DIETARY Developments

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Kentucky Equine Research®

A look back at 30 years of advancements in equine nutrition research

Veterinarians and nutritionists gathered in Lexington, Kentucky, recently to discuss the latest in feeding horses, while reflecting on the past three decades of equine nutrition research. Kentucky Equine Research (KER) hosted its 2018 Conference around this landmark anniversary, Oct. 29-30; nutrition and exercise physiology researcher Joe Pagan, PhD, formed KER in 1988 and, since, he and his staff have witnessed the evolution of equine nutrition and research trends. Here are some take-homes from the presentations at the event.

30 Years of Research

Pagan reflected on the range of equine conditions researchers have targeted with nutrition.

Developmental Disorders In 1980s Central Kentucky most equine nutrition research centered around Thoroughbred broodmares and growing horses, along with performance horses. While subjects like equine metabolic syndrome (EMS) and geriatric health weren't yet on scientists' radars, Pagan said, developmental orthopedic disease (DOD, a catchall phrase for disease affecting growing skeletons) was. This was primarily because flaws apparent on the X rays of yearlings and 2-year-olds at Thoroughbred sales devalued those horses greatly.

Researchers were trying to find the cause when, in the mid-'80s, a group at The Ohio State University implied that diets deficient in certain trace minerals were to blame, said Pagan.

"A correlation was found between the level of copper (which can disrupt bone formation) in a breeding farm's ration and the incidence of metabolic bone disease (e.g., DOD) in the farm's foals," he said. "Suddenly, copper was all anyone cared about."

The question that followed was: Should we adjust the foal's diet accordingly or the pregnant mare's? (Because of the exponential increase in fetal growth during the last three months of gestation, supplementing mares in late pregnancy is one way to stock foals with nutrients.)

Out of this "research flare" came a New Zealand study showing mare supplementation as most vital to foal bone health.

"Since then, the feed industry has universally embraced the importance of trace mineral fortification for broodmare and foal feeds," said Pagan.

Over the next decade, however, DOD continued to be an issue, "especially in precocious, fast-growing young horses," he said. Because certain bone lesions appeared to correlate with how fast a foal grows, researchers began looking at the effects of excess dietary energy (e.g., carbohydrates). Theorizing that high-carb diets could lead to osteochondritis dissecans (OCD, a DOD in which cartilage fails to properly turn into bone), he and his team conducted a study of Central Kentucky farms and found a relationship between glycemic response (carbs' effect on blood glucose) and OCD incidence.

"If farms had a high glycemic response, then the farms had a high level of OCD," Pagan said. "Farms with a low glycemic response had a low incidence of OCD."

Skeletal Health Bones experience three stages: formation, equilibrium, and demineralization. The latter can occur when horses are confined for long periods.

When Pagan and his team came across a novel ingredient in the early 2000s purported to suppress bone destruction, called milk basic protein, they conducted a study to determine if it could improve equine bone formation and density. They found that it did, in fact, help prevent bone demineralization in confined horses.

They also studied the effect of buffered mineral complex (a natural calcium source) on racehorses in training and found it increased bone density fourfold.

Digestibility and Nutrient Requirements Different vitamins and minerals have different digestibility and bioavailability (rate of absorption) levels. Whether a vitamin is synthetic or natural can also affect its digestibility. Thus, much research over the years has focused on this topic. Scientists have found, for instance, that a natural source of vitamin E is about twice as bioavailable as the chemically different synthetic source, said Pagan.

COURTESY MATT WOOLEY/KER

Kentucky Equine Research staff have been studying the effects of different nutrients, diets, and exercise on horses of various life stages.

Most recently, he said, researchers have studied the antioxidant nutrient coenzyme Q10 (CoQ10). Pagan explained that in its raw form, CoQ10 is not very digestible, but when it is processed to be water-dispersable it becomes three times as bioavailable. "I think it'll be one of the next big nutrients," he said.

Gastrointestinal Health It's well-known that horses are poor starch digesters and don't handle large grain meals well. This can lead to hindgut acidosis—increased large intestine acidity that alters its natural microorganism population, possibly causing colonic ulcers or diarrhea.

Over the past few decades, said Pagan, researchers have found that processing (e.g., flaking or extruding) grains can make them more digestible in the small intestine and help reduce hindgut acidosis. His team developed a protected sodium bicarbonate (a type of baking soda) to buffer gastric acid. They fed this to horses on high-grain diets, and it reduced the amount of lactic acid hindgut microbes produced. It also reduced lactic acid produced by fructans (nonstructural carbohydrates in grass that can cause hindgut acidosis) in pastured horses.

Unintended Consequences Lastly, Pagan described examples of unexpected results from equine research findings.

Take furosemide (Salix), for instance, a common diuretic administered to race and performance horses to prevent exercise-induced pulmonary hemorrhage (aka "bleeding"). As it turns out, the drug has a performance-enhancing side effect in that it causes horses to urinate frequently and, hence, lose body weight—a desirable reaction in racehorses.

Frequent urination also causes horses to lose the electrolytes sodium and chloride and even calcium, upsetting their mineral balance. Pagan said his team found that these mineral levels go into negative balance on Salix administration day. They developed an electrolyte replacement product to encourage horses to drink and correct these imbalances.

Another example Pagan used was omeprazole administration to treat gastric ulcers. This widely used medication might affect calcium absorption, he said, and scientists have suggested it might result in reduced human bone strength. In one study the KER team found that omeprazole causes a 20% reduction in calcium digestibility in horses.

"Owners should recognize that their horses may have higher requirements for calcium when they are administered omeprazole and/or furosemide," he said.

The Future Pagan predicted future nutrition research will focus on nutrigenomics (the study of nutrition's effect on gene expression) and nutrigenetics (how genes influence response to nutrition). What we feed our horses might just be affecting our horses' genes and genetic expression.

Do We Have an Obesity Problem?

"Absolutely," said Pat Harris, MA, VetMB, PhD, Dipl. ECVCN, MRCVS, head

of the WALTHAM Equine Studies Group, in Leicestershire, England. Researchers have conducted many studies on obesity prevalence in equids, and the findings shed clear light on a problem:

- In one study of 319 pleasure horses in Scotland, researchers classified 45% of the animals as fat or obese;
- In two U.S. studies scientists classified 48% of 366 North Carolina horses as overweight or obese and 51% of 300 mature Virginia horses as such;
- In a study of 127 U.K. horses and ponies living at pasture for at least six hours per day, scientists classified 28% as obese at winter's end and 35% as obese at summer's end; and
- In a study of 300+ horses in a U.K. championship, 41% were overweight and 21% were obese, with show and dressage horses most likely overweight.

Why are so many horses obese? Some factors include:

- **Breed** In a U.K. study native breeds and cobs were 14 times more likely to be obese than other breeds.
- **Pasture** "In the U.K. many fields now used for horse grazing used to be grazed by dairy cows, and we're putting native breeds out on these potentially energy-rich pastures," Harris said. "(Here) it is possible for a 300-kilogram (660-pound) pony to ingest the same number of calories as a 500-kilogram (1,100-pound) racehorse in training."
- **They become wise to their routine** Even if an owner is trying to limit grass intake, their horse or pony might have "wised up to this," Harris said. By Week 5 of limited daily pasture turnout, "ponies ingested an estimated 40% of their daily dry matter intake in grass in three hours—and work has shown that ponies can ingest almost 5% of their body weight in dry matter (all nutrients minus water) per day and more than 1% of their body weight in dry matter during a three-hour turnout on pasture, which is all that would be recommended … on a severe weight loss restriction diet," Harris said.
- **Too many calories and not enough exercise** Researchers and veterinarians have observed that owners often don't feed for the exercise level they're undertaking or believe their horses are working harder than they are and, so, require more calories than they do.

Perhaps the biggest issue with obesity, Harris said, is some owners don't recognize it. In one study of nearly 550 owners, only 11% correctly identified all the examples of overweight horses shown.

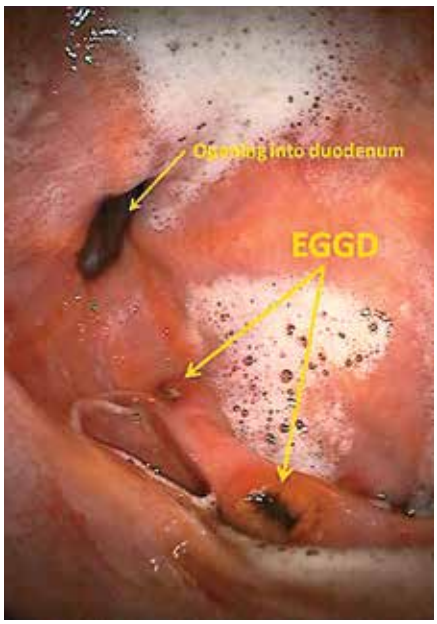
Gastric Ulcers in Horses

We know an estimated 50-90% of horses suffer from ulcers and that performance and racehorses are some of the most susceptible. Al Merritt, DVM, Dipl. ACVIM, a professor emeritus at the University of Florida College of Veterinary Medicine, in Gainesville, described what researchers have learned about equine gastric ulcers in the past three decades.

Horses produce gastric acid continuously, whether they're eating or not. When they chew, their bodies release saliva, which contains sodium bicarbonate and calcium—both of which buffer stomach acid. This is good if horses are grazing continuously, but human management can put a wrench in the gears.

When we supply horses with a few meals a day, the stomach keeps producing acid, but there's not a steady saliva supply. This leaves the stomach to become increasingly acidic and raises ulcer risk.

Ulcers weren't always at the top of vets' differential diagnoses when health problems arose. But with the discovery of gastric lesions on necropsy findings in the mid-'80s, followed by the development of endoscopes (long, flexible tubes with cameras attached), veterinarians began to conduct gastroscopy. During this procedure a veterinarian passes the tool through the horse's nostril, down the esophagus, and into the stomach to peer inside it. This is the only definitive way to diagnose gastric ulcers. Eventually, scientists developed videoendoscopes.



COURTESY DR. AL MERRITT

These EGGD lesions are visible via videoendoscopy of the stomach's pyloric glandular region.

Vets realized ulcers were significant problems for high-performance horses, and researchers began studying them more. In 1999 the Equine Gastric Ulcer Council published its recommendations for diagnosing and treating equine gastric ulcer syndrome (EGUS), introducing the now-common term.

Common clinical signs included poor appetite; dullness; attitude changes; decreased performance; poor body condition; and low-grade colic. While these signs still point to ulcers, Merritt noted that "we know now that they don't even have to show signs to have gastric ulcers."

Around that time two gastric ulcer scoring systems were introduced to grade squamous lesions, with a five-point system (0 to 4) catching on best.

Newer Research Key developments since 1999 include:

- Scientists learned that ulcers aren't just a problem for horses in training when they identified lesions in 16 of 17 horses stabled full-time, 125 of 141 horses turned out on pasture for at least four hours each day, and in all 13 horses turned out full-time;
- Researchers split EGUS into two categories: equine glandular gastric disease (EGGD, the lower half of the stomach) and equine squamous gastric disease (ESGD, the less-protected upper half);
- Scientists found that the pH within the squamous part dropped below 4 (the "cutoff" for when the pH is corrosive to the lining) when horses began trotting and continued into gallop; it then rose when the horses walked;
- The same team determined that intra-abdominal and intragastric pressure increased during exercise, which likely pushes the glandular region's contents (including gastric acid) up into the unbuffered squamous area;
- Horses were more likely to have both EGGD and ESGD if they ate large amounts of concentrates;
- Scientists identified other potential gastric causes as stress and meal-feeding;

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- Horses with higher body condition scores had higher ulcer scores; and
- Risk factors for gastric ulcer development include feeding unprocessed grains, infrequently feeding a complete and balanced diet, lack of hay or haylage, and no grass turnout.

Ulcer Treatment and Management As they were learning more about ulcers, researchers were also working to find treatments that would increase gastric pH, buffer stomach contents, and/or allow existing ulcers to heal, Merritt said. In the late 1980s researchers explored the effect of IV and oral ranitidine on gastric pH.

In 1992 Merritt and colleagues tested enteric-coated omeprazole granules with good results and, subsequently, helped Merial develop an oral paste. They confirmed its efficacy in 1999, and the product went on to become GastroGard. Another product, UlcerGard, is labeled to prevent ulcers from developing. These are the only U.S. FDA-approved products to treat and prevent gastric ulcers in horses.

Merritt said researchers are currently studying a longer-acting intramuscular omeprazole and other oral formulations.

Researchers have also recommended strategies to reduce a horse's ulcer risk:

- Feeding less grain. If horses need extra calories to maintain weight, try adding oil or another fat source to the diet;
- Providing free-choice forage;
- Prolonging hay ingestion time by using slow-feeders and/or haynets;
- Adding alfalfa to the diet, which can aid in gastric buffering; and
- Looking into nutraceuticals with scientific evidence of efficacy.

Moving Forward Researchers are still working to better understand ulcers, particularly EGGD, where, Merritt said, other current research directions include:

- Investigating sucralfate, which might help coat lesions to allow better healing;
- Finding ways to increase prostaglandin E2 (a chemical the body produces that's involved in inflammation and pain perception) production, which decreases acid secretion. Possible methods include sucralfate or corn oil administration or misoprostol treatment;
- Taking biopsies from lesions to see if infectious agents are present;
- IDing causes for different ulcers; and
- Better characterizing how dietary factors contribute to ulcer development.

COURTESY MARK J. BARRETT/KER

Coupled with percutaneous muscle biopsy techniques, high-speed treadmills have allowed scientists to see what goes on in muscles during exercise and study muscle metabolism in real time.

The Bottom Line "I think it's safe to say that mild ESGD … probably falls within the realm of normality for all equids," Merritt said. "The more severe ESGD lesions, those that extend well up into the squamous region and may bleed, and most likely all EGGD lesions, are more likely due to human-determined conditions, such as forced exercise, feeding strategies, housing conditions, increased exposure to infectious agents, and undoubtedly other factors we have not yet thought of."

Understanding Muscle Disorders

Stephanie Valberg, DVM, PhD, Dipl. ACVIM, ACVSMR, the Mary Anne McPhail Dressage Chair in Equine Sports Medicine at Michigan State University's College of Veterinary Medicine, in East Lansing, reviewed how five technology advancements have helped her and others learn more about and discover new equine muscle disorders.

1. Muscle Damage and Blood Samples Researchers knew exertional rhabdomyolysis (ER, aka tying-up) was a muscle disorder. But they learned significantly more information once they determined they could use a simple blood test to assess the amount of muscle damage.

The enzymes creatine kinase (CK) and aspartate transaminase (AST) leak out of muscles and into the bloodstream if muscles are damaged. Elevated serum levels of each indicate muscle damage.

Valberg said researchers noted a normal marked increase in CK levels after horses with ER worked. Those peaked four to six hours following exercise.

2. Exercise Physiology With the invention of the high-speed treadmill for horses came a new research field: equine exercise physiology. Coupled with the development of a percutaneous muscle biopsy technique, scientists could see what goes on in muscles during exercise and study muscle metabolism as it happened, Valberg said.

In the early days of equine exercise physiology, she and colleagues in Sweden studied six Standardbred horses with a history of tying-up and five unaffected control horses. They had horses jog on the high-speed treadmill for 55 minutes at 5 meters per second (roughly 11 miles per hour), collecting samples throughout.

They were able to induce ER in three horses, all of which had sudden onset of significantly elevated serum CK levels 15-30 minutes after exercise started compared to horses that didn't tie up.

In the same study the team tested the theory that increased lactic acid (which muscles produce during intense exercise) buildup in muscle might be involved with ER. However, they found that ER horses did not have much lactate in their muscles following exercise, proving that lactic acidosis isn't behind ER.

3. A Standardized Clinical Approach Valberg said developing this helped vets and researchers discover that not all horses tie up for the same reason or have the same signs of disease. The standard

exam for horses that tie up involves:

- Getting a detailed history;
- Conducting a thorough physical exam;
- Collecting a blood sample and performing a complete blood count and chemistry profile;
- Collecting urine to examine for fractional electrolyte exertion;
- If there's no evidence of muscle damage on all previous tests, conducting an exercise test and evaluating pre- and post-exercise CK; and
- Performing a muscle biopsy.

4. The UC Davis Neuromuscular Diagnostic Laboratory Scientists at the University of California, Davis, (UC Davis) Neuromuscular Diagnostic Laboratory introduced the concept of using specialized freezing techniques to preserve muscle biopsy samples, rather than fixing them in formalin. This allowed researchers to see structures better during analysis. They also found that using different stains on samples can reveal different diseases.

Valberg described a case in which she and colleagues used this new muscle biopsy assessment technique to identify a muscle disorder in a 3-year-old Quarter Horse mare with a history of chronic stiffness, firm muscles, exercise intolerance, and persistently high serum CK levels.

Valberg determined that the mare had abnormal glycogen (stored sugar) building up in her muscles, something not seen in Thoroughbreds and Standardbreds. A biochemistry evaluation revealed twice as much glycogen as normal.

She and colleagues diagnosed the mare with polysaccharide storage myopathy (PSSM), now found in roughly 10% of Quarter Horses and 36% of Drafts. They eventually determined that PSSM horses had too much glycogen, but not enough energy, in their muscles. They worked to find a diet to slow glycogen synthesis and encourage glycogen metabolism.

They found that a diet low in starch and sugars and high in fat (to provide extra energy), along with regular exercise to burn the glycogen, helped relieve PSSM horses' signs and let them return to work.

Valberg said the Quarter Horse mare responded well to this regimen.

5. The Equine Genome Advances in equine genome mapping allowed Valberg and colleagues to identify the gene responsible for PSSM in Quarter Horses. They eventually landed on the glycogen synthase gene *GSY1*, confirming that a *GSY1* mutation altered glycogen synthase activity and that mutations were present in 6% of a random Quarter Horse population and 80% of PSSM horses.

Scientists sequenced the complete equine genome in 2009, allowing Valberg and others to more easily analyze genes of interest and identify those associated with specific traits and disorders.

MFM in Arabians Valberg also described

Supplementing With Vitamin E

Vitamin E is a potent antioxidant primarily found in green pasture grass that plays a role in muscle atrophy (wasting) and neurodegeneration in horses. As land becomes increasingly limited and more horses are housed on less acreage, vitamin E deficiency becomes a real problem. Stephanie Valberg, DVM, PhD, Dipl. ACVIM, ACVSMR, described conditions linked to vitamin E deficiencies and how to manage them.

Veterinarians see three associated neurologic conditions, she said.

Neuroaxonal Dystrophy and Equine Degenerative Myeloencephalopathy (NAD/EDM) This neuromuscular disorder typically appears in horses 6 months to 3 years of age. Clinical signs of ataxia (incoordination) and proprioceptive deficits (awareness of where one's limbs are) are similar to those of horses with wobbler syndrome (spinal cord compression) and persist through adulthood.

"We believe it results from a genetic predisposition and vitamin E deficiency *in utero* and the early six months of life," said Valberg, explaining that the equine nervous system depends on adequate vitamin E to develop normally.

While owners can supplement susceptible horses (i.e., broodmares and foals living on farms that have had cases) with vitamin E to try to prevent development of this disease or reduce its severity, once horses develop clinical signs, supplementation has no effect, Valberg said. It typically crops up on farms that have experienced a decrease in pasture quality and green grass, she added.

Vitamin E Deficient Myopathy This muscle disorder occurs in adult horses ages 7 to 10. Signs include an inability to lock the stifles, weakness, trembling, a low head position, difficulty lying down, weight loss, and muscle atrophy. In acute cases, she said, the most obvious sign is trembling, while in chronic cases owners typically notice reduced muscle mass in the hindquarters and some trembling.

Vets can test for this by taking a biopsy of the sacrocaudalis dorsalis muscle (located above the tailhead on either side of the spine) and looking for abnormal mitochondrial staining. Fortunately, she said, it's reversible with supplementation.

Equine Motor Neuron Disease (EMND) This neurodegenerative disorder affects the spinal cord where the nerves come out to control muscle contraction. Affected horses are typically older (>10), said Valberg, and have been vitamin E-deficient for a long time. They typically display similar signs as horses with vitamin E deficiencies. They might also have a distinct pigmented pattern to their retinas.

"Once horses reach this stage, they might stabilize with supplementation but might not return to performance," she said.

Supplementing With Vitamin E "The impact of vitamin E deficiencies causing subtle but significant muscle atrophy and a decline in performance are underrecognized," Valberg said. "It should be on everyone's radar because it's easy to diagnose with blood samples for vitamin E and can be readily treated with liquid vitamin E supplements."

What supplement to provide varies by case. For healthy horses in at-risk areas, Valberg suggests using 1,000-2,000 IU/day of the oral powdered natural form. If your horse already suffers from EMND or vitamin E deficient myopathy, she recommends using 5,000 IU/day of the natural liquid form until all clinical signs are gone and, then, transitioning to powder over a series of weeks once the horse returns to normal. Expect it to take several months for signs to disappear.

Because responses to vitamin E supplementation vary, Valberg urges vets and/or nutritionists to measure vitamin E levels before and four weeks after supplementation, adjusting the dose accordingly.

She added that while vitamin E supplementation won't resolve other neurodegenerative diseases such as shivers, owners should know that a deficiency might exacerbate them.

"I think it's important to maintain horses at normal vitamin E levels," Valberg said. "I'm a big fan of measuring vitamin E in horses and supplementing as needed. As we have less and less pasture, we'll see more of these cases."—*Alexandra Beckstett*

a muscle disorder she and colleagues are currently working to unravel.

She said the horses that first showed problems were well-conditioned, very fit 100-mile endurance Arabians that suffered intermittent ER, post-race stiffness, increased CK levels, and myoglobinuria (dark brown urine caused by the presence of the protein myoglocin). They'd also develop stiffness about 5 miles into rides that followed about two weeks of rest post-endurance ride.

Valberg and team collected muscle biopsies from 30 Arabian endurance horses and looked for signs of already-known disorders, to no avail. Eventually, she said, they found breaks and weakness in the affected horses' muscle fiber contractile proteins using an electron microscope. They termed their newly identified condition myofibrillar myopathy (MFM).

Because electron microscopy isn't practical for real-world use, Valberg tested whether desmin stain on a biopsy could identify cases. She found that healthy horses' muscle fibers remained aligned, while case horses developed clumps of desmin around their weak myofibrils.

They followed their lab work with an exercise test using healthy and affected horses from which they collected muscle biopsies before and after a 45-minute ride. There were no metabolic differences between the groups, but the team found four proteins at rest that differed in case horses compared to controls.

They took the same genome mapping approach they used for PSSM but found no genetic markers associated with MFM. They also sequenced genes commonly associated with MFM in humans and found no consistent mutations.

Currently, Valberg and colleagues are working to see if they can manage MFM nutritionally and are trialing new supplements, developed in conjunction with KER, in affected horses.

Managing Joint Disease

C. Wayne McIlwraith, BVSc, PhD, DSc, FRCVS, Dipl. ACVS, ACVSMR, is one of the world's leading equine orthopedic researchers and surgeons. He explained how his introduction to synovitis and the addition of arthroscopy to doctors' and veterinarians' toolboxes shaped his career, how joint treatments for horses have changed, and what options might be on the horizon. McIlwraith is a Colorado State University (CSU) distinguished professor in orthopaedics, Barbara Cox Anthony University Chair in Orthopaedic Research, and founding director of CSU's Orthopaedic Research Center.

COURTESY COLORADO STATE UNIVERSITY

Dr. Wayne McIlwraith helped pioneer arthroscopy techniques in horses, which has led him on a quest for better equine joint therapies throughout his career.

Modern Joint Care Today McIlwraith and other CSU researchers are focusing on how to preserve normal joints and, in the event of injury or wear and tear, reconstitute joint tissue—particularly articular cartilage. They're investigating:

- Articular cartilage healing;
- Early disease process detection;
- Risk factors for musculoskeletal injury;
- Novel therapies for traumatic arthritis and osteoarthritis (OA); and
- Rehab protocols, among other topics.

There is no cure for OA, but researchers have identified some effective treatment modalities to reduce pain and minimize disease progression, which are broadly classified as symptom-modifying (SM) and disease-modifying (DM) OA drugs.

The former can improve signs, but do not slow or halt disease progression. The latter can slow or modify progression, he said. Ideally, vets would like both effects.

Disease modification is critical and valuable to managing OA, McIlwraith said. He also noted that removing bone chips and fragments in a timely manner, treating severe articular fractures with internal fixation, and treating OCD appropriately are important parts of preventing long-term OA. He touched on several treatment options, including:

- **Intra-articular (IA) corticosteroid injections** For some time, "IA corticosteroids were common, but the dogma was that they were harmful to articular cartilage," McIlwraith said. Eventually, researchers determined that one type of corticosteroid—methylprednisolone acetate—did, indeed, cause articular cartilage degeneration. However, triamcinolone acetonide, another corticosteroid, had both SM and DM effects and no negative effects on the articular cartilage. Corticosteroids remain an effective OA treatment for horses; and
- **Physical therapies and rehabilitation** This rapidly growing field is an integral part of equine sports medicine, he said. Scientists have studied some of these modalities, including aquatic therapies. "Swimming and underwater treadmills are popular tools after arthroscopic surgery and, increasingly, rehab of non-surgical injuries," he said. In a recent study CSU researchers determined that underwater treadmill work helped decrease OA progression and improved postural stability significantly.

Of course, there are also oral joint supplements (OJS), which studies have shown that 49% or more of owners use.

"The high prevalence of OA in combination with a lack of a definitive cure has contributed to OJS popularity," he said.

Owners typically choose which OJS to use for their horses and generally see them as benign, said McIlwraith. However, because nutraceuticals aren't

often prescribed by a veterinarian, there's generally no real diagnosis of what's plaguing the horse. Further, because the owner "self-prescribes" a joint supplement to treat a lame horse, he added, the vet only sees the horse when his soundness or comfort decreases dramatically.

McIlwraith said many joint supplements contain glucosamine and/or chondroitin sulfate. Other common ingredients marketed to promote joint health include manganese, vitamin C, hyaluronic acid, omega-3 polyunsaturated fatty acids, rare earth minerals, avocado and soybean unsaponifiables, green-lipped mussel, cetyl myristoleate, methylsulfonylmethane, and various herbs.

McIlwraith said some products have undergone *in vitro* (in the lab) testing. The problem, he noted, is it's unclear what happens to the supplement and its efficacy after it passes through the horse's GI tract. As such, some researchers are working to develop "predigestion" techniques to allow them to study the products in an environment more closely resembling that of a horse's gut.

Recently, he said, *in vivo* studies have demonstrated value for a few OJS, including avocado soy, oral hyaluronic acid, and a mixed product called "Sasha's Blend."

Additionally, combination supplements, such as those marketed to support both joints and gut, have become popular. However, McIlwraith said, it's not clear how different ingredients work together, so claims for synergism are unproven.

On OJS efficacy, "manufacturers of these products are investing in research, but most (studies) do not meet a quality standard that provided sufficient confidence in the results," he said. "Consequently, the overall level of evidence for *in vivo* demonstration of efficacy is weak."

The Future McIlwraith sees biologic therapies as the future of treatments in all species. One of these is autologous conditioned serum (ACS), also known as IRAP (interleukin-1 receptor antagonist protein). When a joint sustains injury, trauma stimulates release of inflammatory proteins, including IL-1 and other cytokines (which signal cells to move toward inflammation). Researchers have shown that ACS/IRAP can block IL-1 activity on joint tissues and slow OA progression.

Vets have used platelet-rich products, but we have no definitive data and little experience with effectiveness in OA, he said.

McIlwraith and his team have shown evidence for the value of bone-marrow-derived mesenchymal stem cells in treating both OA and soft tissue injuries. He cautioned that while stem cells have been shown to help heal a variety of injuries, not all products are created equal.

Finally, he said, gene therapy—using genes to treat or prevent disease, including OA—has proven effective in helping horses, but hasn't made it to market.

5 Things to Consider When Feeding Horses According to Research

What should I feed my horse? Equine nutritionists look both to research and their own experience to answer this question. Besides considering stage of life and activity level, they must weigh variables such as environment, climate, genetics, and health conditions, which can alter the horse's needs and lead to, perhaps, the most appropriate answer: "It depends."

> **"Horses are individuals just like us, and there are some animals that seem to need more energy than you would think just to maintain their condition."**
>
> DR. PAT HARRIS

The conference ended with a roundtable on putting feeding requirements—particularly those in the National Research Council's (NRC) *Nutrient Requirements of Horses Sixth Revised Edition 2007*—into practice. Harris; Peter Huntington, BVSc, MANZCVSc, director of nutrition at KER's Australasian facility, in Victoria, Australia; and Laurie Lawrence, PhD, professor of equine nutrition at the University of Kentucky, in Lexington, fielded questions posed by moderator Pagan.

Here are five take-home messages for horse owners from this session.

1. Stop and consider whether you're overfeeding your horse or pony.

"(Horse owners) generally do believe that their horse/pony is doing more work than they actually are," said Harris. "They can be putting in the inappropriate (work level into the NRC's tool to calculate diet) and throwing it all off."

This extends to performance horses, too. "There's a bit of a disconnect between how hard people are actually training or not training their horses," said Pagan.

Lawrence said the NRC adapted its tool from three categories—light, moderate, or intense—to four, adding very heavy work, "to better separate out the horses that were truly in light exercise from those that were moderately working, with the idea that the very heavy work category would be the horses that were racing, elite three-day (event) horses, elite polo horses."

Even if they're classified correctly, it's important to remember that some horses seem to be able to maintain condition on fewer calories than others. And, Harris added, researchers have confirmed certain animals can be weight-loss-resistant.

On the other hand, you'll see horses that struggle to keep weight on, even if they aren't in work. "Horses are individuals just like us, and there are some animals that seem to need more energy than you would think just to maintain their condition, although, if this persists or gets worse, it is always worth getting your veterinarian to check there is no underlying clinical problem," said Harris.

2. Take it slow and steady when reintroducing feed to the severely underweight horse. Feeding the very emaciated horse too many calories too quickly can lead to refeeding syndrome, in which the horse can suffer heart and respiratory problems, as well as muscle damage, in part due to abrupt electrolyte imbalances. Veterinary advice is, therefore, always needed in these cases. However, even for the thin rather than the chronically starved animal, changes in the diet quantity and/or quality need to be made gradually.

A slow approach can make it seem like it takes ages to see horses gain weight, said Harris, but once they start to, often the increase can be surprisingly rapid.

"If there's no clinical reason (sickness/abnormality) why they've lost weight, they often will put on more weight than required when fed for weight gain—hence, the continued need to monitor and adjust your feeding program," she said. "Interestingly, weight loss studies in obese animals have shown that whilst more severe restriction might increase the rate

and extent of any weight loss, these animals were more likely to put weight back on more rapidly (when fed the same diet that was needed to maintain their obesity originally) than if they were restricted more moderately. Weight-loss diets need to take this into consideration and balance the level of restriction (and, therefore, rate of weight loss) with the need to provide sufficient fiber/forage over the 24-hour period—the maximum weight loss we recommend is 1% of body weight (BW) per week (after the first week), and we do not recommend feeding less forage than 1% BW in dry matter (with veterinarian involvement and with strategies to extend foraging time)."

3. Feeding racehorses coming off the track, whether going to the breeding shed or into performance horse training, can take time. "Horses that come home to the farm and they've been in race training … we try to put them on a high-forage diet," says Lawrence. "It takes them at least two weeks, and usually a month, before they actually start eating as much hay as you would expect a normal horse to eat."

Consider the mare that comes from the track at a body condition score (BCS) of less than 5 in the fall, and you'd like to increase her BCS to above 5 by February, when breeding season begins. "To increase one BCS unit, you have to feed more than a maintenance level of calories," Lawrence said. "How far above maintenance depends on how fast you want her to gain weight and how big the change in BCS is going to be … one unit or two units, etc.

"In general for a Thoroughbred mare, changing BCS in about 60 days takes 5-6 pounds of regular concentrate above her normal maintenance ration," she continued. "So if she is at a stable BCS of 4.5 and she is getting ad lib high-quality hay/pasture and 3 pounds of concentrate per day, then you are going to increase the concentrate to 8-9 pounds per day to achieve the weight gain in 60 days. Ideally you might want to achieve the weight gain more gradually … say 90 days. Then you can feed 3-4 pounds above maintenance per day (so, a total of 6-7 pounds/day). The other advantage of starting earlier if you live in cold climates is that you can take advantage of milder weather and probably better pasture. In all cases, diet changes should be made gradually."

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Make sure you're feeding according to your horse's activity level; many owners overestimate this.

4. Be sure horses fed in groups get their rations. "You need to keep in mind that some horses eat fast, others slow, and mares, especially maiden mares who have just come off the racetrack and are low in the group pecking order, might not be getting enough in groups," said Huntington.

Keep this in mind with groups of broodmares with foals at their sides, too, as older foals will eat some of the mare's food. "So if you're calculating how much you're going to feed a lactating mare, you've got to factor in that the foal might be having 20-25% of the dam's feed," said Huntington.

"Some older horses can't get their heads down to graze or they can't move to get to the grazing, or problems with their teeth or jaw mean they cannot chew properly," added Harris. "So you think they've got plenty of forage and, if the owner reports the horse is losing weight, it might just mean they're not able to use it."

Or they simply eat concentrate much more slowly than the other horses do, added Lawrence.

5. Consider pasture intake, hay wastage, and horse type when calculating forage intake. Diets are built around forage first, but it can be challenging to know exactly what the horse is consuming. Lawrence said she generally estimates hay intake to be 2% of body weight, but individual ranges vary greatly.

She calculates pasture the same way, thinking about total dry matter intake and, of course, the horse's pasture access.

"The biggest thing that's going to affect how much pasture they're going to eat is how much pasture is there," said Lawrence. "So, if they have to wander from one plant to the next on the range, that's a lot different than if they're in a beautiful Central Kentucky pasture that's 8 inches tall and dense."

As for whether horses are consuming enough pasture, her solution is to throw hay to the pastured horses. "If they eat it, there's not enough pasture out there," she said. "And if I take them hay and they leave it, then there's enough pasture."

But Harris says this can depend on the grass and the individual: "When we've got very, very rich, low-fiber pasture, horses will sometimes eat hay because they seem to want the fiber. Some horses might ignore really wonderful grass in favor of some more fibrous hays."

Either way, remember that ponies seem to have the potential to eat more as a proportion of their weight than do horses.

"We have seen that ponies can eat up to 1% of their BW in dry matter when out at grass in just three hours and nearly 5% over a 24-hour period, whereas horses more typically eat around 2-2.5% BW in dry matter per day," said Harris. "But they are all individuals—so, again, monitoring is key.

Huntington said to always put out one more hay feeder/pile than there are horses, and place them in a circle, not a line, to help the natural pasture politics play out, even while everyone gets to eat.

Bottom line: Allow for 10% wastage, he said, as well as variation with individual intake, while also considering the variability of digestibility and metabolism. Adjusting the feeding program to a horse's individual needs is vital.