal tongue movement/retraction, chewing ability, etc.

Signs such as nystagmus (repetitive eye twitching), a head tilt, weak tongue, jaw deviation, food coming out of the nose, weak eyelid function, drooping ear, or abnormal pupil response to light suggest compromised neurologic function.

Spinal Reflex, Muscle Evaluation The next stage of the exam is to evaluate tail/anal tone and go over the horse systematically, usually testing with something like a pen, car key, or hemostats, to see if any nerve reflexes (skin flinching from the prodding) are abnormal. Neurologic disease signs could include excessive reaction (hyperesthesia) or areas of analgesia (no sensation), areas of abnormal sweating, and/or areas of muscle atrophy.

Gait/Posture Examination Finally, Johnson evaluates the horse standing and in motion with a combination of straight-line walking, curves, serpentine, circles, backing, walking while the tail is pulled to either



▶ See TheHorse.com/AAEP2010

Learn how to spot neuroaxonal dystrophy in this case series video, described by Dr. Carrie Finno.

side, and walking up and down off curbs. Spastic motion, loss of balance, irregular or inappropriate foot placement, foot dragging, and inappropriate limb crossing all can indicate neurologic problems.

“This exam is designed to start with relatively easy maneuvers and increase in complexity to highlight subtle neurologic

deficits,” Johnson noted. Neurologic problems might cause the veterinarian to halt the exam for safety reasons.

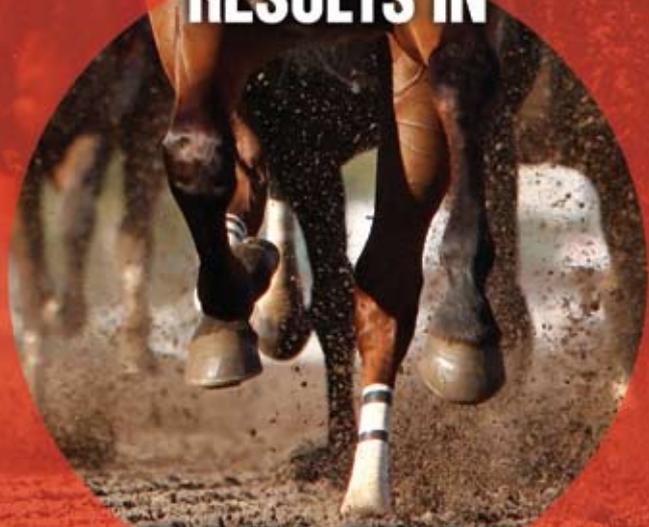
If the veterinarian finds any abnormalities during any phase of the neurologic exam, Johnson said the vet should determine the most likely location of the neurologic problem based on the abnormalities observed and follow up with more advanced diagnostics targeting that area. She commented that recording the exam on video can help monitor the horse’s progress, refresh your memory later, and allow slow-motion evaluation, which can help pick up subtleties.

“After abnormalities are confirmed and localized, construction of a differential diagnostic list becomes much easier, and both the diagnostic and therapeutic plans will fall into place,” she concluded. 🐾

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■ Watch the Neurology/Ophthalmology in Horses video, TheHorse.com/Video.aspx?vID=486.

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Hoof Care

BY NANCY S. LOVING, DVM, AND CHRISTY WEST

Horse Foot Work: Farriery Program Emphasizes Teamwork

“No foot, no horse” is perhaps the most used and still the most true statement there is in horse care. A horse is generally worthless without functional feet, which is why the AAEP devoted a complete day during the 2010 convention to farriery topics and the working relationship between veterinarians and farriers.

“Heat adds strength to any relationship; this is the perfect metaphor for this discussion,” said Jay Merriam, DVM, of Massachusetts Equine Clinic, in Uxbridge, in his presentation on veterinarian/farrier working relationships, titled “Sharing the Fire.”

“Vets can’t do it all alone, and neither can farriers,” he said. “Vets can add podiatry to their practices, and farriers can add veterinary consultation to theirs. There are things we just shouldn’t do alone.”

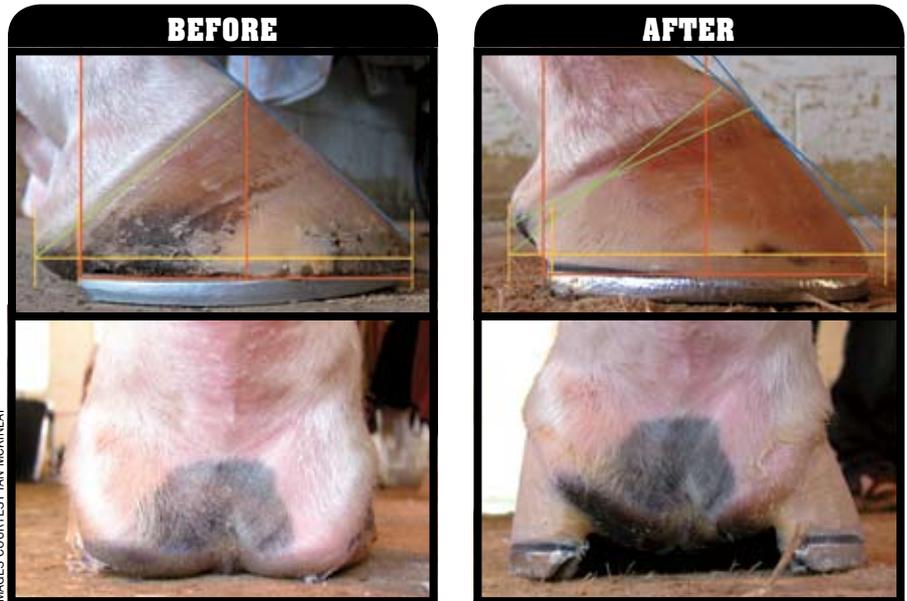
Topics discussed during this year’s farriery program included basic foot anatomy/examination, hoof crack repair, supporting the heels, puncture wounds of the hoof, foot surgery, and more.

Foot Examination Before you can treat problems in the foot, you have to know its proper anatomy and function. Andy Parks, MA, VetMB, MRCVS, Dipl. ACVS, department head and professor of large animal surgery at the University of Georgia, discussed examination of the foot for the audience with numerous images from the Glass Horse anatomy program.

“Why are you looking at the foot?” he asked the attendees. “Because something’s wrong with it or it’s a purchase exam. Presenting symptoms can include abnormalities in form (misshapen) or function (lameness).”

“Most things that affect the foot are trauma or infection,” he went on. “The foot shows you where excess stresses are, and specific diagnosis leads you to specific treatment. Predisposition to disease leads to preventive care. Indicators of abnormal stress lead to symptomatic treatment.”

Parks expanded upon several guidelines



Farrier Ian McKinlay demonstrated his methods for trimming low-heeled feet, resizing the shoes, re-building the heels as needed, and using a special rim pad under glued-on shoes to cushion the heels.

for examining the foot, including the following:

- First, do the free/easy diagnostic techniques (such as visual examination, using hoof testers, etc.);
- Record a thorough case history;
- Look at the whole horse first to assess his stance and body condition, and evaluate the environment he’s living in; and
- Then do a basic foot examination, followed by an examination of the foot relative to the limb, a more detailed examination of hoof characteristics, evaluation of the limb in motion, and evaluation of the shoeing and/or trim.

Cleaning the foot is essential to a good exam (a good wire brush is very helpful).

Hoof Crack Repair “Hoof cracks are a common problem and can affect any part of the foot, causing variable lameness,” said Kent Carter, DVM, MS, professor of equine lameness at Texas A&M University. “Some are devastating and cost millions in lost revenue, while others are insignificant. Recognizing the difference will help us all.”

The key to fixing a quarter crack is not the patch, screws, or plates put across it,

he said. Rather, healing and getting rid of a quarter crack for good depends on proper trimming/shoeing to correct the foot imbalance that caused the crack. Without fixing that imbalance, cracks will often return even if they are repaired in the short term.

He discussed the pros and cons of several hoof crack repair strategies and products, ending with this summary: “Proper trim of the foot is essential, therapeutic shoeing is important, and stabilization of the crack (with wires, staples, patches, etc.) is not always necessary but it is beneficial if performance is desired. Exposed soft tissue may become problematic (if it’s not dried out well before covering it with a patch); don’t create more problems.”

He also briefly discussed hoof cracks and separations caused by white line disease, an opportunistic fungal infection of the hoof. Removing any detached wall is essential, he noted, as this loose wall isn’t doing any good. This also makes it much easier to treat problems underneath the separated wall.

Hoof Puncture Wounds If your horse picks up a nail or other sharp object in his foot,



one of the first questions many of us have is whether to remove that nail immediately or wait until the veterinarian can see it. Rich Redding, DVM, MS, Dipl. ACVS, associate professor of equine surgery at North Carolina State University, recommended leaving the foreign body in if at all possible until the veterinarian can take radiographs to see how deep the wound is and what structures might be affected.

"If you can't leave the foreign body in place, mark the site (so it can be found for later examination)," he recommended.

Redding discussed several types and aspects of foot wounds in horses, along with reviewing additional strategies for evaluating such wounds including contrast fistulography (injecting contrast material into the wound and taking a radiograph to see how deep the wound is), physical exploration of the wound with thin, blunt metal probes, ultrasound, thermography (examination of heat patterns), and MRI.

Lastly, Redding discussed several options and technique tips for treating these

wounds, which often require some degree of surgical debridement (opening up the wound tract so it can drain and be medicated). Additional treatment strategies include thorough cleaning of the wounds, antibiotic treatment (both systemic and regional might be indicated), wound protection with waterproof bandaging, and lavage (flushing) of any compromised joints.

Hoof Biomechanical Research "I'd like to introduce a third person to the hoof care team, so we have veterinarians, farriers, and research scientists," began Jeffrey Thomason, MSc, PhD, an anatomy professor at the University of Guelph's Ontario Veterinary College in Canada. "Biomechanical research is helping us elucidate the exact causes of many injuries, which is leading to better diagnoses, treatments, and prevention."

He went on to discuss the basic biomechanical properties of the horse, including the heavier body compared to thin, light legs that can be moved quickly for great

speed. "The horse uses his own weight very effectively," he observed.

However, there are trade-offs to this structure—for example, long, light bones give more speed and stamina, but this also means a higher risk of fracture. Long tendons and ligaments act as energy-storing springs, but those long springs are at risk of mechanical injury.

Thomason went on to describe several types of biomechanical research strategies, from direct measurements to calculated ones in live horses, to in vitro studies with cadaver limbs.

"Biomechanics researchers, veterinarians, and farriers can all meet in the middle for applicable interpretation of research information," he concluded. "Everyone should communicate well so researchers understand the problems faced 'on the ground,' and can devise studies that take that into account."

Saving the Heels "I see thin walls in so many breeds," began well-known racehorse farrier Ian McKinlay of South Amboy, N.J.,

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whose practice focuses mainly on repairing hoof cracks and other foot problems. "Pliable, thin walls often cause the heels to collapse under the horse's own weight," and pain and lameness in the palmar (rear) part of the foot are the all too common results.

McKinlay discussed a number of factors contributing to low heels in his clients' horses, from poor trimming to short shoes to too many baths/foot soaks. He also demonstrated his methods for trimming the foot, sizing the shoe (often using a longer one than the horse was wearing), rebuilding the heels as needed with hoof repair composites, and using a special dual-material rim pad under glued-on shoes to cushion the heels.

This pad, which is much like the ones McKinlay put on Triple Crown hopeful Big Brown, includes a hard rim under the front half of the foot and a softer rim in the rear part of the foot to cushion the heels. Also, a cut-down channel around the inner edge of the pad can hold a rubber strip or dam to keep the glue from getting on the sole and applying pressure there with weight bearing.

McKinlay reported success with more than 100 cases of palmar foot pain (mostly in racehorses) treated in this manner in a six-month period.

"The advantage of the method described in this report is that the procedure has a strong bond (to the hoof) with a minimal amount of adhesive, zero sole pressure, and total support of the heel while being

relatively simple and easy to learn," he concluded. However, he cautioned that inappropriate trimming, shoe selection, and shoe placement will negate the benefits of the pad.

Custom-Molded Horseshoes After reviewing various methods of gluing horseshoes onto hooves, Derek Poupard, CJF, Dipl. WCF, of the United Arab Emirates, described a novel method for building a horseshoe directly on the horse's foot using a hoof repair composite injected into a silicone mold wrapped around the foot.

Sound confusing? It's a bit like putting on a glove that's a little too big for your hand and squirting a composite into the glove to build you a new, completely tailored glove that fits just right.

This method of shoe creation is quick and easy, noted Poupard, and yields a protective covering that functions much like the natural hoof in terms of expansion/contraction. It's also easy to rasp to reshape as needed once cured. However, it's not inexpensive, doesn't stand up to quite as much wear as a metal shoe, is harder to maintain in a wet climate, and yields a raised heel that necessitates some sole support to maintain frog pressure.

Sport Horse Farriery Sport horses place great demands on their feet, as they're often "maintained at a competition readiness condition year-round," began Duncan Peters, DVM, MS, of Hagyard Equine Medical Institute in Lexington, Ky. "This means that from a fitness level and foot-care standpoint, these horses are always in a

high-maintenance situation."

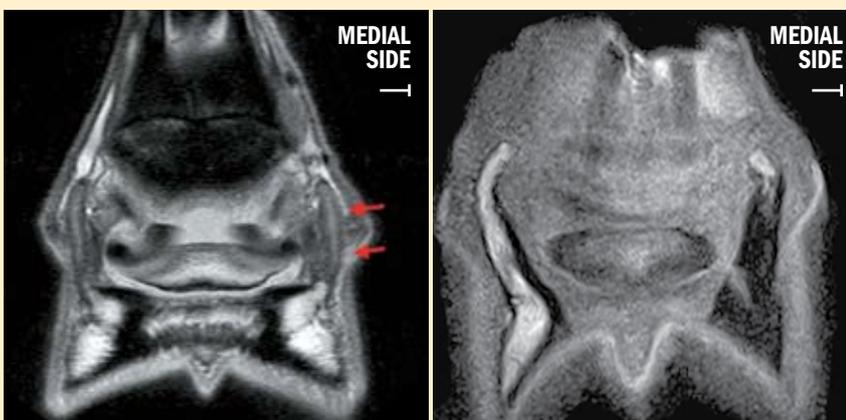
It's key to maintain good communication between owner, trainer, veterinarian, and farrier to optimize soundness in such horses, he noted. Sometimes those people will disagree on the best approach for the horse and, thus, "There needs to be open discussion and ultimately, collaborative decision-making," he added.

Peters noted several challenges when managing sport horse feet (such as little to no turnout time, high competition demands, and too-frequent baths and wetting of the feet). He also offered several tips on keeping them sound, such as trimming/resetting every 4-5 weeks to keep feet in top shape, providing proper breakover in the front half of the foot, supporting the heels, maintaining proper mediolateral (inside to outside) balance, providing good breakover to the sides of the foot as well as the toe, aligning the bones of the leg for optimal soundness, and protecting the bottom of the foot.

"Foot care of the sport horse requires all involved to be attentive to the functional needs of the horse and any changes in performance that may occur related to the feet," he concluded.

Foot Surgery "You often need to surgically invade the foot to treat infection, benign tumors (keratomas), penetrating wounds, and lacerations," began Clifford Honnas, DVM, Dipl. ACVS, of the Texas Equine Hospital in Bryan. He described a number of conditions he treats with surgery as follows, as well as the critical aftercare provided by a farrier to help the horse recover.

- Removal of a sequestrum (diseased, isolated piece of bone) that's often due to infection from a puncture wound. The fragment is removed as well as any dead tissue, and the area is medicated and protected for healing. These usually do very well, Honnas noted.
- Keratomas, or benign soft tissue masses that develop between the hoof wall and the coffin bone, might result from chronic inflammation. These are removed through as small of an opening as possible, and the prognosis is "excellent," said Honnas.
- Infection/necrosis (tissue death) of the collateral cartilage can occur from various wounds or traumas, and cause lameness as abscesses form, he explained. Removal of the infected/dead tissue under general anesthesia is the



IMAGES COURTESY DRs. KURT SELBERG & NATASHA WERRY

(Left) Proton density dorsal plane MRI image through the navicular bone, unguis cartilages, and palmar aspect of a normal distal phalanx (P3). Red arrows: normal (not ossified) unguis cartilage. (Right) In this T1-weighted image of bi-axial severely ossified unguis cartilages, the medial ossified cartilage/palmar aspect of P3 is black (low signal intensity), indicating sclerosis. The white (hyperintense) fracture line (arrow) runs from the base of the cartilage distally and dorsally into the palmar aspect of P3.

recommended treatment, and the prognosis is good provided all the dead tissue is removed.

■ White line disease can result in a significant amount of hoof wall detaching from the underlying structures, and removal of this loose wall allows access to medicate affected areas and removes the ground reaction force on the loose wall. This helps the remaining healthy wall grow down tight to the inner structures of the foot.

Abscesses beneath the sole are “probably the most frequent condition affecting the foot of the horse for which invasion of the hoof capsule is required,” Honnas noted. Abscesses can cause severe pain, but opening these abscesses up surgically to allow drainage and medication provides effective treatment.

“Surgery of the foot is a very common occurrence; one thing we can’t emphasize enough is that it necessitates a good team approach (between veterinarian and farrier),” Honnas concluded.

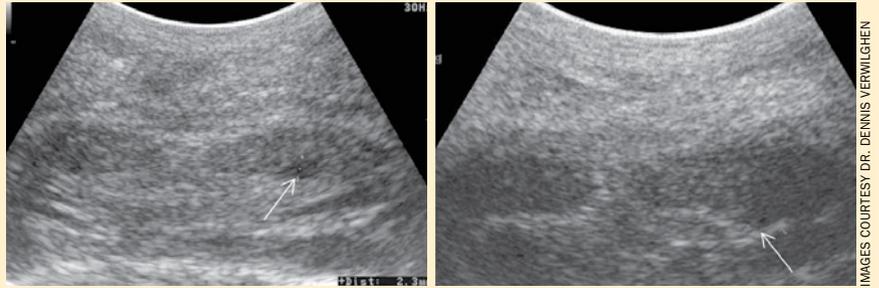
Sidebone and Associated Injuries

Sidebone, or ossification (hardening) of the collateral cartilages in a horse’s foot into bone, is sometimes passed off as an insignificant finding if it’s noticed at all. However, new research on the condition suggests that it might play a significant role in foot-related lameness.

The horse has a collateral, or ungual, cartilage on both sides of the coffin bone in each foot. In combination, these cartilages “provide support to the palmar/plantar (rearward) aspect of the foot, dissipate forces of the foot’s impact with the ground, and are involved in venous return from the digit (blood flow from the foot back toward the heart),” explained Sue Dyson, VetMB, PhD, FRCVS, head of Clinical Orthopaedics at Animal Health Trust, in Newmarket, U.K.

Especially in larger/heavier animals, collateral cartilages can ossify or harden from somewhat flexible cartilage into rigid bone (termed sidebone). Outwardly, the only sign of sidebone might be that the cartilages feel firmer to the touch than usual.

Dyson described the normal appearance of the collateral cartilages extensively, then she discussed findings in a number of horses with primary injury of ossified cartilages (i.e., a fracture or trauma to this area) as well as findings in horses with injuries of



Above are transverse ultrasound images of the deep digital flexor tendon obtained through the bulbs of the heels. In figure 1 (left) there is a small hypoechoic (black) round lesion on the dorsal aspect of the lateral lobe (on the right of the image) of the tendon (arrow). Even when small in size, these lesions are usually clinically significant. In figure 2 (right) a deformation of the dorsal border of the lateral lobe (on the right of the image) with a change in shape and size of the affected lobe compared to the medial one is clearly visible (arrow).

nearby structures deemed related to the ossified cartilages (such as the coffin bone and neighboring ligaments).

Diagnosing if sidebone was the only cause of lameness was sometimes challenging. Diagnostic analgesia (nerve blocks) are helpful but can be misleading, said Dyson. Radiographs and MRI can detect sidebone, but the veterinarian might not be able to distinguish between fractures of ossified cartilages and other trauma. Nuclear scintigraphy (bone scan) allows the veterinarian to see active bone remodeling and was generally useful for detecting injuries of abnormally ossified cartilages, she added.

In horses with trauma to or fracture of an ossified collateral cartilage, lameness was usually mild to moderate at examination time and most apparent when the horses were circled; in addition, this lameness was often reported to be improved compared to the original lameness at onset. Horses were treated with rest for at least three months, controlled exercise, and better foot balance/shoeing. Most affected horses returned to full work after this treatment regimen.

“This study provides further evidence that ossification of one or both cartilages of the foot (sidebone) is not necessarily an incidental observation of no clinical significance, but may be associated with lameness,” Dyson summarized.

Sidebone+Coffin Bone Fractures

When it comes to lame horses, things aren’t always simple: the problems don’t always come one at a time. In a recent study, for example, researchers described a series of cases with sidebone, coffin bone fractures, and associated soft tissue problems.

“The ungual or collateral cartilages in the foot (on either side of the coffin bone, thought to function in hoof expansion and shock absorption) start out as (soft) hyaline cartilage, then can ossify (harden into bone, termed sidebone or ossified collateral/ungual cartilage) with age or other factors,” explained Kurt Selberg, MS, DVM, a veterinary resident at Colorado State University (CSU). “The causes are unknown, but might include concussion (from working on hard surfaces), ligament strain, poor farriery, or other factors. Clinical signs include a shortened stride and obscure lameness, perhaps because the ossified cartilages don’t function in their normal expanding and contracting manner (with each step).”

Selberg and co-author Natasha Werp, DVM, Dipl. ACVR, assistant professor of imaging at the Gail Holmes Equine Orthopaedic Center at CSU, described MRI findings in 22 horses from nine equine hospitals that had both ossified collateral cartilages and coffin bone fractures (23 affected feet). All cases had these problems in the forefeet.

Selberg reported that the fractures were simple and nondisplaced, originated at the base of the ossified collateral cartilage in all cases, and involved the fossa of the collateral ligament on the coffin bone (depression on the bone where the ligament attaches) in 17 of the 23 affected feet. Also, adjacent ligaments and other soft tissues were compromised in all cases. A limited number of cases had long-term follow-up information, and those fractures healed completely by 14 months after the initial case presentation.

Radiographs can detect the fractures,



noted Selberg, but not the soft tissue problems. "MRI highlighted these injuries quite well," he said. "Injury of the ligaments associated with the cartilages was thought to be contributing to these cases' lameness.

"Injuries of the ligaments associated with ossified collateral cartilages have the potential to be a source of lameness," he concluded. "The routine site of fracture in this study at the base of the ossified collateral cartilage extending into the distal phalanx suggests a biomechanical cause or focal stress point from cycling. Are sclerotic ossified cartilages more likely to fracture? At this point we don't know for sure, but it seems that way."

Foot Pain in Horses: Diagnosing Soft Tissue Problems

When pain is localized to the foot but no abnormalities can be seen on radiographs (X rays), problems in soft tissues within the foot are often the culprit. However, imaging soft tissues in the foot to arrive at a diagnosis can be challenging, especially when magnetic resonance imaging (MRI) is not available or financially feasible. One veterinarian discussed the use of ultrasound as a lower-cost option for imaging soft tissue problems in the hoof.

Denis Verwilghen, DVM, MSc, DES, Dipl. ECVS, specialist in equine and large animal surgery at the University of Liège in Belgium, discussed findings in 39 horses, reporting that veterinarians using ultrasound examination were able to identify specific soft tissue problems in all cases. The most common issues were deep digital flexor tendon lesions (30 horses), followed by abnormalities in the coffin joint and associated ligaments (27 horses), and navicular bursa distension (22 horses).

All but three horses had abnormalities of multiple structures within the foot, highlighting the often complex nature of lameness diagnosis.

"Ultrasound allowed documentation of digital soft tissue injuries, especially deep digital flexor tendinopathy (disease of a tendon), in horses without radiographic findings," Verwilghen concluded. "The distribution of findings was similar to previous MRI studies. Ultrasound can provide a diagnosis of foot pain if MRI is not available or possible financially."

Valeria Busoni, DVM, PhD, Dipl. ECVI, specialist in diagnostic imaging at the University of Liège, added: "Ultrasound

examination of the foot requires practice and experience as it is more technical compared to a routine tendon ultrasound. Moreover, the approach through the bulbs of the heels (which is the one that shows most deep digital flexor tendon lesions) requires a microconvex probe, which is not the probe routinely used to image tendons. So equine practitioners willing to apply this technique to the foot have to be equipped and trained to perform foot ultrasound."

How to Manage a Quarter Crack

Lameness caused by quarter cracks is a nemesis of horses and owners, and treatment is often a complex and time-consuming process. Steve O'Grady BVSc, MRCVS, of Northern Virginia Equine in Marshall, discussed the importance of these injuries and how, with the exception of traumatic injury cases, it's rare to see a quarter crack without a concurrent sheared heel.

O'Grady described sheared heels as a common hoof capsule deformation caused by disproportionate loading on one side of the foot. This results in one heel bulb displacing upward relative to the adjacent heel bulb. Tissue on the displaced side between the hoof wall and surface of the short pastern bone changes shape, resulting in constant foot pain in the back of the hoof. Over time, uneven loading leads to hoof capsule distortion, subsolar bruising, corns, hoof wall separation, and quarter cracks.

According to O'Grady, veterinarians and farriers should target and correct sheared heel conformation by stabilizing the heels and repairing the crack. He explained that the hoof capsule's viscoelastic nature normally allows it to deform when stress is applied; yet, hoof capsule distortion occurs when compressive and shear forces exceed its capacity to deform.

This overload of the heel creates structural changes that make the hoof more upright, he explained. This decreases the foot's ground surface contact, the hoof wall straightens, heels contract, and the foot narrows. The overloaded heel rolls under with a hoof wall flare developing on the opposite side of the foot. The ungual (collateral) cartilage (on either side of the coffin bone, thought to function in hoof expansion/shock absorption) becomes trapped on the displaced side, restricting hoof expansion.

Radiographs of affected feet show the solar surface of the coffin bone positioned in an appropriate horizontal relationship with the ground, indicating the heel disparity originates behind the body of the coffin bone. Trimming heels unevenly has been blamed as a cause of sheared heels, however, O'Grady emphasized that the viscoelastic nature of the hoof capsule negates this effect—normally, the hoof accommodates trimming imbalances. Instead, limb conformation seems to be a key cause, especially if there is rotational limb deformity of the forelimbs, in particular toed-out conformation due to carpus valgus (outward rotation of the cannon bone at the knees). Limb conformation dictates hoof flight path and landing; hoof capsule deformation thus is an adaptation to limb conformation—excess impact leads to disease.

O'Grady's objective is to trim and shoe the foot to improve hoof landing—to unload the displaced side of the foot, engage the frog, and lower the side of the displaced hoof capsule to increase ground surface contact. The trimmed foot should end up as wide as it is long. Then, additional horn is trimmed from the affected quarter back to the heel and a bar shoe is applied. Impression material beneath a leather pad further improves frog loading, he noted. Within a month's time, improvement is usually measured as ¼-⅜-inch growth at the coronary band that causes the heels to even out.

The displaced coronary band must be allowed to relax for 24 hours before repairing the crack with an implant. O'Grady suggests that veterinarians and farriers consider full-thickness quarter cracks a type of fracture necessitating stabilization with implant wires and placement of a composite patch over the top of the wire repair.

O'Grady said he cannot overemphasize enough the importance of determining the underlying cause and implementing the appropriate farriery when managing a quarter crack. Veterinarians and farriers should assess limb conformation, improve foot conformation, and apply the appropriate shoe to repair the defect.

Styrofoam Reduces Hoof Pressure

Laminitis is a critical cause of lameness in horses: Not only is the exact cause not known in all cases, but considerable controversy persists about how to treat and



manage this disease. Jennifer Schleining, DVM, MS, Dipl. ACVS-LA, a clinician in the department of veterinary clinical science at Iowa State University, discussed the common practice of using industrial Styrofoam to increase weight-bearing surface area while decreasing total contact pressure on the bottom of a painful hoof. This method is used primarily as the first line of defense in an acute case of laminitis when veterinarians are trying to prevent permanent mechanical damage.

Schleining reviewed the significant financial impact of lameness, including laminitis, with costs of \$675 million for all lamenesses reported in a 1998 USDA study. According to that study, each lameness event resulted in an average of 110 days of lost use as well as an emotional impact on owners and veterinarians. Laminitis is the second leading cause of equine death, behind colic—nearly 200,000 horses were diagnosed with laminitis in 2007.

In the developmental stage of laminitis, Schleining explained that a shift in weight

bearing is not evident before clinical signs are recognized—the typical laminitis stance is not seen until after the coffin bone has displaced. Treatment goals are to diminish or eliminate the inciting cause, to minimize pain, and to prevent permanent damage and mechanical collapse of hoof laminae (sensitive tissues that connect the coffin bone to the interior of the hoof wall).

“No one technique benefits all patients,” Schleining reported, explaining that approaches to mechanical support are attempted in numerous ways with the Lily pad, roll gauze taped to the frog, heart-bar shoes, Steward clogs, shoes or hoof casts with fillers, or Styrofoam. She commented that, based on previous studies, Lily pads increase laminitic pain in the initial five days, roll gauze has no peer review to substantiate claims that it works, and the efficacy of controversial heart-bar shoes is dependent on farrier skill in application. Hoof wall casts with 15-20° heel elevation decrease hoof wall strain by 60% at the

toe, yet she said the effects are disappointing since lateral hoof wall strain along the sides of the hooves increases 35%.

In the study Schleining and colleagues hoped to show that industrial Styrofoam (1½-inch blue foam) increases the weight-bearing surface area, decreases contact pressure, and results in pressure shifts toward the heel. She said the study, which the team performed on normal horses, corroborated this hypothesis. The result was immediate benefit through decreased hoof pressures.

An unexpected finding was that the center of pressure did not significantly move toward the heel until 24-48 hours after placement. Eighty percent of the horses had areas devoid of weight-bearing in the center of the foot, likely due to standing on wood shavings over rubber mats.

Shift of the center of pressure toward the heels is beneficial to decrease the pull of the deep digital flexor tendon on the coffin bone, thereby lessening the risk of coffin bone rotation. Schleining suggests that

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better results might be achieved by using less thick Styrofoam initially and then adding an additional layer after 24 hours, or by applying a 1-2° wedge prior to placing the Styrofoam.

Cryotherapy Methods for Laminitis Treatment Compared

Recent surveys of equine veterinarians reveal that laminitis is the No. 1 lameness concern of equine practitioners, due to how difficult it is to treat and manage this debilitating condition. On the topic of laminitis control, Heidi Reesink, VMD, a veterinary resident at Cornell University, discussed a comparison of three methods of cryotherapy (cold treatment) as measured by blood vessel temperature in the foot. Reesink noted that cryotherapy is the only treatment shown to prevent development of acute laminitis, calling it the “gold standard.” Chris Pollitt, BVSc, PhD, (2004) demonstrated the safety of prolonged immersion of the distal limbs for 48 hours to abolish associated lameness and to minimize pathologic changes related to laminitis. Reesink explained that cryotherapy controls hoof inflammation by potentially lessening metabolic tissue demands, directly inhibiting temperature-dependent enzymes, and/or reducing blood-borne delivery of inflammatory mediators.

Reesink and her colleagues set out to examine if ice-filled wader boots would be more effective at cooling the hoof than other methods. They compared an ice-filled wader boot to packing the feet to the level of the fetlock by filling 5-liter fluid bags with crushed ice slurry, or using gel ice packs replaced at 60-minute intervals. The opposite (nonchilled) limb of each horse was used as a comparative control. Reesink also wanted to determine if digital venous temperatures would approximate laminar temperatures, and if digital venous temperatures would be slightly warmer.

Nine healthy horses free of lameness or laminitis were used in the study. Before the researchers applied any trial therapy, they took pre-treatment baseline temperature readings for 15 minutes. Then they tracked each 120-minute treatment method with periods of rewarming between each treatment. Treatment time was based on previous studies that showed minimal additional cooling is achieved after two hours of ice immersion.

The investigators obtained temperature

measurements every minute during each treatment, using thermocouples (capable of transmitting temperature readings on an ongoing basis) placed in blood vessels in both forelimbs. Treatment began with two hours in the gel boot, after which the leg was allowed to rewarm. Then came two hours in the ice bag, and after a final rewarming, two hours in the wader boot. Minimal cooling occurred in the gel boot, whereas in the ice bag and wader boots dramatic temperature decreases in both laminar and venous blood were achieved. Laminar temperatures remained slightly cooler than venous temperatures, as expected.

Reesink stressed the clinical relevance of this study, which demonstrated that 5-liter fluid bags filled with ice slurry provide a practical and affordable method of cryotherapy, whereas a gel ice boot is ineffective.

Penetrating Hoof Injuries

When it comes to penetrating hoof injuries, early, aggressive treatment is key to a favorable outcome, stressed Isabelle Kilcoyne, MVB, of the University of California, Davis. In a retrospective study she and colleagues examined complications, prognosis, and outcomes associated with penetrating foot injuries, particularly in the areas of the frog or the collateral sulci (clefts on either side of the frog).

Penetrating foreign bodies confined to the frog or sulci can invade critical structures including the coffin bone, navicular bone, navicular bursa, deep digital flexor tendon sheath, and/or the coffin joint, noted Kilcoyne. All of the cases the team examined involved horses presenting with a nonweight-bearing lameness and diagnostic radiographs corroborating foot penetration. They graded each according to penetration depth:

- Grade 1 = penetration of less than 1 inch of superficial corium (the soft tissues between the sole of the hoof and coffin bone);
- Grade 2 = penetration greater than 1 inch of deep corium or digital cushion (helps absorb concussion; located between the distal coffin bone and the sole), but no contact with the coffin bone or synovial (joint) structures;
- Grade 3 = penetration of the coffin bone, but not of synovial structures; and
- Grade 4 = penetration of synovial structures such as the coffin joint, navicular

bursa, or deep digital flexor tendon sheath.

Nearly 89% of Grades 1, 2, and 3 horses returned to full soundness following various treatments.

In 54 of 63 Grade 4 cases (86%), a nail was the cause of penetration—34 of these horses (54%) were nonweight-bearing, with the majority (64%) experiencing navicular bursa penetration. Twenty-eight of 63 horses (44%) were euthanized at presentation. The other 35 underwent conservative standing treatment of paring out, flushing the wound, packing and bandaging the foot, and receiving systemic antimicrobials. Veterinarians performed regional limb perfusion of antibiotics in 16 of these horses, with 91% becoming sound. Surgical treatment under general anesthesia returned six (40%) of the other 15 horses to full soundness by six months and the final seven (47%) were euthanized. Overall, 10 of 34 horses (29%) with synovial structure involvement regained soundness.

Treatment expense varied greatly relative to approach: Conservative treatment cost an average of \$1,162, with an average hospital stay of five days (stays ranged from one to 18 days) as compared to an average of \$5,850 for surgical treatment, with an average hospital stay of 21 days (stays ranging from one to 38 days). Kilcoyne summarized the study findings, noting:

- Penetrating wounds in the middle to caudal (rear) portions of the frog are most likely to affect synovial (joint/tendon) structures: Synovial structures were penetrated in the middle frog 58% of the time, 61% in the caudal frog, and 31% toward the frog apex (the forward-most point).
- Horses with hind foot injury were more likely to regain soundness (72%) than forelimb cases (42%).
- The time to presentation (how much time passed between the injury and a veterinarian's examination of it) affected outcome; aggressive treatment initiated within the first 48 hours returned a higher percentage of horses to soundness.
- Regional limb perfusion with antibiotics greatly improved prognosis/outcome. 🐾

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- Foot Lameness Table Topic, TheHorse.com/17733.
- Watch the Joint/Foot Lameness video, TheHorse.com/Video.aspx?vID=477.

Respiratory Topics

BY STACEY OKE, DVM, MSC

Infectious Respiratory Disease: PCR Testing Suggested

Polymerase chain reaction (PCR) is a fast, accurate, quick, and easy testing method to diagnose pathogens associated with equine upper respiratory tract infections, and researchers on a recent study recommended that veterinarians pursue PCR in cases of infectious upper respiratory disease. Not only does it allow the veterinarian to pinpoint the causative pathogen, it also can help control the spread of the pathogen.

“Infectious respiratory diseases are the most common medical conditions treated by ambulatory veterinarians throughout the country,” explained Nicola Pusterla, DVM, PhD, Dipl. ACVIM, associate professor at the University of California, Davis, School of Veterinary Medicine, who discussed the use of real-time PCR. “Many of these respiratory infections have similar clinical presentations (e.g., fever, nasal discharge, coughing) and many horse owners and vets often do not pursue diagnostics when dealing with single cases. However, determining the exact causative agent(s) associated with infectious upper respiratory tract diseases is essential in order to prevent outbreak and minimize spread.”

Real-time PCR is a reliable diagnostic laboratory technique with a quick turnaround time (results are generally available within 24 hours) that can help veterinarians diagnose infections caused by equine herpesvirus (EHV)-1 or EHV-4, equine influenza virus (EIV), and *Streptococcus equi* subsp. *equi*.

Pusterla and colleagues set out to determine the benefits of PCR by testing 761 horses with signs of acute respiratory infections or acute neurologic signs. With PCR they were able to successfully identify DNA from one or more of the pathogens EHV, EIV, or *S. equi* subsp. *equi* in 201 (26.4%) of the tested horses. Of these 201



Determining the exact causative agent(s) associated with infectious upper respiratory tract diseases is essential to preventing outbreak and minimizing spread.

horses, there were:

- 82 EHV-4 infections;
- 60 EIV infections;
- 49 *S. equi* subsp. *equi* infections; and
- 23 EHV-1 infections.

Fifteen horses had double infections and one horse was infected with three of the four disease-causing organisms.

“Testing and knowing the exact cause of the respiratory infection is essential for implementing proper management practices and to help control the spread of disease,” concluded Pusterla.

Horses with Pneumonia Benefit from a New Form of Ceftiofur

A new sustained-release formulation of the antibiotic ceftiofur, approved by the U.S. Food and Drug Administration (FDA) for use in horses with pneumonia, makes

treating affected foals easier.”

The bacterium *Streptococcus equi* subsp. *zooepidemicus* is a common cause of pneumonia in horses,” said Scott McClure, DVM, PhD, Dipl. ACVS, an assistant professor at Iowa State University. “The antibiotic ceftiofur, initially introduced in 1994, remains effective against *S. equi* subsp. *zooepidemicus*.”

Currently, ceftiofur is licensed for use in horses, but is labeled for administration every 24 hours.

“As part of the FDA approval procedure, we tested a sustained-release formulation of ceftiofur that only needs to be administered by a veterinarian two times to horses with *S. equi* subsp. *zooepidemicus* pneumonia,” explained McClure. “This is an easy-to-use product that will ... improve client compliance.”

McClure and colleagues administered the sustained-release formulation intramuscularly two times, four days apart.

In total, 201 affected horses that tested positive for pneumonia due to *S. equi* subsp. *zooepidemicus* were enrolled in the study. A clinical cure was achieved in 66.9% of the 145 treated horses, whereas only 32.1% of the 56 placebo-treated horses were cured.

“This study demonstrates that the tested sustained-release ceftiofur formulation was effective for pneumonia due to *S. equi* subsp. *zooepidemicus* as the sole therapy,” McClure summarized. “It is safe, effective, and simple to use.”

McClure and colleagues hypothesized that these success rates are likely to improve if veterinarians also employ anti-inflammatory drugs and bronchodilators to treat affected horses.

Electroacupuncture and Chronic Respiratory Disease

A group of University of Florida (UF) researchers recently found that



electroacupuncture has anti-inflammatory effects in the horse and could potentially be a useful treatment modality for equine chronic respiratory diseases. Weerapongse Tangjitjaroen, DVM, PhD, who works in the Department of Large Animal Clinical Sciences in UF's College of Veterinary Medicine and also with the Faculty of Veterinary Medicine at Thailand's Chiang Mai University, presented results of the study at the convention.

Electroacupuncture is similar to acupuncture except that the practitioner connects stainless steel needles to an electrostimulator after inserting them through the skin at the acupuncture points.

"The use of acupuncture and electroacupuncture as alternative or complementary therapies to contemporary equine medical practice is increasing worldwide," said Tangjitjaroen, who noted that the benefit of these therapies for certain conditions is well documented.

Tangjitjaroen noted that researchers on a number of studies evaluating

acupuncture and electroacupuncture in humans and horses with respiratory disease showed positive results. For example, in one study horses with recurrent airway obstruction (heaves) showed improvement in lung function after only a single acupuncture treatment. Tangjitjaroen and colleagues therefore evaluated the effect of electroacupuncture on immune response and pulmonary function of Thoroughbreds.

They divided 20 healthy horses randomly into either an electroacupuncture group or a control group. The horses in the treatment group received 12 electroacupuncture treatments at seven acupoints (BL-13, Ding-chuan, Fei-men, Fei-pan, Fei-shu, CV-22, and GV-14). Control horses underwent the same procedure, except that needles were taped to acupoints rather than penetrating the skin.

Tangjitjaroen explained that those acupoints were chosen according to previous research, clinical experience, and details in veterinary acupuncture textbooks.

They treated horses based on guidelines published by the Council of Acupuncture and Oriental Medicine Association and previous research. Treated horses underwent 12 treatments over a 3.5-week period.

Tangjitjaroen said that electroacupuncture had a systemic anti-inflammatory effect based on *in vitro* evaluation of the blood, but the research team did not observe changes in any of the pulmonary function test parameters.

"More studies are needed to determine if electroacupuncture at the seven points used in this study can be used to treat inflammatory diseases in horses, including chronic respiratory diseases," Tangjitjaroen concluded. 🐾

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Rhodococcus equi

BY ERICA LARSON AND STACEY OKE, DVM, MSC

R*hodococcus equi* is a dangerous pathogen that causes pneumonia in foals that are generally between the ages of 3 weeks and 5 months. In cases caught early on, the foal can make a full recovery with proper treatment. However, in more serious cases the mortality rate is quite high, noted Steeve Giguère, DVM, PhD, Dipl. ACVIM, professor and Marguerite Thomas Hodgson Research Chair in Equine Studies at the University of Georgia's College of Veterinary Medicine. He discussed the importance of understanding the pathogenesis of the bacterium *R. equi* (how it's acquired and how it causes disease), the associated clinical signs, and the diagnostic methods used to detect infection.

"The most common manifestation of *R. equi* infections in foals is a chronic suppurative (pus-producing) bronchopneumonia with extensive abscessation," Giguère said. "The slow spread of the lung infection combined with the remarkable ability of foals to compensate for the progressive loss of functional lung makes early clinical diagnosis difficult."

Clinical Manifestations Giguère closely analyzed the different clinical manifestations of *R. equi* pneumonia that the foals presented.

He noted that many foals with *R. equi* pneumonia also have extrapulmonary (outside the lungs) disorders, such as immune-mediated polysynovitis (arthritis of multiple joints), ulcerative enterotyphlocolitis (small erosions and abscesses in the wall of the small or large intestines), intra-abdominal abscessation, abdominal lymphadenitis (inflammation in one or more lymph nodes), uveitis (moon blindness), and pyogranulomatous hepatitis (microscopic abscesses in the liver).

Intestinal lesions were one of the most common extrapulmonary disorders, evident in about 50% of foals with *R. equi* pneumonia that were presented for necropsy, Giguère noted. However he added that most foals that contract *R. equi*



Foal owners have struggled with controlling *R. equi* and the infections it causes for years.

pneumonia do not show signs of intestinal disease while undergoing treatment for the pneumonia. "Foals with abdominal abscesses typically have a high fatality rate," Giguère said.

Giguère also found that polysynovitis (a condition in which multiple joint surfaces are inflamed) was present in about 25%-30% of live foals undergoing treatment for *R. equi* pneumonia. He added that in many of these cases, lameness was mild, if present at all.

Giguère added that immune-mediated processes might aid in the development of other extrapulmonary conditions seen in these cases, such as uveitis, anemia, and thrombocytopenia (low platelet counts) in some foals.

Pathogenesis According to Giguère, little was known about the virulence of *R. equi* before scientists identified a virulent plasmid in 1991 that is essential to the bacterium's ability to cause disease.

"With the presence of the plasmid, *Rhodococcus* can replicate in macrophages (white blood cells) and cause disease," Giguère said. "Without it, it loses its ability to cause disease in foals. Without the

plasmids, the foals cleared the *Rhodococcus* within two weeks."

Researchers sequenced the plasmid's nucleotide and "the genes for a family of eight closely related virulence-associated proteins," targeting one that they designated as VapA. After further research, Giguère said, scientists discovered that while VapA aided reproduction of the bacteria in the foal, it wasn't able to produce an *R. equi* infection on its own. Other proteins were evaluated as well, although the role that each plays in the pathogenesis of *R. equi* is unknown, Giguère concluded.

Giguère also relayed that inhaling *R. equi* bacteria is one avenue by which a foal can contract pneumonia. He added that *R. equi* pneumonia could be detected as little as three days after a foal inhaled a large concentration of bacteria.

Diagnosis Giguère said that several tests are available for diagnosing foal pneumonia, but the key is determining whether *R. equi* pathogens caused the pneumonia, or whether another issue is to blame.

There are several tests that are able to detect *R. equi*, including complete blood counts, measurement of fibrinogen



concentrations, and ultrasonographic and radiographic exams. But Giguère cautions that veterinarians should use a bacteriologic culture or a polymerase chain reaction (PCR) test for the VapA protein, along with a cytological exam of the tracheo-bronchial aspirate, to definitively diagnose pneumonia caused by *R. equi* bacteria.

“A PCR test is slightly more sensitive than the other tests; however, the culture offers the advantage of detecting other bacterial pathogens present and permits *in vitro* susceptibility testing of the recovered pathogens,” Giguère said. “As a result, PCR amplification of the VapA gene may be done in association with, but should not replace, bacterial culture.”

Giguère added that foals should be tested for *R. equi* infections at the first sign that they might be ill: “Early diagnosis is of paramount importance for successful therapy of infected foals.”

Epidemiology

Noah Cohen, VMD, MPH, PhD, Dipl. ACVIM, professor of Large Animal Clinical Sciences at Texas A&M University's College of Veterinary Medicine & Biomedical Sciences, presented a study on the epidemiology (“scientific discipline concerned with quantifying the distribution of disease and determinants of disease and health in populations”) of *R. equi*.

In his presentation he reviewed published research about why some foals contract *R. equi* pneumonia in the same environment where other foals do not, and why *R. equi* is prevalent at some farms but virtually nonexistent at others.

According to Cohen, virulent (disease-causing) *R. equi* has been isolated from several sources on breeding farms including feces (from both foals and their dams), horse feed, the soil, and the air. Especially at farms with high concentrations of foals, Cohen says it's likely that all foals are exposed to the disease-causing bacterium, but only a small portion of foals actually contract pneumonia.

He noted in the study that the concentration of virulent (disease-causing) *R. equi* in the dams' feces was not related to the risk of a foal developing pneumonia caused by the bacterium; in other words, mares shedding more *R. equi* in their feces did not appear to explain the disease. However, that study also observed that nearly all mares shed virulent *R. equi* in

their feces during the period shortly after birth of foals.

There might be genetic factors that influence a foal's susceptibility to *R. equi*, he said, as veterinarians in the field report that some mares have had multiple foals that have contracted the disease. Moreover, variations in the DNA sequence (known as polymorphisms) for several genes have been associated with somewhat greater risk of disease. He also suggested that some foals could just be particularly immunologically susceptible to the disease.

No matter the cause, he stressed that more research is needed to obtain more accurate information about what predisposes some foals to contract *R. equi*.

Cohen also examined why some breeding farms seem to have a higher prevalence of *R. equi* than other farms. Again, combing through the available data provided few definitive answers.

“The density of mares and foals per acre seems to be positively correlated with incidence of *R. equi* pneumonia,” he noted. Foaling at pasture also may reduce risk of this disease, but more work is needed to confirm existing observations.

Cohen also explained that in the studies he examined, *R. equi* seemed to occur at “well-managed farms that use practices generally deemed to be desirable for preventing infectious diseases of foals.

“This association is not likely causal,” Cohen wrote. “But it does indicate that practices effective for preventing other infectious diseases of neonates are of limited benefit against *R. equi*.”

The take-home message, Cohen said, is that researchers don't yet understand why some foals contract the disease while others in the same environment do not. Some farm-level interventions such as reducing density of mares and foals and foaling at pasture need to be systematically evaluated.

Control/Prevention

For years foal owners have struggled with controlling *R. equi* and the infections it causes—some farms manage cases annually, despite following strict farm management strategies to reduce the risk of infection. Resulting pneumonia and diarrhea can be deadly for foals, and treating survivors is costly and labor-intensive.

Cohen said preventing and controlling *R. equi* infections might be the ideal way

to deal with some farms' recurrent *R. equi* problems. However, finding the means to prevent and control *R. equi* infections is still a challenge that researchers face.

Cohen explained that two options for controlling and preventing *R. equi* infections were recently the subjects of several peer-reviewed studies: chemoprophylaxis and immunoprophylaxis.

Chemoprophylaxis (the use of antimicrobial agents to prevent foal pneumonia), was considered as an option for preventing *R. equi* infections, Cohen said. He cited two studies in which researchers used azithromycin in an attempt to prevent infections, one of which showed a 76% reduction in the risk of contracting an infection. The other study, however, showed little difference between the infection risk

“In the absence of a preventative strategy, further application, evaluation, and development of screening tests are greatly needed to address this important health issue in foals.”

DR. NOAH COHEN

of foals treated with azithromycin and those untreated. Cohen said the reason for the discrepancies in the results is unknown. But the reason for the discrepancy is moot; using azithromycin for preventing *R. equi* infections should not become common practice because it could create microbial-resistant bacteria in the foal and its environment. If the foal subsequently contracts an *R. equi* infection, the prognosis would be worse due to the resistant bacteria (which can be shed by carriers and picked up by other foals, resulting in them contracting a resistant form of infection).

Cohen also discussed the option of immunoprophylaxis (immune system modifiers) to prevent *R. equi* infections. He said that despite extensive research into developing a vaccine, no such product has been effective against *R. equi* infections.

The only clinically acceptable prevention



method, Cohen said, is the administration of hyperimmune plasma (which contains high levels of antibodies against *R. equi*) to young foals via transfusion shortly after birth and possibly again at 3 to 4 weeks of age. Hyperimmune plasma is thought to provide passive immunity to treated foals against *R. equi* and reduce the incidence of pneumonia caused by this bacterium.

Cohen adds that although observational studies haven't produced uniform evidence of effectiveness, the cumulative interpretation of published studies indicates that plasma transfusion has reduced the risk of foals contracting *R. equi* infections.

"There is tremendous need for the development of a highly effective preventative strategy," Cohen said in his study. "In the absence of a preventative strategy, further application, evaluation, and development of screening tests are greatly needed to address this important health problem of foals."

Antimicrobial Combo Targets *R. equi*

The ideal treatment for *R. equi* infection remains debatable because of the lack of research comparing the efficacy of each possible treatment in foals. However, according to Giguère, current evidence suggests that the most successful treatments include a combination of the drug rifampin and a macrolide (a class of antimicrobial drugs). He reviewed treatments for *R. equi* pneumonia.

Giguère said that veterinarians have used the combination of rifampin and erythromycin (a macrolide) since the 1980s, and with this strategy they have drastically reduced the number of fatalities resulting from *R. equi* pneumonia, at least compared to historical data.

"The combination of a macrolide and rifampin is synergistic both *in vitro* (in the laboratory) and *in vivo* (in a live animal), and the use of the two classes of drugs reduces the likelihood of *R. equi* resistance to either drug," he said. Giguère added that rifampin and macrolides are liquid-soluble, a trait that "allows the drugs to penetrate cell membranes."

In addition to erythromycin, veterinarians have begun using two more recently developed macrolides to treat *R. equi* infections. Both azithromycin and clarithromycin have more modern chemical properties, meaning a smaller amount of drug is required to be effective, and the drug can be administered less frequently.

Both characteristics result in fewer doses for the horse.

Giguère mentioned that there is a need for newer antimicrobial agents that are long-acting and require less frequent administration. However, the two long-acting macrolides currently available in the United States (tulathromycin and tilmicosin) are poorly active against *R. equi*. As a result, their use for treating *R. equi* infections is not recommended.

In addition to the macrolide antimicrobial agents, Giguère mentioned a few alternative classes of drugs that can be used for foals with *R. equi* pneumonia. One treatment option that might be successful in some foals is an oral dose of doxycycline in combination with rifampin. Finally, he said the antibiotic drug chloramphenicol has some activity against many *R. equi* strains, but it carries with it a health risk to the humans administering it.

The antibiotic drug chloramphenicol has some activity against many *R. equi* strains, but it carries with it a health risk to the humans administering it.

R. equi Immunity and the Foal

Why is it that only foals are affected by *R. equi* pneumonia? According to M. Julia B. Felipe, DVM, MS, PhD, Dipl. ACVIM, of Cornell University's College of Veterinary Medicine, one of the contributing factors is that some aspects of the foal's immune system take time to develop and, thus, contribute to susceptibility to disease. Felipe summarized research findings on the topic at the convention.

"The unique susceptibility of young foals to *R. equi* disease is still puzzling, despite many studies investigating their innate and acquired immune systems," Felipe said. Part of the puzzling aspect is why only certain foals contract the disease, while other foals remain healthy.

Despite the fact that many foals with naive immune systems (they haven't been exposed to the pathogen in question before) are exposed to *R. equi*, only some of them develop disease in the face of that exposure. According to Felipe, this points

towards some foals having individual risk factors that make them more susceptible to the *R. equi* bacterium.

Felipe explained that the foal must have both innate and acquired immunity for complete protection from *R. equi* bacteria. The innate immune system recognizes the presence of organisms without the need of previous exposure. Some cells of the innate immune system of the foal are very effective in killing extracellular (outside cells) pathogens, including *R. equi*. But the interaction of the innate with the acquired immune system seems necessary for protection against disease.

She added that acquired immune responses develop after *R. equi* exposure, and are carried out by a variety of "T-helper" cells, which scientists call "Th cells." Each Th cell plays a different role in fighting diseases. For example, in the horse Th-1 cells support an immune response to fight intracellular (within cells) infections, while Th-2 cells promote antibody production for protection against extracellular organisms.

According to Felipe, recent studies have indicated that foals can develop Th1 immunity as a defense against *R. equi*. She said this is the type of immune response that adult horses produce when challenged with experimental infection in scientific studies; such a response indicates that some foals can defend against *R. equi*. The question remains if, for some foals, this type of response takes longer to become effective, creating the window of susceptibility to the organism.

Additionally, she examined the possibility of antibodies providing immunity for the foal against *R. equi*. Although a protective effect of antibodies on the bacterium has been shown *in vitro* (in the laboratory, not in the live horse), studies evaluating the use of plasma products enriched with antibodies against *R. equi* have contrasting results in the field. Nevertheless, colostrum and plasma products supply at birth essential antibodies for the optimal function of the cells of the innate immune system, until the foal can produce its own antibodies through the acquired immune system.

Felipe concluded that while scientists have made strides in understanding how *R. equi* affects foals, further studies are required to uncover how—and why—it only affects certain foals.



“Many current studies (are investigating) the pathogenic mechanisms in the early stages of infection,” she said, adding that the goal is to develop better preventive methods, including immunomodulators (drugs that alter the immune system), vaccines, and herd management techniques.

The Hunt for Effective New Antibiotics Continues

It isn't for lack of effort that the equine industry still doesn't have new options for treating *R. equi* pneumonia in foals. According to Cohen, he and his colleagues are well aware that veterinarians are in dire need of better antibiotic alternatives. “Treatment of foals with *R. equi* pneumonia is generally prolonged, making treatment both expensive and labor-intensive,” said Cohen. “Currently, the treatments of choice are a combination of the drug rifampin with azithromycin, clarithromycin, or erythromycin.”

The latter three drugs are members of a family known as macrolides. Cohen

explained the significance of macrolides, noting, “To date, alternatives to macrolides for effective treatment of *R. equi* pneumonia in foals have not been identified. Thus, when new macrolide treatments are developed, there is considerable interest among equine practitioners and farm managers about the prospects of using these new macrolides to treat foals with pneumonia.”

One of the disadvantages of azithromycin, clarithromycin, or erythromycin is that these must be administered at least every 24 hours. Because treatment is generally prolonged, availability of a macrolide that could be administered less frequently to foals is desirable.

Tulathromycin is a long-acting injectable macrolide antibiotic, and data from Germany has suggested tulathromycin was useful for managing abscessing pneumonia in foals at a large breeding farm.

Cohen et al. therefore tested tulathromycin and 14 other antimicrobials on 98 different types of *R. equi* bacteria grown

in laboratory culture dishes (they tested these drugs *in vitro*, or in the laboratory, rather than the live horse). They wanted to determine if any of these drugs might be potentially beneficial in live foals with *R. equi* infections.

“Unfortunately, we found tulathromycin had poor activity against *R. equi*,” Cohen said. “It appeared that it would be impossible to achieve therapeutic concentrations of tulathromycin in blood or tissues.”

Giguère is also well aware of the need for new drugs for treating *R. equi* infections.

“There are other long-acting macrolides with good *in vitro* activity against *R. equi* that are currently available for use in cattle in other countries,” he said. “These agents are currently being studied in foals here in the U.S. Some viable options do seem to be upcoming.”

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■ Watch the *R. equi* Pneumonia in Foals video, TheHorse.com/Video.aspx?vID=476.

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Reproduction

BY ERICA LARSON AND CHRISTY WEST

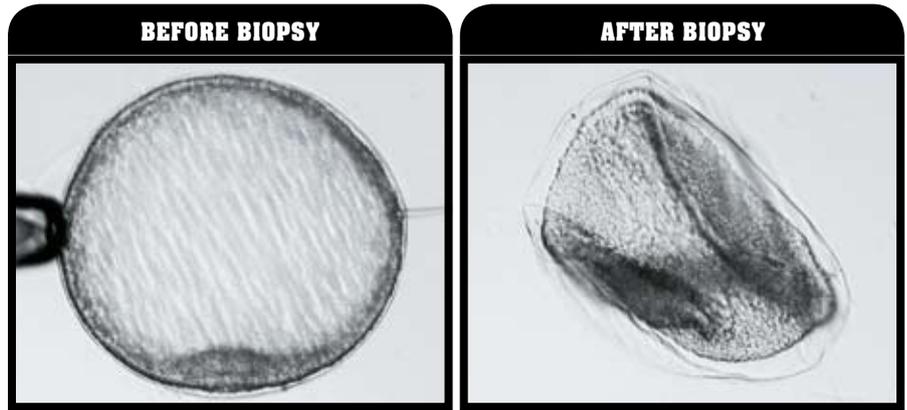
Practical Assisted Reproduction

Technology is an amazing thing—especially technology that allows veterinarians to produce live foals from horses with very poor fertility and even from those that have died. A number of assisted reproductive technologies (ART) for horses have been optimized for commercial use, and veterinarians discussed these in detail.

“For the equine practitioner, application of ART can range from simply sending ovaries to a laboratory after a mare’s untimely death to setting up complete oocyte and embryo culture systems in a practice,” began Katrin Hinrichs, DVM, PhD, Dipl. ACT, professor of veterinary physiology and pharmacology and Patsy Link Chair in Mare Reproductive Studies at Texas A&M University. She discussed several ART methods and techniques as follows.

Postmortem Shipment of Ovaries If a mare dies but the owner still would like foals from her, her ovaries can be harvested immediately and oocytes (egg cells) from them can be matured in the laboratory, then placed in a recipient mare for fertilization and gestation (more on oocyte transfer in a moment). Alternatively, those matured oocytes can be fertilized in the lab (using intracytoplasmic sperm injection, ICSI, or injecting a sperm cell directly into the egg; more on this in a moment). The fertilized eggs are cultured in the lab and resulting embryos can be placed in recipient mares for gestation.

The best success rates with this method are achieved when oocytes are recovered less than eight hours after the mare’s death, said Hinrichs. She added that ovaries recovered from mares following barbiturate overdose (customarily used for euthanasia) and those recovered from live mares under general anesthesia had all yielded live foals, and that these ovaries should be kept at body temperature for short trips of less than two hours, or at room temperature for longer trips. She also recommended the



Texas A&M researchers have biopsied equine embryos successfully for genetic testing; these embryos have normal pregnancy rates and can be frozen for storage more effectively than in the past.

use of high-quality semen for these oocyte transfer situations, given the limited oocytes available.

Historically, researchers have reported success rates of 32% when they’ve transferred harvested oocytes into recipients for fertilization, noted Hinrichs. They achieved rates of 63% when oocytes were fertilized via ICSI and embryos were placed in recipients.

It’s also possible to harvest the oocytes from ovaries and ship those; Hinrichs described the harvesting and handling procedures that she and her colleagues have found successful in their laboratory at Texas A&M.

Oocyte Recovery from Live Mares Sometimes a mare’s oocytes are fertile, but she can’t maintain a pregnancy because of uterine problems. For these mares, veterinarians can surgically harvest mature or immature oocytes for fertilization and/or transfer into recipient mares. Each oocyte type has its advantages. It’s easier to harvest mature oocytes from pre-ovulatory follicles, said Hinrichs, but these oocytes are very sensitive to temperature and other environmental influences; thus, shipping and handling can compromise their viability. In contrast, immature follicles are more resource-intensive to harvest and yields can be low, but they’re less fragile.

Oocyte Transfer This method is “currently the most effective method for getting a foal from a mare’s isolated oocyte,” said

Hinrichs. Some studies have reported pregnancy rates of up to 83% with this procedure, in which a recovered oocyte is transferred into the oviduct of a recipient mare, then the recipient is inseminated. These success rates were achieved in healthy, fertile horses; she estimated that in practice, when subfertile horses are used, success rates might be around 35% per cycle.

In Vitro Fertilization *In vitro* fertilization (IVF) in humans, where a sperm and egg are put together in culture and allowed to fertilize, doesn’t work well in horses because the sperm don’t usually penetrate the egg’s outer covering. However, Hinrichs described one IVF study in which researchers found that inducing hyperactive sperm movement resulted in a 60% fertilization rate, thus “opening up an exciting area for further investigation in equine IVF,” commented Hinrichs. Although embryos have not developed after fertilization with this strategy, researchers continue to work on it.

“Establishment of effective methods for standard IVF would allow use of this ART in many equine practices, because it alleviates the need for micromanipulation equipment and associated expertise,” said Hinrichs.

Intracytoplasmic Sperm Injection (ICSI) As mentioned earlier, this technique involves injecting a single sperm into an oocyte in the laboratory, and is thus useful when fertilizing harvested oocytes and/or when

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only a limited amount of viable sperm is available for use (such as when there are limited quantities available, or the stallion is subfertile or deceased). Fresh and frozen semen can be used.

Typically, 20 to 35% of oocytes subjected to ICSI produce embryos that can be transferred. Pregnancy rates after transfer of embryos produced with this procedure have increased with improved embryo culture conditions, and they were as high as 83% in one report. Although no published reports exist on the health of foals produced with ICSI, Hinrichs reported that Texas A&M-produced ICSI foals were all normal and healthy from birth.

Cloning (Nuclear Transfer) Only four laboratories have reported the birth of foals produced by cloning of cells from adult horses. Cloning involves harvesting a small piece of subcutaneous tissue from a donor animal using sterile techniques, removing the nucleus (genetic material) from one of the cells, and transferring the material into an oocyte that has had

its genetic material removed. Pregnancy rates approach that of normal breeding methods, although about half those embryos are lost throughout gestation, said Hinrichs. She estimated that in her lab about 30% of transferred cloned embryos produce live foals, which is "very efficient compared to other species."

While many think of cloning as a way to reproduce a proven performance horse, Hinrichs reported that cloned foals have a higher incidence of health problems such as maladjustment and contracted tendons just after birth (which could affect adult athletic ability), and as such they might be best used as breeding animals rather than performance ones.

Another factor in cloning is that although some breed and competitive associations will accept cloned foals as competitors, most breed registries won't register cloned foals largely because of a mitochondria issue. Mitochondria are tiny organelles within cells that synthesize energy to carry out the cell's functions,

explained Hinrichs, and they come from the oocyte that receives the donor's genetic material. Those mitochondria could be from any breed of horse, and variation in mitochondria from the donor's mitochondria could theoretically offer variations in growth, stamina, and possibly other traits compared to the original animal. "No real information is available on the effect of mitochondrial origin in the horse," Hinrichs added.

This is an issue for cloned mares, but not for stallions, because mares will pass on their mitochondria via their oocytes, whereas stallions will not. Texas A&M researchers are currently studying cloning using oocytes from mares of the same maternal line as the genetic material donor, reported Hinrichs.

"That way you'd get a foal with the same mitochondria as the original horse," she explained.

Embryo Biopsy for Genetic Testing If an embryo is being handled in the lab, why not test it for genetic diseases (such as

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hyperkalemic periodic paralysis (HYPP) or hereditary regional dermal asthenia (HERDA) before putting it in a recipient mare that will carry it to term? Hinrichs reported that Texas A&M researchers have recently published a description of a technique whereby embryos are biopsied for testing, and the embryo recipients still have a normal pregnancy rate of 83%. Foals born from biopsied embryos were normal, she added.

"This technique should allow horse breeders to avoid the production of individuals affected with these devastating genetic diseases," she said. "We anticipate that this technique will allow for the eventual elimination of these diseases from the industry altogether."

So far, the researchers have had about a 75% success rate in detecting genetic disease with this method, which is technically challenging to perform on just a few cells. "This is not yet clinically applicable; 75% accuracy is not accurate enough yet for me," Hinrichs commented.

Embryos might be implanted before test results are complete, but the test results might lead a producer to terminate a pregnancy if the foal is diseased. Or, alternatively, the embryo can be preserved using the last procedure Hinrichs discussed—vitrification, or freezing for storage.

Embryo Freezing (Vitrification) Although veterinarians have been freezing small embryos successfully for many years, their efforts at freezing larger embryos have not fared as well, Hinrichs reported. However, in the course of researching embryo biopsy, Texas A&M University researchers discovered that large biopsied embryos had good survival rates after freezing, and their implantation resulted in pregnancy rates greater than 50%.

"It is possible that blastocyst collapse (collapse of the rounded embryo's shape when cells were removed and less fluid was contained inside) may allow even standard cryopreservation procedures to be performed; this is a currently developing area," said Hinrichs.

"The year 2010 brings to an end a decade of amazing progress in equine ART," she concluded. "The next decade should show a notable increase in efficiency and accessibility of many equine ART procedures."

Nature vs. Nurture

The phrase "nature vs. nurture" is usually

used to refer to the debate over which has a greater impact on a person's personality and preferences—genetics or environment/rearing. But for this article, we'll use it in the context of fetal programming, or what makes a foal develop into a physically healthy (or not so healthy) horse. Hint: Nature and nurture in this case are scientifically proven to be intertwined, with nurture (environment) affecting genetic expression even in later generations and genetics obviously controlling much of a young horse's development.

"The athletic performance of horses may be highly susceptible to fetal programming," said Carey Satterfield, PhD, assistant professor of animal science at Texas A&M University. Thus, our management of the pregnant mare and young foal could help that foal run faster, spin harder, and/or jump higher as an adult—or the opposite.

Satterfield delivered an in-depth talk on the relatively new (to horses) field of epigenetics, or the study of changes in physical

“The next decade should show a notable increase in efficiency and accessibility of many ART (assisted reproductive technologies) procedures.”

DR. KATRIN HINRICHS

characteristics occurring independently of genetic changes. To date, few epigenetic studies have focused on horses, but the bit of research that exists, plus findings in other species, have opened the door to a universe of possibilities—both helpful and harmful—for manipulating the physical characteristics of our children and the animals we raise.

How Nurture Affects Nature "The question of nature vs. nurture is unanswerable," stated Satterfield at the convention. "Nature and nurture can't be separated because nurturing can alter gene expression (nature)."

That doesn't mean that hot weather or nutrition changes alter a person's or animal's genetic code or DNA; rather, a variety of conditions can change how the organism "uses" its DNA. The genetic code

is unchangeable, but various genes within it are "switched on or off" to generate appropriate proteins as needed. For example, genes that control the development of bones, manes/tails, or internal organs switch on at the right time during gestation to create those structures, then switch off once they have done their jobs.

Another way to look at DNA vs. gene expression is to consider that every cell in an organism has the exact same DNA (organ transplants aside), but hoof and heart tissue, for example, are clearly very different. Why? Because different genes within that DNA are switched on in each tissue type.

Genes switch on and off in response to a host of factors (such as injury, disease, or change in diet), in all ages of individuals. However, the younger the organism, the more flexible or "plastic" its gene expression is. "The embryonic state is the most plastic one," explained Satterfield. "With increasing age, plasticity decreases. Adults are pretty set in stone, but the fetus is very plastic and can adapt to its environment. Plasticity continues until weaning.

"The fetus seeks cues to its environment, so it can develop to provide the phenotype (physical characteristics) it needs to maximize its survival once it's born (fetal programming)," he went on. "The adaptive process is rooted in evolution and likely intended to provide an advantage to the fetus after birth. The problem is when the external environment is improperly predicted, then the offspring develops adult disease (because it developed to match an environment it doesn't live in).

"For example, a poorly nourished fetus would predict that nutrient availability will be scarce later in life and develop an extremely efficient metabolism," he continued. "If, in fact, the nutrient availability is high later in life, this metabolic efficiency would result in the deposition of fat. Indeed, some horses are described as 'easy keepers'—a 'condition' that may result from the metabolic programming of the fetus in utero.

"Equine conditions such as obesity, metabolic syndrome, and laminitis could all have fetal origins," he commented.

Another aspect of fetal programming is that timing is everything, Satterfield said. "Not all organs grow at the same time or at the same rate," he explained. "The same environmental cue can have very different responses depending on the timing of



administration to the fetus.”

Research in Other Species Satterfield described several studies in humans, sheep, and rats to illustrate the impacts of fetal programming on later health. Many studies focus on undernutrition, because as he noted, “In livestock, drought during gestation is the most common cause of a mismatched prenatal and postnatal environment.”

- Human mothers who gave birth during the Dutch potato famine (mid-1940s) had smaller offspring than normal, and females born to those mothers also had smaller offspring than normal despite healthy diets, suggesting a heritable epigenetic alteration.
- Mothers exposed to famine (in general) have children who are predisposed to diabetes, obesity, cardiovascular disease, microalbuminuria (a kidney problem), schizophrenia, other neurologic disorders, higher cholesterol, and reduced growth (height).
- Rats fed low-protein diets gave birth to pups who had increased systolic blood pressure (the first/higher number in a blood pressure reading) compared to controls. Pups of those offspring also had higher blood pressure than controls (whether one or both grandparents had had low-protein diets).
- Reduced or low birth weight has been correlated with increased risk of death from adult coronary heart disease in men and women.
- Fetal programming effects can vary with gender as well; one study found that ewes fed diets deficient in methionine (an amino acid) for 30 days had male lambs with higher resting blood pressure at one year of age; females did not have abnormal blood pressure. “It is imperative that we use caution when giving nutritional supplements to pregnant mares, because using an inappropriate type, dose, or combination may have permanent consequences on the developing fetus,” Satterfield commented.
- Also in sheep, one study compared three groups of initially obese ewes: One with an *ad libitum* (unrestricted) diet during pregnancy, one on an initially unrestricted diet followed by a diet with 65% of the recommended calories (to simulate obese women losing weight during pregnancy), and one fed at 100% of recommended calories during gestation.



ANNE M. EBERHARDT

According to Satterfield, nature and nurture can't be separated because nurturing can alter gene expressions (nature).

The ewes on the heavily restricted diet lost weight quickly at the beginning, then more slowly, and had significantly lighter offspring than the other groups. The lambs of obese ewes on unrestricted diets weighed the same as those on the recommended diet at birth, but had 50% more lipid (fat) content in their bodies and thus less muscle. After birth they also grew more slowly.

- Behavioral characteristics can be modified and inherited as well; Satterfield discussed a study in which licking/grooming (LG) behavior of mother rats towards pups in their first week of life could be modified by changing the amount of methionine in the diet or by adding stress to the environment. Changes in licking/grooming behavior were found to be passed to offspring, suggesting that an animals' behavior and response to behavior modification (i.e., training of horses) could be affected by the genetic results of the mother's experiences.
- Additionally, female pups of low-LG mothers were found to have higher levels of sexual receptivity. If these findings are extended to horses, Satterfield commented, “Perhaps increased mothering could serve as a preventive treatment for later heat-related behavior that interferes with a filly's performance.”
- Finally, pups of rats fed high-fat diets had altered cardiovascular (heart/circulatory system) function and insulin resistance at one year of age. Satterfield

notes that similar research is currently in progress on horses at Texas A&M.

Research in Horses Although epigenetic research in the horse is sparse, Satterfield discussed a few studies on point. First, the mare is well known for her ability to control the size of her fetus, noted Satterfield; in previous studies, Thoroughbred embryos have been implanted in pony mares and vice versa. The pony mares bore 37% smaller Thoroughbred foals than Thoroughbred mares, while Thoroughbred mares bore more than 50% larger pony foals than the pony mares. The differences in size with breed of the recipient mare continued to be apparent several months after foaling, and show the effects of recipient mare choice on fetal size/postnatal development—this is useful information to keep in mind when planning embryo transfer.

He also mentioned a study in which foals from mares on high-starch diets had lower insulin sensitivity (a factor in metabolic disease) through 160 days of age than foals from mares on low-starch diets.

“Epigenetic changes are likely to play an important role in later health and disease, and they can occur in response to transient environmental influences,” he concluded. “We really don't know how long exposure has to be (to have an effect on the foal), but at different times the same factor can have different impacts. Much more work is needed.

“Now that you're aware of it, start looking for this epidemiological evidence and

bring it to those of us who can test it experimentally and answer the questions," he urged the veterinarians in attendance.

Subfertile Breeding Stallions: Management Strategies

"Stallions do not become sires because of reproductive capability," began Dickson Varner, DVM, MS, Dipl. ACT, professor of large animal medicine and surgery at Texas A&M University. "They're selected based on performance, pedigree, and conformation—reproductive ability is last. The equine breeding industry abounds with stallions whose level of fertility is less than optimal."

Varner discussed several cases of breeding stallion subfertility, along with semen and breeding management strategies that effectively increased those stallions' fertility. Some involved live cover programs, while others involved artificial insemination.

"Are we acting unethically when we enhance fertility in stallions?" he asked the audience. "It's not a black and white issue. It is difficult at present, except in isolated circumstances, to differentiate between heritable and nonheritable causes of reduced fertility."

The first step in improving breeding stallion fertility, he said, is to assess a stallion's breeding records to discover the circumstances that result in low fertility. The problem could be with the stallion, mares, and/or their management. In the case of the mares, for example, he referenced one stallion that had above-average pregnancy rates per cycle for maiden and foaling mares, but lower rates for barren mares (which clearly had lower fertility). That latter group could lead you to underestimate the stallion's fertility if you didn't analyze the mares as well as the stallion.

Management factors can also come into play, and they might depend on the stallion. For example, he described a comparison of two stallions, one with a pregnancy rate that increased with increasing numbers of covers in a day. The other stallion had lower pregnancy rates with increasing number of covers in a day and higher pregnancy rates after periods of sexual rest.

"For the first stallion, the more you breed him the better he gets—you'd want to have a large book of mares and keep some test mares around for him to breed if there are no commercial mares available,"



The first step in improving breeding stallion fertility is to assess a stallion's breeding records.

Varner explained. "The second would do better with a smaller book."

Other techniques to improve fertility in live cover programs include:

- Breeding stallions to test mares in the off season, as many stallions have lower fertility after extended periods of sexual rest.
- Using reinforcement breeding (collecting a dismount semen sample, filtering/extending it, and placing this in the mare immediately). Some stallions tend to dismount early, and this can help those stallions considerably (if permitted by the registering organization). This practice also helped one stallion's pregnancy rate following a kick in the groin, until he recovered from that injury. "Overall, it appears that reinforcement breeding can improve pregnancy rates in approximately 60% of Thoroughbred stallions, given the experimental figures available," Varner commented.

Tips for AI Programs For breeds whose registries allow artificial insemination, there are a few techniques that can improve stallion fertility; Varner focused on centrifugation of sperm and deep-horn low-dose insemination techniques.

When semen is collected for artificial insemination, it is often centrifuged (spun for a short time) to increase the concentration of semen in the end of the tube and

thus maximize sperm harvest, as Varner put it. The downside is that sperm can be damaged by this practice, so methods that maximize sperm quality and recovery rates would be ideal. One point he made was that discussions of centrifugation technique should focus on centrifugal forces, not revolutions per minute, as differently sized centrifuges will yield different forces even if spinning at the same RPMs.

Another point was that conical-bottom and nipple-bottom tubes can both be effective for centrifugation, but Varner recommended that nipple-bottom tubes be used when sperm numbers are low or when more seminal plasma needs to be removed.

He also described some cushioned centrifugation strategies that use a cushion medium in the tube, which is "like a little trampoline" that cushions the sperm at the bottom of the tube during centrifugation rather than allowing them to be crushed or suffer concussive injury.

Next, he discussed discontinuous density gradient usage during centrifugation, a process which helps separate sperm that are damaged from those that aren't. The end result, Varner reported, is improved quality of recovered semen; this has been helpful in commercial situations as well as experimental ones.

Finally, he discussed deep-horn, low-dose insemination techniques, which offer



the potential to breed more mares per collection by using a dose of semen that can be 200-500 times smaller (in terms of sperm numbers) than a typical dose. This smaller dose is placed at the tip of the uterine horn with a dominant follicle rather than in the uterine body.

“Breeding and semen-manipulation strategies can be applied to maximize the fertility of these stallions and to extend their productive lives,” he concluded.

Embryo Recovery Procedures and Collection Success: a Review

Since the first live foal produced by embryo transfer was born in 1974, the procedure has become one of the most popular assisted reproduction options for breeders with mares who are valuable or for mares that are to remain in competition.

Patrick M. McCue, DVM, PhD, Dipl. ACT, associate professor of equine science at Colorado State University (CSU), reviewed the results of more than 490 embryo recovery procedures performed at CSU between 2004 and 2008. He discussed the flush techniques commonly used and the success rates of retrieving embryos from mares of various ages and reproductive status.

According to McCue, a majority of embryo flush procedures are attempted at Day 7 or 8 after ovulation. Flushes may be performed on Day 6 or early on Day 7 in an attempt to recover small embryos for cryopreservation (freezing). He typically uses four liters of fluid in an initial series of flushes, and he proceeds with another liter or two if an embryo isn't recovered during the first round.

The average embryo collection success rate of young mares (<15 years of age) was 57.1%, while the embryo recovery rate of older mares (≥15 years of age) was 39.4%. In addition, he noted that embryo collection success was significantly lower in mares that experienced prolonged uterine inflammation after mating (i.e., a prolonged period of fluid accumulation).

The vast majority of mares were flushed on one day only. However, the group performed a re-flush the next day on 31 mares if no embryos were recovered on the first attempt. Embryos were recovered on only three of the next-day flush attempts and a majority of the next-day flushes had uterine debris present. Based on the low recovery rate, it was recommended to only

perform an additional flush the next day if the mare was not going to be available for another embryo transfer cycle.

McCue and his team recovered a total of 257 embryos during the study. More than 97% of those embryos were recovered in “excellent” or “good” condition. Only six embryos were recovered in “poor” condition. McCue noted that it's rare to retrieve an embryo from a mare that was in “poor” condition or one that is not viable since most of these embryos are likely retained in the oviduct.

Additionally, he noted that mares bred with cooled semen had a 51.9% recovery rate, and mares bred with frozen semen had a 33.3% recovery rate. It was interesting to note that embryos recovered from

“Breeding and semen-manipulation strategies can be applied to maximize the fertility of these stallions and to extend their productive lives.”

DR. DICKSON VARNER

mares bred with frozen semen were slightly smaller than embryos recovered from cycles in which mares were bred with either fresh or cooled-transported semen.

Finally, McCue said that the team recovered three unfertilized oocytes (eggs) out of the 490 flushes performed, and in one case a fertilized embryo was recovered with an unfertilized oocyte. In the horse, unfertilized oocytes are usually retained in the oviduct, while fertilized embryos produce a special type of prostaglandin (PGE2) that allows the transport of the embryo down the oviduct and into the uterus. Recovery of an unfertilized oocyte usually means that it was transported down the oviduct along with a viable embryo and that a viable embryo should be present.

Stallionlike Behavior in Mares

Stallions are commonly known to be feisty, fresh, and sometimes difficult to handle, largely attributable to the testosterone coursing through their bodies. But when mares begin to display aggressive or stallionlike behavior, the reason for the

atypical behavior can be less obvious.

Monica Morganti, DVM, a resident in veterinary medicine at the University of California, Davis, presented a study in which she examined the role the adrenal glands play in causing mares to exhibit stallionlike behavior.

The stallionlike behaviors that mares sometimes exhibit include stallionlike vocalizations, aggressive attitudes towards handlers and other horses, and regular performance of the flehmen response. These mares may also have elevated testosterone levels.

Along with a team of colleagues, Morganti set out to determine if the adrenal glands have an effect on testosterone levels in mares that display stallionlike behavior.

The team tested levels of blood serum cortisol, a substance primarily produced by the adrenal gland, in 24 control mares and 29 mares with elevated testosterone levels. All of the mares studied had a history of displaying aggressive or stallionlike behavior. Before testing, Morganti and her colleagues ensured none of the mares were pregnant, and they ruled out granulosa-theca cell tumors in the mares (a type of ovarian tumor and the most common cause of stallionlike behavior in mares).

The team analyzed their results and found that mares with elevated testosterone levels also had higher serum levels of cortisol. They also noted that there was a moderate correlation between serum levels of cortisol and testosterone in both groups of mares, meaning that the control mares had lower levels of both substances.

According to Morganti, the data collected suggest that the adrenal gland (specifically the adrenal cortex) could increase both testosterone and cortisol levels in mares, leading to aggressive or stallionlike behavior. There are no treatment options currently available. Morganti also added that stress in mares could add to the aggressive behavior.

Ovarian Response to Injectable Deslorelin During Anestrus

Most breeders meticulously plan out every detail of breeding a mare. But sometimes things don't go quite according to plan. Suppose, for example, as breeding season approaches, the clinically breeding-sound mare is anestrus (she doesn't show an estrous cycle and, thus, she's difficult to



impregnate). What now?

According to Farhad Ghasemi, DVM, a resident in theriogenology at the University of Saskatchewan, injectable deslorelin (which is currently used to induce ovulation in mares during the breeding season) might be the answer to this problem. Ghasemi presented the results of his recent study, which aimed at determining what effect the drug had on anestrus mares.

Ghasemi and colleagues examined a group of 16 anestrus mares, aged 3 years to 20 years. The mares were considered anestrus after an ultrasound confirmed that no luteal tissue or ovarian follicles larger than 21 mm were present for more than two weeks (luteal tissue forms when the ovarian follicle converts into a structure called the corpus luteum after discharging an egg, and follicles become larger as they are getting ready to discharge an egg). The team divided the mares into two groups of eight: one group received water-soluble deslorelin twice daily for up to 14 days, and the other received a placebo. When a mare had a 35-mm follicle, hCG (a hormone that helps stimulate ovulation in mares) was administered.

According to Ghasemi, seven of the eight mares in the deslorelin group developed follicles larger than 35 mm, and 50% ovulated, achieving pregnancy rates of 37.5%. No control mares developed large follicles or ovulated. He added that the average deslorelin treatment before mares developed larger follicles was 12 days.

Ghasemi added that after a mare is brought out of anestrus, there is a chance that she will return to anestrus if she doesn't become pregnant. He also added that mares with naturally smaller follicles might be less likely to respond to deslorelin.

This treatment may be an option for mares' owners who want to breed their mares out of season, but do not want to use artificial lighting programs that take more than 60 days. More research may fine-tune the protocol and make it more successful, Ghasemi said.

Manual Reduction of Twins: Effect of Operator, Mare Age, and Treatment Drugs

While a mare with twins by her side is rare and sometimes celebrated, twinning in horses is actually dangerous for the mare, especially during delivery. More

often than not, one of the twins, generally the smaller and weaker of the two, will die before birth. In fact, the chances of a mare carrying twins to term and delivering them successfully are about one in 10,000.

The manual reduction of one embryo in mares in the very early stages of carrying twins is a practice that was introduced to the breeding community in 2006 (the technique was first described in the '80s along with the increased use of the ultrasound to detect twin pregnancies), and since then it has become a common practice in managing twin cases. Pete C. Sheerin, DVM, Dipl. ACT, reviewed a study he conducted on manual twin reduction. Sheerin, a reproduction specialist who carried out his study at Rood & Riddle Equine Hospital, in Lexington, Ky., examined whether the performance of the veterinarian, the drug treatment used, or the mare's age impacted the procedure's success rate.

Mare older than 15 years of age had lower live foaling rates (66.2%) after undergoing a reduction procedure than younger mares (83.2%).

In his retrospective approach Sheerin used the medical records of mares that underwent twin reduction at Rood & Riddle. The procedures were performed between Days 13 and 20 of gestation. Sheerin explained that mares from the same farms that had only one embryo served as controls in the study. He noted the mares' ages (which ranged from 3 to 24 years), the veterinarian who performed the procedure (14 veterinarians total), and the combination of drugs that were used on the mares (22 combinations).

Sheerin said the mares that had undergone a twin reduction treatment had a marginally lower live foal rate (80.3%) than those mares that carried a single foal since the beginning of their pregnancy (86.7%). There was no difference in the live foal percentage of the mares that underwent a reduction from Day 13 to 16 of gestation than those undergoing the procedure between Days 17 and 20.

Although the individual veterinarian's

performance affected the live foal rate, Sheerin said differences were not related to veterinary experience. He also noted that "mare populations may have impacted these results, with experienced practitioners being referred difficult cases."

Mare age also impacted twin reduction procedures. Sheerin found that mares older than 15 years of age had lower live foaling rates (66.2%) after undergoing a reduction procedure than younger mares (83.2%).

Finally, the drugs used to treat the mares after they underwent a reduction procedure seemed to impact foaling rates, said Sheerin. He explained that mares treated with flunixin meglumine (Banamine) and progesterone had foaling rates of 84%. Mares treated with other drug combinations had a live foal rate of 84%, and mares not treated with drugs had a live foal rate of 77%.

With this new research on twin reduction procedures, owners can feel confident that their mare with a twin pregnancy can undergo a successful reduction procedure and give birth to a healthy foal.

Determining Fetal Gender: Practice Makes Perfect

For nearly 20 years, veterinarians have been determining fetal gender using transrectal ultrasound. While it's exciting for a mare owner to know the sex of the new addition before it arrives, just how accurate are these ultrasound procedures?

According to Italian field veterinarian Marco Livini, DVM, of Veterinari Associati Ippovet, in Milan, these transrectal ultrasounds can be up to 100% accurate in determining fetal sex when practiced on a regular basis at a determined gestational age.

Livini performed 572 transrectal ultrasounds between 2006 and 2008, categorizing each by gender between 55 and 70 days of gestation, and between 90 and 150 days of gestation. The mares Livini examined were of a variety of breeds and ranged in age from 3 to 18 years.

By focusing on certain anatomical parts for the 55- to 70-day ultrasounds and certain parts for the 90- to 150-day ultrasounds, Livini found it was relatively easy to determine fetal sex. Between 90-150 days of gestation, in female fetuses, the "target organs" that Livini focuses on are the teats and the mammary glands, the



vulva, the clitoris, and the gonads. In male fetuses, Livini suggests focusing on the penis and prepuce, the urethra, the epididymis and vascular pedicle, and the gonads.

He was able to correctly determine 203 fetal genders out of 232 examinations between 55 and 70 days of gestation. He made 24 more after longer examination of the ultrasound (Livini implemented a 150-second time limit for his determinations), and five of his determinations were incorrect.

Livini performed 341 transrectal ultrasounds on mares between 90 and 150 days of gestation and was correct in 299 determinations. Only one fetus was incorrectly labeled. According to the study, he did not determine the genders of the other 41 fetuses within the 150-second time limit.

Further analysis of his data revealed that Livini was able to correctly identify 100% of the fetus' sexes between 110 and 130 days of gestation.

"The aim of the ... work is to show that transrectal ultrasound determination of fetal gender between 55 and 75 (days gestation) and 90 and 150 days of gestation can be accomplished in a timely manner in routine stud practice even at the peak of the breeding season, if the veterinarian is experienced in reproductive ultrasonography," Livini wrote.

Uterine Ultrasound, Cytology Helpful in Pinpointing Pathogens

When it comes to a mare's uterus, ultrasound examination and cytology (examination of cells under a microscope) can give a veterinarian a pretty good picture of what's going on inside that could be confounding conception. However, comparing these results to culture (testing of samples for pathogens) helped researchers on a recent study link specific bacteria with certain uterine signs, which ultimately could help veterinarians predict more accurately what pathogens could be at play in problem breeders.

Modesty D. Burlison, VMD, formerly an associate of Rood & Riddle Equine Hospital and presently resident veterinarian at Spy Coast Farm in Lexington, Ky., and colleagues performed a retrospective study to determine the relationships between microorganisms isolated from the uterus, cytology findings, and ultrasonographic findings in Thoroughbred mares during estrus.

The team reviewed 670 positive



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endometrial culture samples from 410 Thoroughbred mares in Central Kentucky. Mares were examined by either Michelle LeBlanc, DVM, Dipl. ACT, or Tom Riddle, DVM. The corresponding cytology and ultrasonographic results from the reproduction examination were recorded to determine relationships between organisms and diagnostics tests. The cultures were obtained by either culture swab (n=453) or by small volume flush (n=217).

Burlison and her colleagues uncovered the following key findings:

- *β-Streptococcus* and *E. coli* were the most common pathogens isolated on both the culture swab (28.3% of the time) and small volume flush (20.5% of the time);
- Mares with intrauterine fluid (fluid in the uterus detectable on ultrasound, which is generally a sign of irritation, contamination, or infection) were 1.4 times more likely to have moderate to severe inflammatory cytology results than those with mild or no inflammation. Greater than five neutrophils (white blood cells capable of engulfing and destroying bacteria and other disease agents) per high power field under the microscope indicated severe inflammation;
- Mares with positive cultures for *β-Streptococcus*, *Klebsiella* spp, and yeast were more likely to have intrauterine fluid present. Fluid was less likely to be seen when *Enterobacter cloacae*, *E. coli*, *Staphylococcus aureus*,

Pseudomonas, two or more organisms, or non-pathogens (*Bacillus*, *Micrococcus*, or *α-Strep*) were isolated;

- Mares with positive cultures for yeast, *Klebsiella* spp., *β-Streptococcus*, and non-pathogens were more likely to have positive cytology results with greater than two neutrophils per high power field; and
- Moderate to heavy debris on cytology was more likely to be seen when, yeast, non-pathogens, *E. coli*, *β-Streptococcus*, or two or more organisms, were isolated on culture.

Intra-uterine fluid was associated more commonly with moderate to severe inflammatory cytology results than with isolation of a specific micro-organism. The presence of intrauterine fluid, which is an indicator of inflammation, was most commonly associated with *β-Streptococcus*, *E. coli*, and other gram-negative bacteria.

"Two of the common dogmas in the world of reproduction were found to be not true in all cases," Burlison noted. "First, a bacterial or yeast infection must be associated with intra-uterine fluid. And second, if bacteria are isolated on culture and the cytology is negative, the isolate is considered to be a contaminant." 🐾

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Miscellaneous

BY ERICA LARSON; STACEY OKE, DVM, MSC; AND CHRISTY WEST

In-Depth: Piroplasmosis

Equine piroplasmosis (EP), which is classified as a foreign animal disease, has made several appearances in the United States over the past few years, and it's causing concern at racetracks around the nation—the main locations at which EP has been diagnosed. But horse owners should be happy to know that their horses are likely not at risk for contracting the dangerous disease as long as their horses are being managed with industry-standard hygiene practices. Many of the EP cases diagnosed since 2008 were completely preventable, according to the panel members who presented during a special session on EP at the convention.

The session, moderated by Josie Traub-Dargatz, DVM, MS, Dipl. ACVIM, a professor in the Animal Population Health Institute and population health at Colorado State University, gave practitioners a timely in-depth review on EP and its impact on the American equine industry.

Equine piroplasmosis is spread through the transfer of blood. Naturally, it is spread by certain species of ticks; however, according to Traub-Dargatz it can also be spread by the reuse of needles, syringes, and other blood-contaminated equipment that has not been sanitized between uses. Two distinct agents cause the disease: the hemoprotozoas called *Babesia caballi* and *B. equi*. After a U.S. outbreak of the disease in the 1960s, extreme measures were taken to eradicate EP and the country was declared EP-free in 1988, said Traub-Dargatz.

Some horses infected with EP show few to no clinical signs, while others show various combinations of clinical signs that include fever, anemia, icterus (jaundice), and anorexia (the horse is off his feed). Some horses will also display colic with altered fecal consistency. The method of choice for diagnosing the disease is a laboratory blood test.

In August 2008 a Florida horse tested positive for EP, said Mike Short, DVM, equine program manager from the Florida



Equine piroplasmosis is spread through transfer of blood; naturally, it is spread by certain species of ticks, but also can be spread by blood-contaminated equipment.

Department of Agriculture. Investigation into the source of the disease found that horses recently imported from Mexico (two of which tested positive for EP) likely carried the disease agent into the country.

Investigators diligently searched the horses for ticks and tested any that they found on horses or in closely surrounding areas; however, they were not able to detect *B. equi* or *B. caballi* in the ticks. Finally, investigators determined that the likely means of transmission was the reuse of needles and/or syringes, and a practice called blood doping, Short said. All of the positive horses were involved in nonsanctioned horse racing, meaning that all the horses were likely managed using less than optimal hygiene practices, he noted.

The Florida outbreak was well-controlled, Short added, with the final quarantines lifted in February 2009.

A very similar outbreak occurred in Missouri, beginning in June 2009. Again, the index case was a Quarter Horse that participated in nonsanctioned racing, said

Angela Pelzel, DVM, a Western region epidemiologist with the USDA Animal and Plant Health Inspection Service. A total of eight horses were determined to be infected with EP, all of them sharing the same trainer as the index horse.

Extensive tick surveillance was conducted on the premises in Missouri; however, only a few ticks were found and none were species capable of transmitting *B. equi*. Investigators believe the method of transmission of the disease agent was, again, reusing needles and/or syringes among a group of horses and other less-than-optimal hygiene practices.

The only outbreak of EP that was determined to be spread by ticks was the 2009 outbreak on a large Texas ranch that produces horses for working cattle and other ranch activities. According to Pelzel, a total of 292 horses on the ranch tested positive for *B. equi*. After extensive testing of many horses that were sold and transported off the ranch prior to the EP diagnosis at the ranch, nearly 380 horses were determined to be *B. equi*-positive.

Authorities tested numerous ticks of several species from the property for *B. equi*, and it was determined that two of the types could spread *B. equi* between horses. It is believed that this is the only U.S. outbreak where the disease agent was spread by natural means in recent years.

Tracy Norman, VMD, Dipl. ACVIM, a clinical assistant professor in equine internal medicine at Texas A&M University, reviewed the activities surrounding the Texas EP outbreak and the ongoing efforts in Texas to plan for evacuating or moving positive horses for veterinary care. She also provided valuable information on how to thoroughly examine a horse for ticks.

The panel indicated that researchers are using this expansive outbreak as a learning experience. The ranch operators have been cooperative in quarantining their horses and allowing researchers to learn all they can about EP during the investigation.

Scientists have been working on several



aspects of research related to EP, including refining the taxonomy (science of classification) of the disease agent, developing more advanced diagnostic tools, and finding treatment options to potentially eliminate the infection in positive horses. Researchers are currently evaluating imidocarb dipropionate for the treatment of *B. caballi*- and *B. equi*-infected horses. Donald Knowles, DVM, PhD, Dipl. ACVS, research leader of the Animal Disease Research Unit of the Agricultural Research Service at the USDA, said that while imidocarb dipropionate has been proven an effective anti-babesial chemotherapeutic drug for treating clinical signs of disease, some other potentially dangerous issues with imidocarb dipropionate need to be addressed before the treatment method becomes standard.

For example, Knowles said that it's been suggested that some treatment regimens with imidocarb dipropionate might contribute to imidocarb dipropionate-resistant strains of both *B. equi* and *B. caballi*, which would complicate control plans, as the goal in the U.S. is to eliminate the transmission risk, not just to resolve the clinical signs.

Equine piroplasmiasis is still classified as a foreign animal disease in the United States, despite several outbreaks occurring on U.S. soil in the past four years. But most horses in the nation remain at a low risk of contracting the disease, the panel noted.

"Owners can obtain more information on how to protect their horses against infection from ... the USDA, from their State or Federal Animal Health officials, or from private veterinarians," Traub-Dargatz added.

Treating Guttural Pouches in Foals

Guttural pouches are air-filled outpouches of the auditory system (Eustachian tube) that connect the pharynx (throat) to the inner ear. In foals with guttural pouch tympany, air cannot exit these pouches normally. Instead, air continuously enters the pouches but remains trapped inside.

Instead of operating on a foal with guttural pouch tympany, vets should consider placing a flexible tube called a Foley catheter through the opening of his guttural pouch(es) via the nasal passage, according to a veterinarian from Auburn University.

"Usually, guttural pouch tympany is not ed soon after the foal is born," explained

Elizabeth Barrett, DVM, a surgical resident at Auburn's Vaughan Large Animal Teaching Hospital. "Affected foals develop a large uni- or bilateral swelling in the throatlatch area."

Foals with guttural pouch tympany can suffer respiratory distress and can aspirate milk when nursing, causing pneumonia. The condition can be managed surgically; however, surgery typically requires special skills and equipment.

"Instead, foals can be treated by using an endoscope to place the end of a Foley catheter, a flexible tube with an inflatable balloon at one end, through the opening of the guttural pouch. The end of the tube is left hanging out of the nasal passage," said Barrett.

She explained that this Foley catheter technique:

- Is inexpensive, effective, and easy to perform;
- Does not require special equipment; and
- Can immediately and permanently resolve the tympany.

The catheter can be replaced easily if it is accidentally removed.

According to Barrett, "If the catheter is left in place for at least three weeks, it causes a (planned) pressure necrosis (destruction of tissue caused by cutting off circulation with external compression) at the opening of the guttural pouch, resulting in unobstructed passage of air into and out of the guttural pouch."

Detomidine and Eye Pressure

If your horse has to be sedated, the effect of that sedative on the fluid pressure within his eyes (intraocular pressure) might be the last thing you're worried about. Unless, of course, he is being sedated for an eye procedure—then this issue becomes quite important.

Some sedatives significantly increase intraocular pressure (IOP), which can cause further problems in compromised eyes such as globe (eye) perforation and glaucoma (permanent optic nerve damage due to elevated IOP), explained Dana Holve, DVM, of Eye Care for Animals in Tustin, Calif. Thus, it is helpful to know which sedatives might not have that effect, so you know which ones to select for ophthalmic (eye) procedures.

For the current study, investigators gave 15 healthy horses from six to 25 years of

age complete physical and ophthalmologic exams, then recorded their IOPs before and 10 minutes after administering intravenous detomidine sedation at 0.02 mg/kg of body weight. They also measured seven horses 20 minutes after sedation. Holve found that IOP decreased by an average of 3.6 and 4.3 mmHg at 10 and 20 minutes after detomidine administration.

She also applied topical anesthesia to the eyes of a second group of horses to see if that modified detomidine's effect on IOP, and found that topical anesthesia did not change detomidine's IOP-reducing effects.

Additional variables that can artificially raise IOP in horses include manipulation of the eyes and nearby tissues, stress, and low head carriage (head held below the heart), she added.

"Detomidine causes a decrease in equine IOP," Holve concluded. "Given the many advantages of standing sedation and analgesia, detomidine is a safe alternative when performing ophthalmological procedures in the horse when increased IOP is a concern."

Areas for future investigation include evaluating the duration of the IOP reduction and determining if the effect is dose-dependent, she added.

Digital Photos Assist in Treating the Equine Eye

A veterinarian doesn't need to be a professional photographer to incorporate a digital camera into his or her practice for eye treatment assistance, suggested Ann E. Dwyer, DVM, of Genesee Valley Equine Clinic, in Scottsville, N.Y. Dwyer discussed using digital photographs to assist in treating eye problems in horses.

"Radiographic and ultrasonographic equipment for imaging the axial skeleton and reproductive and internal organs have been widely adopted by equine practitioners throughout the industry; however, imaging equipment and procedures for the equine eye have not been similarly implemented," said Dwyer.

She noted that even the most basic point-and-shoot digital camera is an "invaluable tool for documenting and following a variety of ophthalmic problems such as those affecting the orbit, eyelids, cornea, iris, and lens of the equine eye."

Such conditions include corneal ulcers or trauma, cataracts and lens-position abnormalities, and tumors such as squamous



cell carcinomas or sarcoids of the eyelids, among others.

Vets in most practices already own digital cameras, but they have yet to use them for ocular photography or have become frustrated with poor-quality, blurred, non-diagnostic images. However, "excellent photographs can be obtained by even the most novice photographer," said Dwyer.

Some key points for practitioners to consider include:

- Setting the capture mode to P for "program" to take advantage of camera internal programming capability;
- Using the autofocus setting in macro mode to focus on close objects, but being sure not to hold the camera too close to the horse's eye;
- Depressing the shutter button halfway to activate the electrical viewfinder so that the camera adjusts the lenses and aperture for sharp focus and appropriate lighting; and
- Quickly depressing the shutter button fully to capture the image, making sure

that neither the camera operator nor the horse moves at all.

Green brackets will appear on the LCD screen when the electrical viewfinder has focused the camera successfully. Look to see if these green brackets are present. If a red signal is displayed instead, then the camera is likely too close to the eye and the image will not be sharp.

Dwyer reminded practitioners, "always refer to the user manual to learn which setting and range specifications will produce the best images."

She also described the use of the camera display as a stall-side client education device: "The stored image can be cropped and centered using the digital zoom feature of the camera, producing a highly detailed photo of the eye," she explained. "The owner will gain a good understanding of the problem at hand by looking at the magnified image on the screen."

"Serial images taken at follow-up examinations can be emailed to the owner," Dwyer said, adding that compliance with a

complex treatment plan will be enhanced if an owner can see tangible progress on images obtained at follow-up visits. Conversely, if a problem is getting worse, serial images can be emailed to specialists for consultation or referral purposes.

"Ocular digital photography is a simple skill that can be mastered by any equine practitioner," she concluded. "Veterinarians who want to incorporate digital photography into their practices are advised to 'try before you buy' when selecting a digital camera, as there is variability among the quality of images that available cameras will produce that is not related to price. High-quality compact cameras that take excellent close-up images are well within the budget of any practice, and ocular photography is a valuable addition to the ocular examination process." 🐾

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