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## Technology Helps Explain Why Riders Say, “Oh, My Aching Back!”



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Riders often complain about lower back pain from riding, but gaps remain in our understanding of riding’s impact on the lumbar spine.

Thanks to a grant from the Central Appalachian Regional Education and Research Center, University of Kentucky researchers Kimberly Tumlin, PhD, MS, MPH, assistant professor of Preventive Medicine and Environmental Health, Athletic Training and Clinical Nutrition

in the College of Health Sciences; Karin Pekarchik, senior extension associate for distance learning in the Department of Biosystems and Agricultural Engineering; and Michael Sama, PhD, PE, associate professor of biosystems engineering, are using technology designed in-house

to quantify physical mechanics of the spine during riding, including force, acceleration, and displacement.

In horse sports, the rider’s interaction with the horse magnifies movements and forces. The horse absorbs forces of approximately 2.5 times its body weight at a gallop (35-38 mph), with an average horse weighing more than 1,000 pounds. The rider’s body absorbs that energy, and baseline data on the subsequent effect on body biomechanics are lacking.

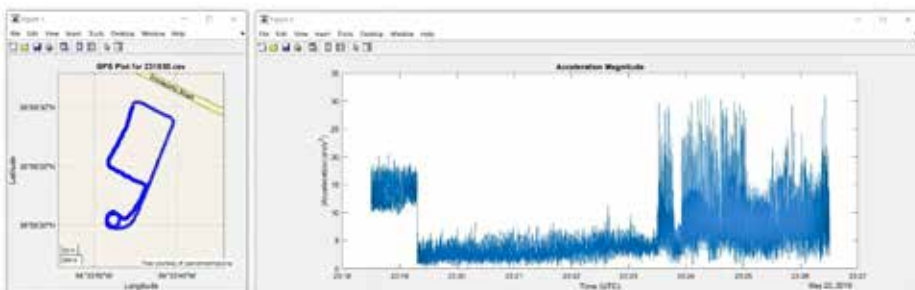
Sama, an engineer in the UK Department of Biosystems and Agricultural Engineering, prototyped the dynamics sensor system (DSS), which enables the group to capture position, acceleration, and orientation data.

To date, Tumlin and Kiley Power, Sama’s undergraduate research assistant, have both completed test rides using the DSS (bottom left). These test rides were intentionally different; Tumlin rides in a Western performance style and Power rides in a hunt seat style.

“It was important to ensure that the DSS was wearable, nonintrusive, and captures all sorts of movement in a live test,” Tumlin said. “My horse’s stops and spins provide quick acceleration and deceleration variability to inform our data interpretations.”

The DSS, as designed, successfully captured changes of the horse’s gait, tracking location, and differences in acceleration.

Later this summer, the team will recruit riders of various levels through



The DSS reveals the horse and rider’s GPS position and magnitude of acceleration during a test ride.

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**"OH, MY ACHING BACK"**

a partnership with the North American Racing Academy. These riders will complete both simulated and live gallop rides while wearing the portable sensor system. The riding simulation will take place as part of the Jockey Equestrian Initiative (JEI) at the Sports Medicine Research Institute. This technology project complements the JEI's goals to embrace and validate diversity, conduct community-based participatory research, and promote safe environments for equestrian athletes and is an example of how team science solves practical challenges.

To support the overall health of the horse industry, this project's larger

research objective is to determine strategies for optimizing occupational success, health, and safety in equestrian sports. The researchers will integrate these results with feedback from riders of all types to assess the feasibility of using this and future technologies in equestrian sport. **UK**

>Kimberly Tumlin, PhD, MS, MPH, assistant professor, University of Kentucky Preventive Medicine and Environmental Health, Athletic Training and Clinical Nutrition, College of Health Sciences; Karin Pekarchik, senior extension associate for distance learning, Department of Biosystems and Agricultural Engineering; and Michael Sama, PhD, PE, associate professor of biosystems engineering, provided this information.

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**How it Works**

The DSS has four main components integrated on a custom printed circuit board: a 9-degree of freedom inertial measurement unit (IMU), a microcontroller, a GPS receiver, and a MicroSD memory card interface.

The microcontroller communicates serially with the IMU and GPS receiver, parses and formats data, and stores data on the MicroSD memory card for retrieval on a PC. Most of the components were surface-mounted and assembled in-house using a reflow soldering process.

The DSS was designed to be powered from a rechargeable battery, features a single switch for turning the system on/off and starting/stopping data logging, and provides system status feedback to the operator via an LED. The DSS is packaged in custom 3D printed plastic enclosure. The device measures 10 cm by 5 cm by 3 cm. The rider wears it in a flexible waist belt originally designed to hold a cellphone.



**Horse Owners Should Be Thinking About Hay Supplies Now**

Wild weather in the Midwest has left livestock producers on the hunt for hay very early in the year. As a result, horse owners might have a difficult time finding it when they need it later this year.

"With the weather conditions across the Midwest and western U.S., the hay crop may be less than what is normal," said Bob Coleman, PhD, University of Kentucky College of Agriculture, Food and Environment equine extension specialist. "Not only horse owners but cattle producers, as well, are going to need forage for their animals, and reduced harvests can put those looking for hay in a tighter market than they are used to. Locally, we've had a lot of rain, too, and that complicates things with our own hay harvest."

Coleman said horse owners need to start planning for the feeding period now. Horses need good-quality hay to thrive in times when pasture forage is not plentiful or just not available.

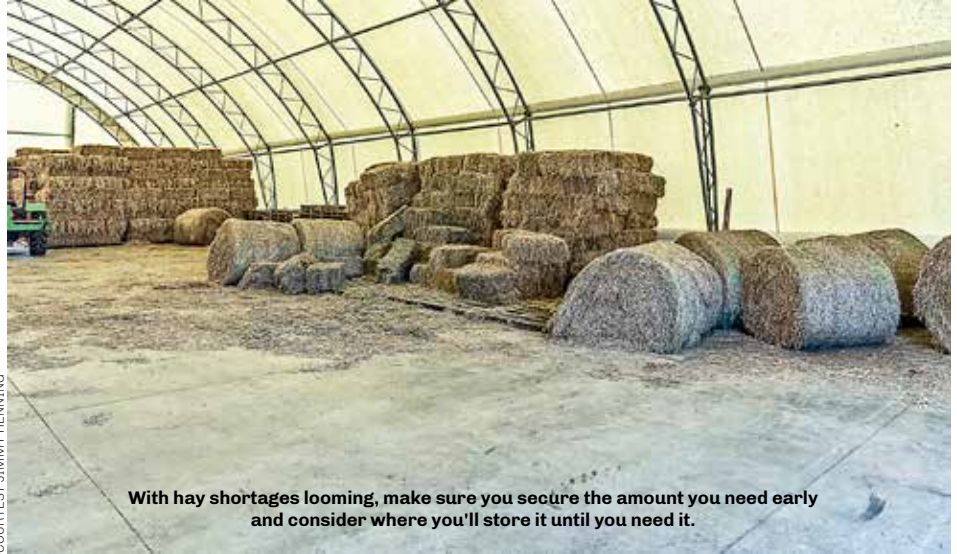
**HAY SUPPLIES**

“Reach out to hay suppliers you’ve used in the past,” he said. “Make sure you’re on their list and they have the hay you are going to need.”

A little math now will go a long way. Owners should estimate the number of days they’ll need to feed hay and pad that figure a bit. Horse owners can use a value of 2% of their horse’s body weight in hay per day for estimation purposes. Coleman said a little waste is inevitable, but owners should work hard to minimize it.

“Plan for 15% waste,” he said. “If you’re feeding hay on the ground, you could be losing up to 50%, and that’ll really hurt your bottom line. Hay is so vitally important, you really don’t want to waste it. You’ll likely recoup the price of a hay feeder after the first year. No feeder is perfect, but having one will make a huge difference.”

Another factor to consider is where owners will store hay until they need it. Before storing hay, it’s important to



COURTESY JIMMY HENNING

**With hay shortages looming, make sure you secure the amount you need early and consider where you’ll store it until you need it.**

have it tested for nutrient content to help with decisions about any necessary supplements.

“Figure out your hay budget, and don’t forget to leave room in there for any supplement concentrates you may need,” Coleman said.

With enough planning, horse owners can help their animals thrive and reduce their own stress in the process. **UK**

>Aimee Nielson is an agricultural communications specialist with UK’s College of Agriculture, Food and Environment.

## Equine Influenza: Vaccinating for Optimal Protection

In the realm of equine infectious diseases, equine influenza is one of the most contagious and costly—both in terms of finances and lost training or showing time—offenders. As such, preventing its spread in the first place is the easiest course of action.

One of the most effective ways to keep equine influenza at bay is by vaccinating horses. However, even that’s not fool-proof. During a Partner Sunrise Session at last year’s American Association of Equine Practitioners (AAEP) Convention, held in San Francisco, California, two veterinarians described optimal equine influenza vaccine responses and concerns regarding antigen interference.

### Vaccine Efficacy

Tom Chambers, PhD, a professor at the University of Kentucky’s Gluck Equine Research Center, in Lexington, and Mark Crisman, DVM, MS, Dipl. ACVIM, equine technical services veterinarian with Zoetis and adjunct professor at Virginia-Maryland College of Veterinary Medicine, addressed whether veterinarians should give vaccines individually (either one at a time on a single day or several individual vaccines administered at separate sites on the same day) or as part of combination vaccines.

Products in the latter group, also referred

to as multivalent vaccines, contain vaccines against several diseases. For example, some combine the vaccines considered by the AAEP to be core (rabies, tetanus, West Nile virus [WNV], and Eastern and Western equine encephalitis [EEE and WEE]), meaning every horse should be vaccinated against them every year, as well as the risk-based vaccines (influenza and equine herpesvirus [EHV]) in a single syringe.

“Some questions have been raised whether multivalent vaccines will induce the same level of immune response as monovalent vaccines due to antigenic (stimulating antibody production) interference,” said Crisman.

Essentially, could having multiple agents in a single syringe potentially confuse the horse’s immune system after vaccination, possibly inhibiting its ability to mount an appropriate immune response to vaccination and leaving the horse susceptible to infection?

Crisman described one study in which researchers vaccinated horses against equine influenza and EHV, plus several core vaccines (Eastern and Western encephalitis viruses, WNV, and tetanus). The research team administered these vaccines to one group of horses separately (i.e., core vaccines in one syringe and flu/EHV vaccines in a separate syringe) and to a second group of horses together in a single combination vaccine.

“The study found that immune responses were better when fewer antigens were included in a vaccine,” Crisman said. “Specifically, for a more consistent immune response, the flu/herpesvirus vaccine should



ALEXANDRA BECKSTEIT

**Researchers have compared the efficacy of multivalent vs. monovalent influenza vaccines.**



**EQUINE INFLUENZA**

be administered as a straight bivalent (containing just those two) vaccine separate from the core vaccines.”

In sum, he said, antigenic interference does occur with equine vaccines, even though, theoretically, multivalent vaccines should work the same as monovalent products.

“That said, there are many polyvalent vaccines that ... are as efficacious as monovalent vaccines,” said Crisman.

**Monitoring Influenza**

Influenza, Chambers said, infects horses worldwide, and he

and colleagues in his lab, together with other OIE (the World Organization for Animal Health) reference labs, monitor its occurrence. Due to antigenic drift—where the flu virus essentially changes its appearance to the immune system—vaccine efficacy can vary markedly depending on how closely the vaccine matches the current circulating forms of flu virus.

“Surveillance teams look for the actual virus isolates, not just whether a horse is ‘positive’ for the flu,” he said. “We need to know antigenically how the horse’s body ‘sees’ that actual strain of the virus compared to the vaccine to create a better vaccine. **UK**

>Stacey Oke, DVM, MSc, is a practicing veterinarian and freelance medical writer and editor based in Saratoga Springs, New York.

**Can Horses With PPID Be Turned Out on Pasture?**

**Q** My veterinarian diagnosed my 20-year-old mare with PPID (pituitary pars intermedia dysfunction) and prescribed medication. He didn’t recommend changing her turnout arrangements, which involve time in a grassy paddock each day. But a friend said grass is bad for PPID horses. Can horses with PPID be turned out on pasture?

—Sally, via email

**A** The short answer: It depends! It depends largely on the PPID horse’s endocrine status—whether this horse has insulin dysregulation (abnormally high blood insulin levels) or equine metabolic syndrome (EMS), as well as PPID.

Why do we care? When horses have EMS or insulin dysregulation, they likely cannot

tolerate pasture. In fact, pasture can exacerbate the insulin dysregulation (i.e., it causes the horse to have even higher levels of circulating insulin in the blood, which contributes to these horses developing laminitis). But don’t assume all PPID horses are insulin dysregulated. They often are, but in some cases they’re not. Work with your veterinarian to determine whether your horse is insulin dysregulated; this can be done by looking at basal insulin levels or insulin levels in response to the oral sugar test. Also consider previous episodes of laminitis as indicators of how much pasture the horse can tolerate.

The bottom line: If your PPID horse is not insulin dysregulated and is of good body condition (i.e., not overweight), then yes, it should be safe to turn her out onto pasture. If your PPID horse is insulin dysregulated, depending on the severity, I would recommend working with your veterinarian or an equine nutritionist to determine how much pasture turnout time your horse should or should not have.

Amanda Adams, PhD  
Gluck Equine Research Center



**What We’re Learning From Racing Research**

Researchers worldwide are examining ways to prevent injuries in racehorses; their findings could help prevent issues in sport horses, as well

When a racehorse suffers a catastrophic injury in a high-profile race, the industry makes headlines ... for all the wrong reasons. In recent decades mainstream media has shone a spotlight on racing injuries, and industry organizations have poured thousands of dollars into investigating why they occur. As a result, we know a lot about the forces placed on these elite athletes’ bodies.

Much of the research has revolved around identifying risk factors for and ways to prevent catastrophic injuries and fatalities. Here, several university researchers from North America and abroad share recently published and ongoing studies on this topic, along with their potential impact on racehorse and sport horse health down the road.

**Identifying Early Warning Signs**

Preventing injuries is important not only for racehorse health but also jockey safety and public perception, says David Horohov, PhD, chair of the University of Kentucky’s (UK) Department of Veterinary Science and director of the Gluck Equine Research Center, in Lexington. He and his colleagues have been working on a series of studies investigating injury prevention.

An assembled group including James MacLeod, VMD, PhD, and Jennifer Janes, DVM, PhD, Dipl. ACVP, of the Gluck Center; Laura Kennedy, DVM, Dipl. ACVP, of the UK Veterinary Diagnostic Laboratory; and Mary Scollay, DVM, of the Kentucky Horse Racing Commission, are evaluating injury risks and possible precursors.

Horohov says their research thus far suggests that orthopedic injuries in racehorses are related to long-term effects rather than acute events. “It’s a chronic injury pattern that eventually leads to

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an acute failure,” he says.

In addition, Horohov and colleagues, including UK's Allen Page, DVM, PhD, are looking at whether inflammatory changes that occur in racehorses and sport horses indicate a pathologic (causing disease or damage) condition is brewing.

As bones and muscles experience stress during exercise, they undergo microdamage as part of their normal adaptive process. Ideally, this process helps strengthen both bone and muscle. However, if the horse is overtrained or does not adapt well to training, the result is inflammation and potential injury. Horohov and Page have hypothesized that bloodwork should reveal certain inflammatory marker patterns that indicate systemic inflammation caused by early microlesions.

“Some microlesion formation is likely part of the normal remodeling effort,” Horohov says. “It is when the destructive aspect of lesion formation gets ahead of the repair process that the inflammatory response becomes exaggerated, leading to systemic inflammation ... thus, the tipping point where inflammation does more harm than good.”

The team has already examined bloodwork of 2-year-old racehorses and older racehorses in training, along with racehorses working on treadmills. They're now gathering data from endurance horses, jumpers, and dressage horses to look for similar patterns in those populations.

Horohov says the underlying goal is to identify horses with abnormal expressions of inflammatory responses so trainers can back down a horse's training as needed to prevent him from becoming predisposed to or developing an injury.

Another important population this team has studied is racehorses rehabilitating from injury. Their goal is to identify inflammatory markers to help trainers determine the rate at which they can safely bring horses back into training and how much training a horse can tolerate.

### Identifying Fatality Risk Factors

Some racing and training injuries are so catastrophic that they result in death or euthanasia. In a retrospective study led by Peter Physick-Sheard, BVSc, Dipl. VetSurg, MSc, FRCVS, at the University of Guelph<sup>1</sup>, in Ontario, researchers analyzed racehorse deaths logged with the Ontario Racehorse Death Registry from 2003 to



FLICKR CC VIA COLIN KNOWLES

**Research into injury prevalence and prevention in racehorses can translate to sport horses.**

2015 that occurred within 60 days of a race or trial entry (timed workouts and Standardbred qualifying races).

The researchers examined differences between racing Thoroughbreds, Standardbreds, and Quarter Horses as they related to age, sex, and circumstances of death, such as time and location, suggested cause, and whether it was an exercise-associated mortality (EAM) or non-exercise-associated mortality (NEAM).



COURTESY DR. DOUG HERTHEL

**The fetlock is the most common site of musculoskeletal injury in racehorses.**

The mean combined EAM and NEAM mortality rate was highest for Thoroughbreds (2.93 deaths per 1,000 starts), which was 4.6 times higher than that of Standardbreds (0.63/1,000 starts). Quarter Horses landed in the middle (2.08/1,000 starts). Thoroughbred mean annual EAM was 8.1 times that of Standardbreds.

Physick-Sheard's team said their most notable finding was that Thoroughbred mortality was highest in young, intact male horses. In Thoroughbreds and Quarter Horses, mortality rates of all sexes were higher at age 2 than any other.

Researchers noted a higher mortality rate across all breeds for younger horses (possibly due to skeletal immaturity and a propensity toward fatigue) and older horses (possibly due to cumulative damage). The mortality risk among middle-aged horses was lower. Basically, says Physick-Sheard, mortality rate followed a curve, falling over the first two to three years, then increasing. Groups were aged by year, for Thoroughbreds, from 2 to 10.

When looking at cause of death, “musculoskeletal injury, including breakdowns, fractures, dislocations, and tendon ruptures, was the largest category,” said the authors. Thoroughbreds experienced musculoskeletal injuries 8.59 times more than Standardbreds.

The second-most-common cause was collapsing for no reason and sudden



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death. Colic; medical problems (e.g., bacterial infections, septicemia, kidney disease, etc.); iatrogenic problems (those inadvertently caused by treatment); and accidents of any kind (including necks and pelvises fractured in falls) followed.

“Breed differences in mortality provide pointers toward management strategies that could reduce mortality, enhance welfare, increase longevity, and reduce costs of participation,” wrote the study authors. “Exercise-associated mortality, in particular, is clearly related to the nature and intensity of competition undertaken by the different breeds and may reflect the time different industries allow for preparation of young athletes.”

In the U.K., Sarah Rosanowski, PhD, PGDipl. VCS, and colleagues evaluated risk factors for race-day fatalities in flat racing (not jumping obstacles) Thoroughbreds in Great Britain from 2000 to 2013 as part of her postdoctoral research at the Royal Veterinary College.<sup>2</sup> She’s currently an assistant professor in evidence-based veterinary medicine for the Centre for Applied One Health Research and Policy Advice at the City University of Hong Kong’s Jockey Club College of Veterinary Medicine and Life Sciences.

The study included 806,764 race starts, 548,571 of which were on the turf. Out of 610 fatalities, 377 (61.8%) occurred on the turf. The incidence of race-day fatality during all flat racing was 0.76 per 1,000 starts, with 0.69 per 1,000 starts on turf and 0.90 per 1,000 starts on all-weather (synthetic) surfaces. This indicates that all-weather surfaces increase fatality risk, says Rosanowski, compared to turf.

Her team divided fatality causes into three categories:

- Musculoskeletal injuries (88.8%);
- Nonmusculoskeletal injuries (10.3%); and
- Related to both (0.9%).

Of musculoskeletal-injury-related deaths, 75.5% were due to fractures, with tendon or ligament injuries, fetlock dislocation, and multiple injuries accounting for the rest.

Of nonmusculoskeletal-injury-related deaths, 8.6% were due to vascular catastrophe (any terminal event of vascular origin, such as cardiac issues or ruptured aortas); sudden death due to this cause is rare compared to musculoskeletal injury, says Rosanowski. They attributed a small proportion of deaths to epistaxis (bleeding



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In one study researchers found that all-weather racing surfaces increase fatality risk.

from the nostrils), lacerations, other soft tissue injuries, or multiple causes.

Risk factors on both turf and all-weather tracks included a firmer (turf) or faster (all-weather) racing surface, longer race distance, wearing an eye cover such as blinkers for the first time, increased age, racing in autumn or summer, horses in their first year of racing, and high average performance scores (betterperforming horses). An increased number of starts reduced a horse’s odds of fatality.

**“Because 80% of racehorse deaths are due to catastrophic injuries, focus on factors that affect injury risk should be a high priority.”**

DR. SUSAN STOVER

Auction races (restricted to 2- or 3-year-olds bought or sold at certain public auctions) had 1.46 times the odds of fatality as other race types. Turf horses running in Group 1 races (the highest-level stakes race) were 3.19 times more at risk.

Rosanowski’s team published a 2017 study<sup>3</sup> using the same data set that showed epistaxis incidence was 1.59 per 1,000 starts on all-weather surfaces. Faster (firmer) going increased a horse’s odds of epistaxis and distal (lower) limb fracture but not fatality. Longer race distance increased the odds of fatality but reduced the odds of epistaxis. The odds of distal limb fracture increased with firmer surfaces, with more than 14 runners in

a race, with increased horse age at first start, in better-performing horses, and in horses that raced eight to 93 days previously. Horses from trainers with higher win percentages on all-weather surfaces were at increased odds of fracture, as well.

### Preventing Catastrophic Injuries

Researchers at the University of California, Davis, (UC Davis) have been studying racehorses in various capacities, particularly their injury risk, for decades.

“Because 80% of racehorse deaths are due to catastrophic injuries, focus on factors that affect injury risk should be a high priority,” says Susan Stover, DVM, PhD, Dipl. ACVS, director of the UC Davis J.D. Wheat Veterinary Research Laboratory. “Because the causes of injury are multifactorial, a several-pronged approach is needed,” including racing surfaces, hoof management and shoeing, and training schedules.

She says her team’s most recent impactful findings include using ultrasound to detect humeral (the bone between the shoulder and elbow joints) stress fractures in racehorses (TheHorse.com/167901) and positron emission tomography (PET scan) to detect pre-existing issues that could lead to catastrophic fetlock injuries.

In a 2018 study<sup>4</sup> UC Davis researchers compared the use of PET scans with F-sodium fluoride (F-NaF, which serves as a tracer to detect changes in bone) to other methods of diagnosing bone-stress-related fetlock injuries, in hopes of preventing catastrophic injury. They found that PET scans with F-NaF picked

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up more bone lesions than nuclear scintigraphy (bone scan), computed tomography (CT), standing magnetic resonance imaging (MRI), and histologic (microscopic) examination. They concluded that a combination of PET with CT is important for localizing these lesions because PET findings reflect the tissues' metabolic activity and CT provides the activity's anatomic location.

"Consequently, PET has particular advantages for imaging the fetlock in racehorses because of its usefulness for not only detecting but also discriminating between metacarpal condylar (the distal cannon bone) and proximal sesamoid (in the fetlock hinge joint) bone abnormalities," said the study authors.

"California has made several changes to the industry that stemmed from UC Davis research and have contributed to an overall reduction in injuries in racehorses," says Stover. "The first key discovery was the recognition that catastrophic bone fractures were the acute manifestation of more chronic (pre-existing) stress fractures."

Because the fetlock is the most common site of musculoskeletal injury in racehorses and the leading cause of fatalities in the U.S., UC Davis researchers have focused on the relationship between race surface hardness and fetlock injury risk. This has led tracks to harrow (drag) racing surfaces more frequently during training sessions to help prevent injuries.

Using computer simulations, UC Davis researchers also recently looked at race surfaces' effects on fetlock motion during the stride's stance phase (when the foot is

in contact with the ground).<sup>5</sup> They found that, basically, providing sufficient cushion material on top of the surface's harder base can help prevent abnormal fetlock motion and reduce injury risk.

The team concluded that harrowing depth and frequency can influence limb motion significantly. They said computer simulations can give researchers more information on how race surface design and maintenance might reduce injury risk.

Stover says future UC Davis studies will focus on sesamoid bone fracture causes in racehorses, hard arena surface effects on the extended trot in dressage horses, economical ways to detect humeral stress fractures using ultrasound, and arena surface property effects on show jumpers.

**Take-Home Message**

This is just a small sampling of the research involving racehorses around the world. As scientists reveal more information about and ways to preserve racehorse health, their findings can translate to athletic horses of all types. Some are even leading to follow-up studies involving sport horses specifically.

These studies might be "of even greater importance to the sport horse due to ... the fact that you're expecting years of performance out of that animal," says Horohov. "The ability ... to both prevent as well as overcome injury is critical to the long-term health of that horse and the program it's involved in." **UK**

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## Commentary: Expect Hay Prices to Remain High

I have been asked many times during the past year, “How long will hay prices remain high?”

Although I cannot predict the future, there are many indications that prices will remain high in many parts of the country for the foreseeable future. This prediction is based on several factors. The stocks of hay this spring in most states were at almost historic lows. Weather conditions continue to be highly variable with drought in parts of the Southeast and excess rain in the central U.S. Alfalfa hay fields in the upper Midwest had extensive winterkill this past winter. Plus, dairy producers have been feeding less hay in recent years. Let’s explore each of these factors.

The May U.S. Department of Agriculture report on stocks of all agricultural products showed that hay inventories were at their lowest levels since 2013 and at one of the lowest levels in the last 70 years. This shows that hay producers and hay brokers had very little hay remaining in their barns this spring.

In most years, hay stocks will recover during the summer hay production season, but this year may well be different than normal. While some areas of the country have been experiencing drought, news reports of excess rain and flooding show the greater problem. Quality hay cannot be produced when it keeps raining because the plant continues to grow and become stemmier. Also, if hay is cut and rained on, leaf loss and mold growth occur. Additionally, flooding and waterlogged soils can drown out hayfields or at

least make them less productive. Hay will be produced in 2019, but expect quality horse hay to be at a premium.

Another factor that will likely cause a continued hay shortage is the extensive alfalfa winterkill that occurred across the Upper Midwest last winter. Alfalfa or alfalfa/grass mixtures are the premium hay crop across the country, and even if you do not buy alfalfa hay, any shortages will affect the price and supply of quality grass hay. An additional issue with alfalfa winterkill is that alfalfa cannot be planted directly back into old alfalfa stands. In most cases, hay producers in the Upper Midwest must wait a year before replanting their alfalfa hayfields.

Dairy producers across the country are feeding less hay. This relates to low on-farm milk prices, cheaper commodity prices like corn, and greater supplies of byproduct feeds, such as almond hulls in California. On the surface, it would seem that less hay going to dairy farms means more hay will be available for horse farms. But because the dairy market is huge for quality hay, hay producers are losing market share and, thus, producing less hay. In other words, horse owners need a strong dairy industry to encourage hay producers to produce good supplies of quality hay.

The take home message: When you find good-quality hay from a trustworthy source, buy instead of waiting for prices to come down.

For a more detailed report on alfalfa stocks in the U.S., see the recent article published in *Hay and Forage Grower* magazine entitled [“We’re Producing and Feeding Less Hay.”](#) by Mike Rankin. **UK**

>Ray Smith, PhD, is a forage specialist in University of Kentucky’s College of Agriculture, Food and Environment.



COURTESY UNIVERSITY OF KENTUCKY

When you find quality hay, don't wait to buy.

## Changing Trends in Equine Reproduction

Research advances in equine reproductive biology and health over the past 50 years have contributed to improved fertility and breeding efficiency in horses. The development of endocrine and ultrasonography diagnostics aids the clinician in determining potential fertility of mares and stallions. Follicular dysfunction and ovulation failure can be diagnosed with high precision in mares, embryo and fetal development can be monitored from 10 days after ovulation throughout gestation, and fetal/placental abnormalities diagnosed to identify high-risk pregnancies. In stallions, biochemical and genetic

sperm abnormalities have been identified that previously remained undetected based on traditional breeding soundness examinations. Furthermore, testicular abnormalities and blood flow can be determined with high accuracy by Doppler flow ultrasonography.

The current trend in horse breeding is characterized by a decline in mares that are bred and a new focus on well-being of established pregnancies as well as enhanced genetic selection with regards to health and future performance of the foal. In addition, great advances in the area of assisted reproductive technologies offer numerous possibilities that were not available in the past.

### Monitoring Healthy Pregnancy

Biomarkers for high-risk pregnancies and efficient treatments to prevent late

pregnancy losses are being investigated. As new potential markers for unhealthy conditions are discovered, effective treatment options need to be developed. A similar trend is seen with regards to endometritis as well as the development of new diagnostics for dormant bacteria and uterine biofilms. While new therapeutic regimens for endometritis often include non-antibiotic alternatives or supplements, most treatment options for high-risk pregnant mares include long-term use of broad-spectrum systemic antibiotics without the possibility of performing bacterial sensitivity tests.

There is a global awareness of consequences when antibiotics are overused in human as well as veterinary medicine—and equine reproduction is not an exception. An overuse of antibiotics can lead to bacterial resistance and contribute to one

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of the most urgent public health issues today. New trends in equine reproduction reflect these challenges to veterinary medicine, public health and the global equine breeding industry, and additional nonantibiotic treatment options need to be developed.

### Improved Genetic Selection

The art of breeding horses is based on genetic selection. Horsemen evaluate visible characteristics (phenotypes), such as conformation, coat color, speed, endurance as well as family history (bloodlines) and make breeding decisions based on these evaluations. As equine breeding has shifted from quantity to a greater focus on quality, genetics and genomic research in reproduction has the potential to improve the accuracy of breeding selection criteria.

Research leading to sequencing of the equine genome has resulted in the identification of a growing number of genes that have been linked to positive characteristics (speed, coat color, etc.) as well as heritable diseases. These scientific advances are currently used to test potential carriers before making breeding decisions. If allowed by the breed registry, pre-implantation genetic testing of embryos provides a more effective method to select for (or against) certain genetics. Recent and ongoing research allows us to recover embryos nonsurgically from the uterus a week after conception and test the conceptus for the presence or absence of specific genes. The embryo can be cryopreserved while molecular genetic testing is performed in the laboratory and if test results are favorable, it can be transferred into a recipient mare or even into its biological mother at a later time.

The potential benefit of this technology to horse breeding is obvious. For example, unless genetic carriers of a debilitating disease (and potentially also carriers of some desirable genes) are completely removed from breeding, selection of healthy embryos based on pre-implantation genetic testing is the only way to eradicate the disease. Because of its practical benefit to horse breeders, the technology of pre-implantation genetic testing in horses can be expected to be further developed and gain popularity as research identifies additional genes that influence a variety of characteristic of horses, and tests become available.



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A related area of expected research intensity in the near future is investigations on the importance of environmental influence on gene expression during fetal development (epigenetics).

### Assisted Reproduction

Assisted reproduction is not suitable to all breeders. However, current knowledge and expected future research advances in this area offer exciting possibilities for selective high-end breeding operations. Various assisted reproduction techniques carry some important advantages with regard to management of both fertile and subfertile stallions, allowing for treatment of the semen. For example, frozen and preserved semen can be shipped anywhere in the world, making valuable genetics available globally, and preserving genetics from stallions long after their death.

**A recently developed semen extender allows semen to be stored for an extended period at ambient temperature**

Researchers in Australia have recently developed a semen extender that allows for storage of equine semen for an extended period at ambient temperature. This is without doubt a major breakthrough that can simplify breeding with shipped semen and reduce some hurdles associated with timing of the shipment in relation to expected ovulation. Research advances on semen biology has also resulted in improved management of

stallions with specific and selective fertility problems.

Stallions that produce ejaculates with poor sperm quality and viability can often be managed by centrifugation of their ejaculates and resuspension of the sperm in an extender with supportive nutrients. Furthermore, the quality of an ejaculate can be enhanced through gradient centrifugation that can separate “good” and “bad” sperm before insemination. Further research to enhance our understanding of relevant sperm biology and advanced diagnostics to identify preferable sperm populations in an ejaculate is expected to create a need for robust and efficient technologies to select superior sperm within an ejaculate.

Research that makes it possible to separate x- and y-bearing sperm through flow cytometry (based on the fact that x-bearing sperm contains more DNA), has been commercialized and is currently offered by specialized laboratories. The method is very accurate, but efficiency is still quite low and results in a low number of sex-sorted sperm. This hurdle has been a limiting factor for the method and more research is needed to improve the technique. Recent research exploring the use of nanotechnology to target specific sperm DNA sequences has the potential to develop a new efficient technology to select sperm for sex-sorting, and maybe more importantly—to select sperm based on other genetics that can be used as a replacement or complement to pre-implantation genetic testing of embryos. Preliminary results from studies using nanotechnology for sex-sorting in donkeys and other species appear to be promising.

Logically, technologies that involve sperm selection in the laboratory will always result in limited number of sperm



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that can be used for breeding. However, recent scientific and clinical advances make it possible to use a single sperm from an infertile stallion and inject it into an egg that has been retrieved by ultrasound guided follicular aspiration from the ovary, culture the conceptus in a petri dish under controlled conditions and transfer the embryo into a recipient mare or back into the same oocyte donor mare at a later time. Intracytoplasmic sperm injection (ICSI) has become increasingly popular and a suitable method to use genetically valuable semen of poor quality or with restricted access because of disease or death of the stallion. Research to improve the efficiency of this technology would greatly benefit breeding operations that allow assisted reproduction.

Few, if any, breed registries accept foals resulting from somatic cell cloning of an existing individual. The technology is nevertheless offered for horses and has become popular among some horse owners that don't need to register their foals. Although cloned horses have been used successfully as athletes, the greatest bene-

fit of the technology may be the possibility to produce an intact stallion as a genetic copy of an existing gelding with a successful athletic career. It should be kept in mind that even if the genetic make-up of the cloned copy is identical to the original horse, the phenotype (looks and performance) may be different because of the influence of the environment that the embryo and fetus were exposed to in the test tube and uterus of the surrogate mother (epigenetics). The best prospective for the cloned intact stallion may therefore, be for breeding purposes. In other words—an expensive way to put testicles back on a gelding. **UK**

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This is an excerpt from *Equine Disease Quarterly*, funded by underwriters at Lloyd's, London.

**Upcoming Events**

**Sept. 5, 3:30-8 p.m.**

**UK Equine Field Day**

Weber's Retired Horses LLC, 1013 Dripping Springs Rd., Princeton, Kentucky  
Free meal will be provided.  
RSVP to DL\_CES\_Caldwell@email.uky.edu or 270/365-2787.

**3:30 p.m.** Registration

**4 p.m.** Exhibitor booths

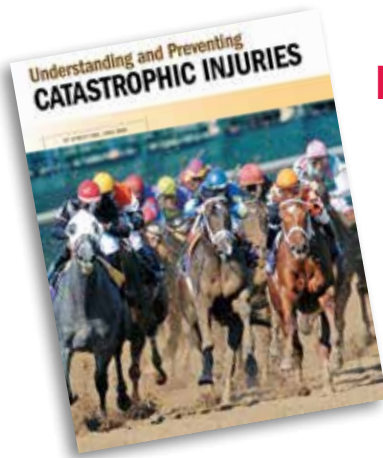
**5 p.m.** Welcome, dinner provided by Caldwell County Extension Office

**5:30 p.m.** Overview, Rob and Kim Weber, owners

**6-8 p.m.** Educational sessions, concurrently every half hour:

- Feeding from the inside out, *Bob Coleman, PhD*
- Using cost share to reduce overgrazing, *Krista Lea, MS, and Mike Clayton*
- Establishing horse pastures, *Ray Smith, PhD*
- Maintaining a healthy horse, *Libby Maddux, DVM*

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