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Bluegrass Equine DIGEST

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Updated Horse Parasite Control Guidelines Released

The American Association of Equine Practitioners (AAEP) has released an updated version of its parasite control guidelines for horses. The guidelines, first published in 2013, have been revised and to reflect recent research findings.

For the past several years, Martin Nielsen, DVM, PhD, Dipl. ACVM, Schlaikjer Professor of Equine Infectious Disease and associate professor at University of Kentucky (UK) Gluck Equine Research Center, in Lexington, has led the AAEP parasite control guideline subcommittee.

One key takeaway: Different equine age groups have different parasite control needs. Another important point: Fecal egg count surveillance is a necessity, but it should be applied in different manners in foals, yearlings, and adult horses.

In foals, the main target is the large roundworm (*Parascaris* spp), while small strongyles and tapeworms primarily infect yearlings. Adult horses typically have much lower parasite burdens than those in the younger age groups.

The guidelines put forth a basic treatment foundation that should be considered for all horses every year. Fecal egg counts can then identify which parasites horses are harboring (in foals and short yearlings), which horses are high strongyle shedders (adult horses), and whether the treatment worked as intended (all age groups).

Table 1 summarizes the current levels of dewormer resistance in important horse parasites. All equine dewormers have resistance issues in at least one parasite category, and these are global trends. It is important to follow the guidelines and ensure that our horses receive adequate parasite control.

Read the entire updated parasite control guidelines document at aaep.org/guidelines/parasite-control-guidelines. UK

>Martin Nielsen, DVM, PhD, Dipl. ACVM, Schlaikjer Professor of Equine Infectious Disease and associate professor at the UK Gluck Equine Research Center, provided this information.

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Adult horses typically have lower parasite burdens than younger horses, a finding that's reflected in the updated guidelines.

Table 1. Current levels of resistance documented in peer-reviewed studies in major nematode parasites to the three anthelmintic classes in managed horse herds. These are world-wide trends that have also been reported in several US surveys.

Drug class	Cyathostomins	Large strongyles	*Parascaris* spp.
Benzimidazoles	Widespread	None	Early indications
Pyrimidines	Common	None	Early indications
Macrocyclic lactones	Early indications	None	Widespread

Widespread: reported on multiple continents with high farm prevalences often above 80%
Common: reported on multiple continents with varying farm prevalences
Early indications: few single farm cases of reduced efficacy (ascarids) or reports of reduced egg reappearance periods (strongyles)

In This Issue

Equine Immunity From Birth to Old Age

Do you ever wonder how it is that you travel to clinics and events away from home and, for the most part, your horse returns in good shape, with not even a sniffle? It's largely due to a well-functioning immune system defending him from a world teeming with microorganisms. Many factors affect your horse's ability to mount an effective immune response, one of which is his age. Basic immune mechanisms are similar in foals and adults, but cell response, regulation, and response to pathogens and vaccines do differ in these populations.

Priming Immune Systems for Life

A newborn foal acquires protective immunity from antibodies (proteins that target and eliminate foreign bodies called antigens) he obtains from his dam's colostrum (first milk), through a process called passive transfer. The antibodies are ones the mare has produced in response to her environment and to immunizations received in the last month of pregnancy. The protein molecules in colostrum can pass easily through the intestinal tract lining immediately after birth. By 12 to 24 hours, however, specialized cells in the foal's intestinal lining no longer pass these large molecules through into the bloodstream. Breeders can have their veterinarians determine the extent of foals' protection via a blood test that measures concentrations of immunoglobulin G (IgG) antibodies in serum.

"Foals are capable of producing antibodies to foreign antigens while in the womb, starting around nine months gestation," says David Horohov, PhD, director of the UK Gluck Equine Research Center. "Once born, they have the capability of responding to any environmental antigen they encounter, but with two limitations. First, the ability to make specific subclasses of IgG is impeded for the first couple of months by the low expression of certain cytokines (molecules that affect and modulate the behavior of other surrounding cells, such as those necessary to mount an immune response). Second, and more importantly, the presence of maternal antibodies can interfere with a foal's own immune system's ability to respond."

Adaptive immunity is the foal's second

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A newborn foal acquires protective immunity from antibodies (proteins that target and eliminate foreign bodies called antigens) he obtains from his dam's colostrum, through a process called passive transfer.

Masthead

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The Horse: Your Guide To Equine Health Care

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line of defense, but it only develops later in life as maternal antibodies wane and the immature immune system begins to respond to stimulation by foreign proteins. Antibodies develop, and specialized white blood cells get summoned to areas under attack. Immune cells retain a memory that allows them to respond rapidly to future insult by the same antigen.

This process is the basis of vaccination. When foals first need to be vaccinated depends on the degree of maternal antibody interference derived from the colostrum.

"Maternal antibodies remain in the foal's circulation until approximately six months of age," says Elizabeth Davis, DVM, PhD, Dipl. ACVIM, professor and head of the Department of Clinical Sciences at Kansas State University's College of Veterinary Medicine, in Manhattan.

At this point, foals need the first of their three-dose series of core vaccines (rabies, tetanus, West Nile virus, Eastern/Western equine encephalitis). Veterinarians typically administer the first dose at 4 to 6 months of age, followed by a booster approximately one month later and a third dose two to three months after that.

"Boosters are then administered once or twice annually according to manufacturer recommendations and environmental risks," she adds.

Foals might begin receiving immunization against viral respiratory diseases at 6 months of age, with a series of three given over four- to six-week intervals. Regardless of when these vaccines are initiated, foals should receive influenza and rhinopneumonitis boosters at 10 to 12 months of age.

Keep in mind that weaning is a stressful time that renders a foal more susceptible to infection because increased cortisol (the stress hormone) diminishes cell-mediated immunity (which does not involve antibodies but, instead, relies on other cellular responses to antigens.)

Factors Affecting Adult Horses

Owners should work with their veterinarians to construct a vaccination program that includes core and risk-based vaccines for each horse. Amanda Adams, PhD, assistant professor at the Gluck Equine Research Center, says because horses' vaccine responses vary greatly, it is important to follow AAEP guidelines for immunization (aaep.org/guidelines/vaccination-guidelines), ensuring horses receive core vaccines at least annually and more often in areas with year-round exposure to endemic diseases such as West Nile virus and encephalitis. She also stresses the importance of following vaccine manufacturers' labels for duration of protection, along with your veterinarian's recommendations.

Some factors beyond immunization, however, can affect a horse's level of immunity. We'll describe three here.

Gastrointestinal health Did you know that a large percentage of the equine immune system is located in the gut? "An imbalance in the gut microbiota allows overgrowth of 'bad' microbes," says Adams. "This stimulates an inflammatory response that damages the intestinal lining and contributes to or causes a 'leaky gut.'"

> **"Leaky gut syndrome leads to a number of problems, including malabsorption of nutrients, autoimmune diseases, and systemic inflammation."**
>
> DR. ELIZABETH DAVIS

With a leaky gut, says Davis, "severe damage to the intestinal lining may limit its ability to maintain an effective barrier between intestinal contents and the bloodstream. Bacteria and/or bacterial products (endotoxin) may enter the circulation, resulting in sepsis. Such a systemic infection significantly reduces white blood cell numbers, which markedly impairs immune function.

"A vicious cycle continues because inflammatory cells within the gut wall activate resident immune cells and/or recruit more immune cells," she adds. "Leaky gut syndrome leads to a number of problems, including malabsorption of nutrients, autoimmune diseases, and systemic inflammation, which in turn contributes to many chronic diseases."

The immune system demands a lot of nutrients and energy to maintain homeostasis (stability) and function.

"This delicate dance between gut microflora and the immune system is a relationship one wants to keep happy with appropriate nutrition and management," says Adams. Both she and Davis recommend practical ways to achieve this: a balanced diet, abundant roughage, minimal processed concentrate, and routine exercise.

Davis also recommends avoiding antimicrobial therapy unless veterinarian-prescribed to treat a condition. "Antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) can have marked detrimental effects on the gastrointestinal health of horses, including a direct toxic effect to intestinal lining (epithelial) cells," she says. "In extreme situations, NSAIDs irritate the intestinal lining, potentially leading to protein loss and diarrhea."

Davis says she can't overemphasize the importance of a healthy gastrointestinal tract on a horse's immune system. "For high-stress situations associated with competition or in combination with (the antibiotics or NSAIDs described), additional nutritional aids, like probiotics (live organisms), may be indicated," she adds. "Horse owners should work with their veterinarians to determine which probiotic products contain appropriate ingredients that are ideal for horses."

Adams describes one study she and colleagues performed in collaboration with Purina Mills on 40 senior horses, in which they found that a specific dose of a prebiotic (plant fiber that promotes probiotic growth) added to the horses' diets reduced inflammation and improved immune responses to vaccination.

A competent immune system also needs certain nutrients to function well: amino acids (methionine, arginine, glutamine); trace minerals (zinc, copper, selenium); vitamins (folate, B6, B12, vitamins C, A, D, E); and polyunsaturated fatty acids.

Exercise Low- to moderate-intensity exercise benefits the immune system. High-intensity exercise or exercise for long durations (as experienced by endurance athletes), on the other hand, might put horses more at risk of developing lung infections due to short-term immunosuppression soon after exercise. Scientists believe horses might inhale normal bacterial inhabitants in the back of their throat into the lower airways during intense exercise. Because airway turbulence during high speeds might adversely affect the respiratory tract lymphocytes' (a type of white blood cell) immune competence, bacterial infections might ensue as microorganisms proliferate. Stress-induced immunosuppression that occurs during travel, competition, and changes in routine adds to infection risks.

In recreational and competitive sport horses cortisol concentrations increase temporarily following exercise, but they do so in a beneficial way that increases neutrophil (another type of white blood cell) bactericidal activity.

Researchers have shown that conditioning is associated with health benefits for the immune system. "However, this response in aged horses differs from younger horses and remains diminished, even with conditioning," says Adams.

In 2013 Liburt et al. showed that the pituitary and adrenal glands experience declining function with age, but exercise training helps counteract these deficits by improving the hormonal axis function. This axis intertwines the endocrine and nervous systems and serves as a stress control center for all body functions.

Obesity In human medicine doctors have associated obesity with a "pro-inflammatory" state. Severely overweight people often have reduced responses to vaccination and increased susceptibility to infectious disease. In horses, says Adams, obesity similarly contributes to inflammation in both systemic and local tissues.

"There is clear evidence that obesity in equine metabolic syndrome (EMS)-prone horses has negative health effects besides insulin dysregulation (hyperinsulinemia, excess levels of insulin in the blood due to overproduction in response to glucose, or insulin resistance, defined as a decrease in tissue sensitivity to insulin), which predisposes to laminitis," says Davis. "Some horses may not demonstrate obvious obesity, yet may have metabolically active adipocytes (fat cells)."

Dianne McFarlane, DVM, PhD, MS, Dipl. ACVIM, professor of physiological sciences at Oklahoma State University's Center for Veterinary Health Sciences, in Stillwater, says that, "in people, adipose depots (fat stores) directly release inflammatory mediators that add to systemic inflammation. Not all adipose tissue is equally damaging. Evidence supports that adipose deposits in horses, particularly fat stored in the neck, is most active in driving systemic inflammation."

Adams and her group examined equine antibody production in response to vaccination and found no differences between EMS and non-EMS horses. "However," she says, "comparable to data seen in humans, EMS horses demonstrate a lower cell-mediated response to vaccination than non-EMS horses."

Dr. Amanda Adams believes the clinical effects of "aging" might simply be due to the immune system's decline as a horse gets older.

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Until challenge studies are performed, in which researchers expose horses to the antigens the vaccines protect against, we don't know if a reduced immune response to vaccination means a horse is not well-protected.

"Due to the risk of adverse effects on immunity and increased risk of contracting disease due to obesity, it is ideal to routinely examine horses' body condition while maintaining exercise and nutritional programs that foster a healthy body condition score," says Davis.

Declining Immune Function With Age

As horses live longer thanks to excellent management and veterinary care, we see syndromes not previously recognized in horses in their late teens or early 20s. Veterinarians consider horses over the age of 20 geriatric. These animals decline in obvious ways, including lost muscle tone, diminished body condition scores, and an overall reduced well-being.

Researchers debate whether such physical changes are the source of declining immune function or the result of it, referred to as inflamm-aging or immunosenescence.

"Inflamm-aging is the result of chronic, lifelong exposure to triggers to the immune system," says McFarlane. "Exposure to environmental toxicants, poor diet, changes in gut bacterial flora, persistent viral infections, and chronic inflammatory diseases may tip the balance from a protective immune system to a detrimental inflammatory state."

Adams describes the chronic inflammatory process: "Lymphocytes are part of a horse's adaptive immune activity; these white blood cells respond to invasion by specific foreign antigens. But with age, exhausted lymphocytes or those that no longer divide (differentiate into various immune responders) are sources for production of significant amounts of inflammatory cytokines. Macrophages, another cell population responsible for inflamm-aging, are likely reacting to molecules from cellular debris that accumulates with age." This debris stimulates inflammation, which adversely affects the immune system.

"The hallmark characteristics of immunosenescence ... include reduced T cell (a lymphocyte integral to cell-mediated immunity) proliferation and function, reduced immune responses to vaccination, and the inflamm-aging process," she says. "All these factors contribute to age-related increased susceptibility to disease, both infectious and noninfectious."

She believes the clinical effects of "aging" might simply be due to the immune system's decline as a horse gets older.

In her research Adams has also identified seasonal changes in senior horses' immune function, immune cell proliferation, and cytokine production.

Inflammatory levels peak in the spring and drop in late summer into winter. However, she says, "neither season nor hormones are the cause or driving factor of inflamm-aging." Rather, age and obesity have greater effects on increased cytokine production and the resulting inflammation.

Approximately one-third of the older horse population is affected by pituitary pars intermedia dysfunction (PPID, or equine Cushing's disease), adding another layer of immunosuppression to normal age-related influences. Study results indicate that antibody titers (which reflect protection against disease) don't persist as long in PPID-affected horses.

"Increased adrenocorticotropic hormone due to PPID leads to abnormal adrenal cortisol synthesis and release, which has immunosuppressive effects," says Davis. "PPID-affected horses demonstrate a variety of clinical signs: increased sweating, increased water intake, improper shedding, and a persistently long hair coat, along with diminished immune function. They often suffer from chronic infections, such as dental disease, sinusitis, and parasitic disease."

Based on her research, Adams reports that she and others don't see differences between PPID and non-PPID aged horses' adaptive immune response. Also, when comparing immune responses to vaccination, they did not notice antibody differences in how the horses responded to the influenza component of a combination vaccine. "However, there are differences in how PPID horses respond to West Nile virus and equine herpesvirus components of combination vaccines," she says (TheHorse.com/112280).

Therefore, she says, it might be better to give senior horses single injections of each vaccine antigen rather than combining multiple antigens into one injection. Her study group is also investigating pergolide (for PPID) treatment's effects on aged horses' immune systems.

The Importance of Preventive Care

The key to maintaining good health and immunity in horses of all ages? An effective vaccine and deworming program, quality nutrition, conditioning, and biosecurity measures to reduce risk of exposure to infection, says Davis.

"Don't forget about your older horses or assume they don't need vaccination," Adams adds. "Maintain geriatric horses, especially PPID horses, on a regular vaccination program. This is most critical for horses still in training, competition, and travel.

"Decreasing immune function with advancing age also hampers the ability of the immune system to keep parasite burdens in check," she adds. "A study done in collaboration with parasitologist Martin Nielsen, DVM, PhD, Dipl. EVPC, of Gluck Equine Research Center, identified that old horses had significantly higher fecal egg counts (FECs, which are evidence of parasite infection) compared to young adult horses. Both groups responded well to two different classes of anthelmintic treatment, with FECs significantly reduced after deworming."

Adams recommends following similar AAEP deworming guidelines for both adult and senior horses: Fecal egg counts once or twice a year; FEC reduction testing to assess dewormer efficacy; and deworming treatments focused on peak transmission seasons (spring and fall).

Biosecurity practices are also important for all equine populations, but the young and old are most susceptible to infectious diseases, says Davis.

"Separate new from resident horses for two to four weeks following arrival, handle new arrivals after caring for the resident population, and check daily for body temperature, changes in respiratory character, cough, nasal discharge, and fecal character or consistency," says Davis. "Implementing herd health practices by vaccinating all horses against infectious diseases substantially diminishes the risk of disease at the individual level by maximizing herd immunity."

Find the AAEP's biosecurity guidelines at bit.ly/2J37JtN.

Take-Home Message

For optimal immune function in any horse, minimize stress, supply quality nutrition, provide preventive care through vaccination and deworming programs, and facilitate exercise and conditioning to maintain a healthy body condition score. Finally, limit your horse's risk of exposure to pathogens by implementing optimal biosecurity practices. UK

>Nancy S. Loving, DVM, owns Loving Equine Clinic, in Boulder, Colorado.

Bioinformatics Specialist Joins Gluck Center Faculty

Earlier this year, Theodore (Ted) Kalbfleisch, PhD, joined the Gluck Equine Research Center faculty. His work will focus on a secondary analysis of equid genomes and transcriptomes.

Previously an associate professor at the University of Louisville (UofL) School of Medicine, Kalbfleisch earned his doctorate in physical chemistry from Boston University and his bachelor's degree in chemistry from UofL. He is originally from Louisville.

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Dr. Ted Kalbfleisch will be studying equid genomes and transcriptomes at the Gluck Center.

"I am very pleased that Dr. Kalbfleisch has joined our department, as he brings an international reputation in equine bioinformatics, a wealth of technical expertise, and a record of significant accomplishments in this area," said David Horohov, PhD, chair of UK's Department of Veterinary Science, director of the Gluck Equine Research Center, and Jes E. and Clementine M. Schlaikjer Endowed Chair and Professor at the Gluck Center. "His presence will allow our faculty and students the opportunity to expand their research through the application of bioinformatic analytics, thereby leading to new approaches to solve problems affecting various aspects of equine health and welfare."

When asked about what he'd be researching, Kalbfleisch said, "We have learned a lot from our preliminary analyses of the whole genome sequence (genomic), and RNA-Seq

(transcriptomic) data sets we have generated over the last decade. We have built comprehensive catalogs of genetic variation that exist across horse breeds and of tissue specific profiles of gene expression.

"As the sequencing technology has evolved, we are now able to identify a great deal more about how genetic variation both impacts, and is reflected by, gene transcription and transcriptional regulation," he continued. "This is a wonderful time to be working in this field as there are any number of new and exciting ways to study cellular function and gain a better understanding of the genetic and genomic basis of equine health. The next few years are going to be a lot of fun."

Kalbfleisch recently participated in a Q&A on his transition to and work at the Gluck Center:

Q: What excites you about starting in your current position?

I've been working with Gluck scientists now for about seven or so years and have had wonderfully productive collaborations. The work has been very interesting and equally rewarding. The chance to interact and exchange ideas with them is an exciting opportunity.

Q: What's the coolest or most interesting thing you're working on right now?

We are working on a process to better analyze RNA-Seq data. The pipelines as they exist today rely heavily on quality of the reference genome and its companion genomic annotation. There is an opportunity to miss a lot when there are missing transcripts or poorly annotated genomic regions. I believe we can reanalyze much of the RNA-Seq data that has been generated for the horse and derive a great deal more information with respect to what genes are transcribed, whether or not there is allelic specificity, and even if there are contributions to the expression profile from bacterial or viral species that could contribute phenotypically. This is a lot of fun.

Q: What could you give a 30-minute presentation about with no advance preparation?

When you sequence a genome, or a transcriptome, you sequence all the genomic DNA or transcribed RNA in that sample. There is so much information in those samples, including the genomic DNA or RNA of any bacteria that may be present in the sample, the genomic DNA of cells containing somatic mutation (some of these could be cancerous), or, in circulating blood samples, various cells that have sloughed off from any number of organs or tissues, some of which could be under stress. These datasets are a treasure trove of information. Although, with our current approaches and tools, any analysis broad enough to study all these components would be impractical at best; it is loads of fun to think about just how you would do it, and what you would do with information you uncovered.

Q: What's something that has surprised you about your chosen career path?

Just how unpredictable it has been. As an undergraduate studying chemistry or even as a graduate student studying physical chemistry, I never would have imagined the trajectory my career has taken. I have been incredibly fortunate in that really interesting opportunities have bubbled up at the same time I have had an open enough mind to consider grabbing them. It has worked out pretty well.

Q: Anything you would like to add?

I honestly don't know if there has been a more fun time to be in science. We are limited in what we can learn only by our imaginations. I can't wait to see what we and the next few generations of scientists do. UK

>Holly Wiemers, MA, APR, is UK Ag Equine Programs' communications and managing director.

What's New With Weaning Horses?

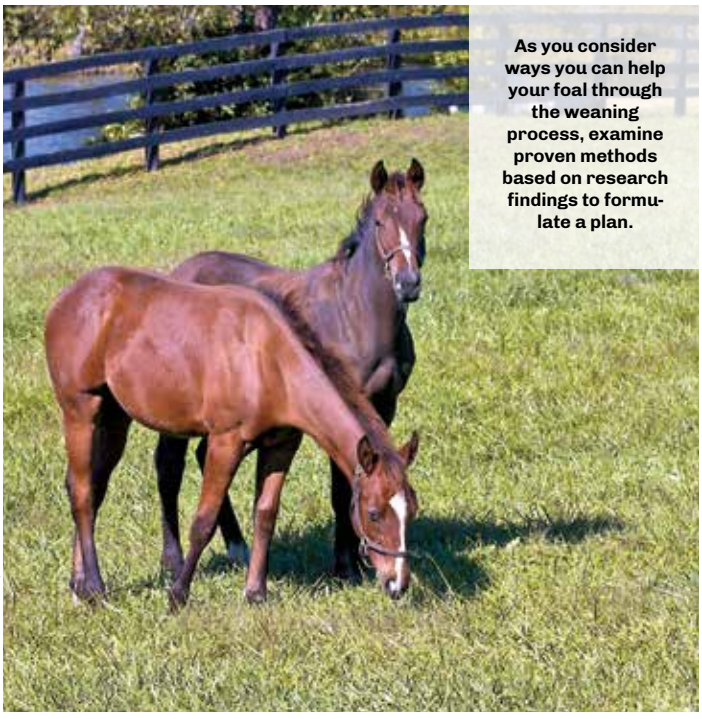
Barring a mare's illness, injury, or death—which would necessitate separating her from her foal sooner than expected—you have the luxury of planning your foal's weaning process. You can take steps to minimize potential negative effects of this stressful time and ensure your foal has the best possible outcome.

You also want your foal to become independent. Weaning him will allow you to begin his training without Mom's ever-present influence and learn about and enjoy his personality as he develops into the horse you've dreamed about since you picked his sire.

Read on to learn about practical, proven tips and what recent research has revealed about how you can advocate for your foal's optimum health and well-being during this typically tension-filled time.

Wipe Out Weaning Stress

Amanda Adams, PhD, an immunology researcher at the UK Gluck Equine Research Center, says maternal separation and changes in environment, diet, and management are what makes weaning stressful for foals. This can result in increased vocalization, motor activity (locomotion), heart rate, and cortisol secretion (the horse's body produces the hormone cortisol during times of stress, and it effectively decreases the body's inflammatory and immune responses), as well as decreased appetite



ANNE M. EBERHARDT/THE HORSE

As you consider ways you can help your foal through the weaning process, examine proven methods based on research findings to formulate a plan.

WHAT'S NEW WITH WEANING?

with subsequent slower daily weight gain post-weaning. Foals might also suffer from gastrointestinal (GI) and respiratory infections during this time.

Jill Mixer, DVM, owns Waterloo Animal Hospital, in Edmond, Oklahoma, breeds Quarter Horse runners, and, until recently, served as track veterinarian at Remington Park and other ovals. She shares advice from her years of raising foals, during which she's seen very few clinical or behavioral problems.

"We start by administering plasma to all our foals within the first 24 hours of life to boost their immune systems and to help prevent future illness or infection," she says.

The weaning method Mixer says causes her youngsters the least stress involves keeping all mares and foals in one or two large groups by age, beginning when they're about 1 month old. "When the foals are 5-6 months old, I'll start to completely remove one or two mares at a time from the property so their foals can't see or hear them," she says. "The foals may nicker and run down the fenceline while we're driving out of our property, but within a few minutes with their pasturemates they become calm again. We repeat the process over the course of one to two months until the last mare is removed.

"If a person only has one or two mares with foals," she adds, "I'd recommend cross-fence weaning by putting mares next to foals in a paddock or pasture with safe fencing (board or V-mesh wire) or in stalls next to each other where they can see and hear each other. I don't use companion animals because we have quite a few mares and foals, but for someone with one mare and foal, I believe it's a good idea for the foal to have a gentle, preferably older companion."

The most stressful form of weaning, she says, is putting two foals together in a stall and leaving the mares out in the pasture. "They can hear their dams, and studies have shown that when two foals are in the same stall, their cortisol levels are higher than when they're by themselves in a stall. I've also found that the foal will bond with you when you enter the stall instead of bonding with the other foal."

As far as your mares go, Mixer says she removes all grain from their diets for one week post-weaning and keeps them turned out for exercise, which helps reduce mammary swelling. "I monitor them closely and have had very few mares develop mastitis (mammary gland infection) over the years with this method," she says.

Studying Immune Response

On the research side of weaning, Adams studies ways to support horses' immune systems and thereby minimize their susceptibility to weaning-related health problems. Here are two recent investigations she conducted.

Study 1: *PPVO* Adams examined the effects of the immunomodulator *Parapoxvirus ovis* (*PPVO*, a large double-stranded DNA virus that's a commercially available intramuscular product) on cell-mediated immunity in abruptly weaned foals. Researchers have previously shown *PPVO* to enhance cell-mediated immune responses and dial down the severity of infectious disease outbreaks among horses and other species.

Adams and her colleagues administered *PPVO* (or a sterile diluent as a control) to—and took blood samples from—pony foals ages 3 to 4 months at set time points prior to weaning, at weaning, and post-weaning. The team weaned the foals abruptly and placed them out of their dams' sight in a neighboring pasture.

"We were measuring cell-mediated immune responses, which are really important for combating viral infections and intracellular bacterial infections that often are causative agents to the respiratory and GI problems that foals can succumb to during weaning," Adams says. Regardless of treatment, the foals' immune responses declined significantly post-weaning and took up to 21 days to rebound to normal.

WHAT'S NEW WITH WEANING?

"We were hoping that the cell-mediated immune response in the foals that received *PPVO* would not be suppressed or that it would actually be enhanced a bit or supported through the time of weaning, but there was no treatment effect, in particular on the production of the lymphocyte (small white blood cell) interferon-gamma (IFN-γ), a key player in cell-mediated immune responses," Adams says.

However, what the 21-day window of vulnerability revealed is that it's particularly important to practice optimum biosecurity during this time. A bit of extra diligence could help prevent exposure to pathogens that might be introduced from outside your facility, so be sure to keep foals away from ingress and egress areas and new horses and to enforce good handler hygiene.

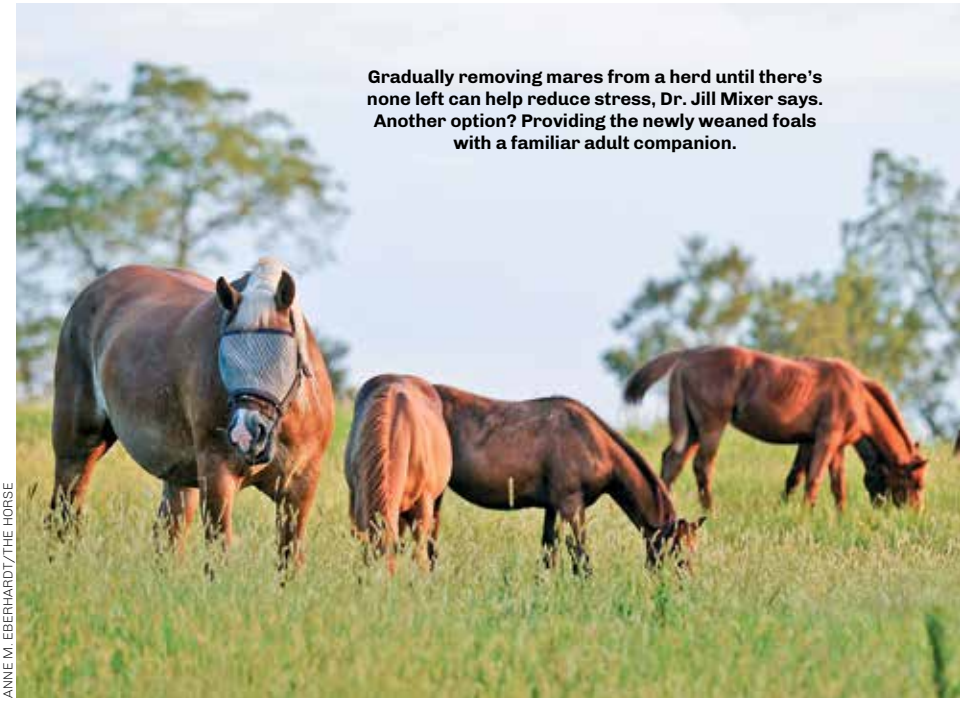
Also, monitor your weaned foals closely during this time frame. "We all hear about newly weaned foals with snotty noses," Adams says. And be on the lookout for foals that are "off their feed" or develop diarrhea. These signs warrant a call to your veterinarian.

Study 2: *P. acnes* Adams also studied pony foals ages 6 to 7 months under stress from abrupt weaning to determine the effects of *Propionibacterium acnes* on cell-mediated immunity and nasal shedding of respiratory pathogens. *P. acnes* bacteria exist naturally in skin flora and are commercially available as an intravenous immunostimulant.

Foals received *P. acnes* injections or saline (control group) at set time points before, during, and after weaning, at which time researchers also checked vital signs, plasma cortisol concentrations, immune function, and pathogen presence. They also watched for outward signs of disease, such as coughing and nasal discharge.

Adams and her colleagues hoped that *P. acnes* would boost cytokine (immune-cell-produced proteins that facilitate cell communication and orchestrate immune response) production in the foals, which in turn would activate T-cells (lymphocytes responsible for cell-mediated immune response) to amp up their defense during weaning.

They found that weaning, regardless of treatment, affected rectal temperature, nasal discharge, and one test's detection of *Streptococcus equi* subsp. *zooepidemicus*.



ANNE M. EBERHARDT/THE HORSE

Gradually removing mares from a herd until there's none left can help reduce stress, Dr. Jill Mixer says. Another option? Providing the newly weaned foals with a familiar adult companion.

It increased serum cortisol levels and both decreased and increased cytokine production.

"When analyzing the effects of *P. acnes* treatment on these parameters, treatment modulated rises in cortisol after weaning and affected production of IL-1β, which may indicate enhanced innate immunity," says Adams.

"Looking back at both studies, though," she continues, "foals in the *P. acnes* study were a bit older at weaning, almost starting to self-wean, and we didn't see as drastic a decline in immune response as we did in that first study (*PPVO*) when the foals were a little bit younger when weaned. You have to be cautious in how you look at it, because they were two different crops of foals done in two different years, as well, but the results go along with studies that have shown behavioral differences for different weaning ages, and those behavioral differences—the increased vocalization and motor activity and decreased appetite—(negatively) influence the immune response."

In other words, older foals might simply be able to cope with the stresses of weaning better and, thus, remain healthier through the process.

"Of course we'd like to put this theory to the test," she adds, "by conducting a study in which we wean foals during the same year but at different ages to really determine whether or not age impacts changes in immune response during the weaning period."

While these two studies confirmed just how stressful weaning is on the body, the evidence isn't strong enough at this time to recommend either of those treatments.

Other Considerations

Factors that might impact your selection of a weaning method and the subsequent amount of stress your foal experiences include:

- The number of foals you'll be weaning;
- Facilities available (for example, pasture vs. stall);
- How much time you can or want to devote to the process;
- The mare and foal's temperaments;
- The foal's age;
- Feeding changes you've instituted prior to weaning (e.g., creep feeding);
- Whether you prefer an abrupt or a gradual weaning process (e.g., removing one or two dams per day from a group or separating foals from dams for progressively longer periods each day); and
- If you favor lone vs. group weaning, including using unrelated mares or geldings as companions.

Take-Home Message

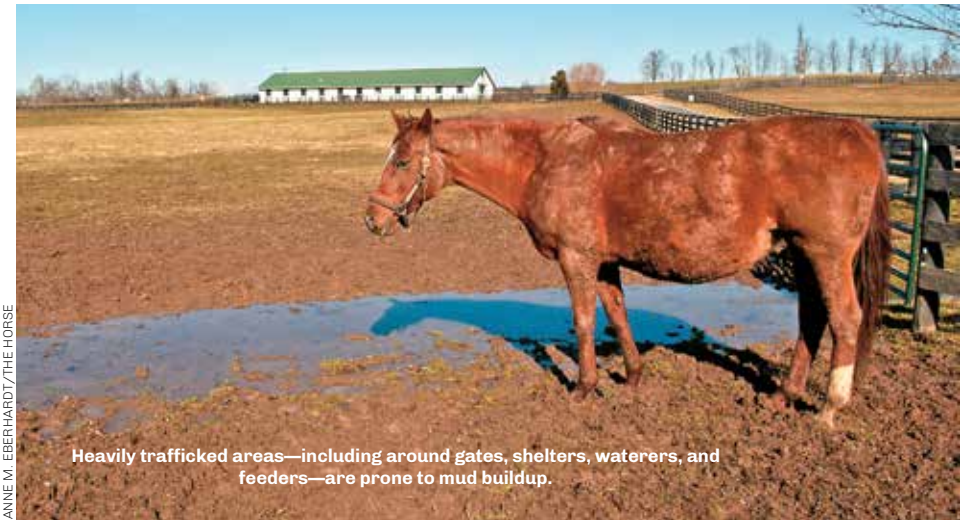
As you consider ways you can help your foal—and his dam—through weaning, examine proven methods based on research findings to formulate a plan. UK

>Diane E. Rice is a freelance writer, editor, proofreader, and photographer.

Mud Management Key to Horse Health, Safety During Wet Weather

Horse owners and caretakers gathered recently at The Red Mile Clubhouse, in Lexington, Kentucky, to learn how to better care for their farms and four-legged charges during wet weather. The Kentucky Equine Networking Association (KENA) session, presented by the Kentucky Horse Council (KHC), featured a panel of experts who addressed mud management on horse farms.

Soggy conditions are nothing new in the Bluegrass: 2018 was one of the wettest years on record, and model projections suggest that wetter-than-average weather will persist in the future. At the KENA meeting, Bob Coleman, PhD, and Krista Lea, MS, both from UK, offered insights into wet-weather care for fields and shelters, while Craig Lesser, DVM, CF, of Rood & Riddle Equine Hospital in Lexington, Kentucky, described possible equine health issues that can arise during wet weather.



ANNE M. EBERHARDT/THE HORSE

Heavily trafficked areas—including around gates, shelters, waterers, and feeders—are prone to mud buildup.

Mitigating Mud

Coleman, UK Extension horse specialist, reviewed ways owners can modify their farms to better handle precipitation. He said water runoff can come from roads or building roofs but also due to the way the land naturally drains. Installing gutters to divert water away from buildings, as well as using swales and culverts, can help eliminate standing water on farms.

Heavily trafficked areas—including around gates, shelters, waterers, and feeders—are prone to mud buildup. Coleman suggested constructing pads in as many of these areas as possible; this involves removing soil and adding geotextile fabric and rock to encourage water to drain away from where horses congregate.

Coleman also shared good news: In some cases, farm owners might be eligible to receive financial help to install these pads, though he noted that some programs have specific requirements. He encouraged owners to see if they're eligible for financial assistance initiatives through County Agriculture Investment Programs, local extension office programs, and other sources.

Pasture Management

"When it comes to managing mud on horse farms, there is no silver bullet, no product or practice that solely eliminates mud, but careful management can minimize the size and severity of the issue," said Lea, a research analyst with the UK Forage Extension Program, about the impact mud has on pastures and fields. "Whether managing grazing or loafing areas, maintaining grasses in a pasture requires occasional rest, good soil fertility, and, when needed, the addition of desirable grasses through proper seeding."

Field rest periods should be a minimum of one week, Lea said, but resting for two to three weeks is ideal. Field soil samples should be taken every two to three years and only the needed nutrients applied, she said. One exception: Nitrogen can be applied twice every fall without a soil test, at 60 to 80 pounds of urea per acre, she said.

Lea cautioned that no amount of fertilizer can make up for poor pasture management. Though area farmers have long planted a mix of tall fescue, Kentucky bluegrass, orchardgrass, white clover, and some ryegrass in September, farm owners can seed ryegrass alone during much of the year to quickly fill in high-traffic areas for short-term cover.

Health and Hoof Issues

Finally, Lesser reviewed hoof conditions horses and owners might face when dealing with an abundance of mud.

These issues included thrush and abscesses, which many attendees said they were familiar with, along with a complication that can develop due to chronic abscesses: septic pedal osteitis (an infection of the coffin bone). Treatment is much more intense than prescribed for "normal" abscesses and can include antibiotics (administered either systemically or via regional limb perfusion), therapeutic shoeing, or even surgery.

An unusual condition that can develop in muddy conditions is quittor—an infection in and around the coffin bone's collateral cartilage. Lesser said this painful condition can require antibiotic treatment as well as possibly surgical debridement and drain placement.

Another common condition is white line disease, which can contribute to lameness, abscesses, coffin bone rotation, and/or hoof capsule sloughing, none of which should be taken lightly, he said. Supportive shoeing can help in some cases, but more severe cases might require debridement.

Though each condition he reviewed benefits from keeping the horse's legs and feet clean and dry, Lesser conceded that this isn't always possible, especially when horses live outside. He said diligent daily care allows horse owners and caretakers to identify and address hoof issues when they first develop; this often means the condition will require less-invasive treatment to resolve.

Next Up

The next KENA meeting will take place Aug. 20 at the Red Mile Clubhouse. Educational series sponsors include Dinsmore Equine Law Group, Neogen Corporation, Rood & Riddle Equine Hospital, University of Louisville Equine Industry Program, McBrayer Law Firm, and Red Mile. UK

>Edited KHC press release.

Mow Horse Pastures to Reduce Ergot Poisoning Risk

The UK Horse Pasture Evaluation program has observed ergot bodies in headed-out tall fescue pastures in the last two weeks on several Central Kentucky horse farms. *Claviceps* fungal spores are found in soil in much of the U.S. and infect the seeds of many grasses, particularly during wet spring months. This infection results in sclerotia (also called ergot bodies) growth instead of a healthy seed.

JIMMY HENNING/UNIVERSITY OF KENTUCKY

Ergot bodies can infect the seedheads of many grasses, including tall fescue and ryegrass.

The sclerotia, which look like mouse droppings, contain concentrated levels of many ergot alkaloids. A number of these alkaloids are similar to the major toxin found in endophyte-infected tall fescue and can cause clinical signs similar to those seen in mares with fescue toxicosis.

To reduce the risk of ergot poisoning, keep pastures clipped to remove seedheads. Check hay and bedding for presence of ergot bodies. Because of the raking and baling process, ergot bodies in hay or bedding are rare, but can occur. UK

>Cynthia Gaskill, DVM, PhD, Dipl. ABVT, veterinary clinical toxicologist at UK's Veterinary Diagnostic Laboratory; Ray Smith, PhD, forage extension specialist within UK's Department of Plant and Soil Sciences; and Krista Lea, MS, research analyst and coordinator of UK's Horse Pasture Evaluation Program, provided this information.

Buttercups in Horse Pastures

The UK Horse Pasture Evaluation Program has had several calls regarding the safety of yellow buttercup in horse pastures. As such, Megan Romano, PhD, veterinary toxicology resident, described the plant's potential risks to horses.

According to the current U.S. Department of Agriculture PLANTS database, Kentucky is home to nearly 30 species of *Ranunculus*, or buttercups. *Ranunculus* leaves, flowers, and stems have a sharp, pungent taste, and livestock generally avoid grazing them.

Some *Ranunculus* species contain ranunculin, a compound hydrolyzed to protoanemonin when the plants and cells are damaged (for example, when they're chewed). Protoanemonin is a vesicant (an agent that causes skin, mouth, and digestive system blistering). Those *Ranunculus* species with the highest ranunculin concentrations are the most toxic.

Plant cell damage also occurs when buttercups are cut and dried in hay. Ranunculin hydrolysis (when a compound breaks down chemically due to reaction with water) to protoanemonin likely occurs as the plants dry. Protoanemonin then forms anemonin, another bioactive compound which is not a vesicant. Dried *Ranunculus* plants, therefore, are expected to lose toxic potential fairly rapidly, although scientists haven't studied and published research to specifically confirm this.

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Buttercups can cause mouth pain and blisters, drooling, oral and gastric ulcers, colic, and diarrhea in horses, but their acrid taste usually deters grazing.

Buttercups can cause mouth pain and

blisters, drooling, oral and gastric ulcers, colic, and diarrhea. Horses are one of the most sensitive species to *Ranunculus*' gastrointestinal effects. These effects can be severe if horses ingest buttercups in large quantities, but their acrid taste usually deters further grazing. Clinical signs are typically seen only in animals forced to consume buttercups when they have nothing else to eat.

A few anecdotal reports have suggested an association between the presence of *Ranunculus* species in pastures and abortions in cattle and horses; these reports are unconfirmed, however, and attempts to reproduce the disease have been unsuccessful. Bur buttercup (*Ceratocephalus testiculatus*) can cause significant illness, but this plant occurs primarily in the Western U.S. and is not a true buttercup, as it belongs to a different genus.

All in all, the risk posed by *Ranunculus* species in Kentucky appears minimal if there are plenty of other forages present; animals avoid grazing the unpalatable fresh plants, and the dried plants appear to be much less toxic.

A review of UK Veterinary Diagnostic Laboratory records over the last 13 years revealed no cases of livestock deaths attributable to *Ranunculus*. It is possible, however, that cases of colic or diarrhea were unknowingly caused by *Ranunculus* ingestion but never attributed to the plant.

Preventing Toxicosis

Buttercup toxicosis poses the greatest risk to starving animals with nothing else to eat; this can be easily prevented by providing animals with adequate forage. Because animals avoid grazing *Ranunculus*, it proliferates in overgrazed pastures. Overgrazing can be prevented by maintaining appropriate stocking rates.

Ray Smith, PhD, UK forage extension specialist, said it's too late this year to spray to kill yellow buttercup. But maintaining good grass cover prevents many weeds, including buttercup, from germinating in fall or winter. Resting pastures and not overgrazing are key to improving pasture health.

Thin stands with bare patches or areas with summer annual grasses, like crabgrass, can be overseeded with a pasture mix in September. Be sure to soil test every two to three years and apply amendments based on soil test recommendations. In most horse pastures, nitrogen is most beneficial in the fall to improve root density and thicken stands.

Additional information on buttercup in pastures and control methods can be found in an article published in *Forage News* in January 2018; access *Buttercups in Grazed Pastures* at kyforagenews.com/2018/01/31/buttercups-in-grazed-pastures/. UK

>Megan Romano, PhD, veterinary toxicology resident at UK's Veterinary Diagnostic Laboratory; Ray Smith, PhD, forage extension specialist within UK's Department of Plant and Soil Sciences; and Krista Lea, MS, research analyst and coordinator of UK's Horse Pasture Evaluation Program, provided this information.