UC DAVIS SCHOOL OF VETERINARY MEDICINE • CENTER FOR EQUINE HEALTH

HorseReport

SPRING 2024

Equine Ophthalmology

THANK YOU TO OUR CONTRIBUTOR

Dr. Lauren Charnock is an Assistant Professor in the Department of Surgical and Radiological Sciences and a board-certified veterinary ophthalmologist at the UC Davis veterinary hospital. She completed her DVM at the Western College of Veterinary Medicine, University of Saskatchewan, a rotating internship at the Atlantic Veterinary College, University of Prince Edward Island, and a residency in comparative ophthalmology with a Master of Science at Auburn University.

DIRECTOR'S LETTER

Like most equestrians, all of us at CEH have been eagerly anticipating a return to drier, warmer weather, and longer daylight hours. The center has been busy with teaching labs, student activities, outreach events, and research projects.

We are excited to bring you the spring 2024 issue of the Horse Report, all about equine ophthalmology. The topic has been on our list for a while, and we could not have asked for more enthusiastic collaborators than the faculty and residents of the UC Davis Ophthalmology service, in particular Dr. Lauren Charnock, to bring you the latest on equine eye health. We work closely with the Ophthalmology Service to care for client horses in our layup program, as well as our CEH Teaching Herd horses. Dr. Charnock and her colleagues are wonderful partners and we are grateful to them for their dedication and expertise.

In this issue, we give you a glimpse into the Ophthalmology Service and introduce you to a special case that demonstrates the exceptional level of care available to horses at UC Davis. We have also featured a discussion about how our understanding of equine vision affects our horses' performance, insights into equine recurrent uveitis (ERU) and heterochromic iridocyclitis with secondary keratitis (HIK), and more.

This is a dense and often complicated topic, but it is important to think about how our horses see the world, both on a day-to-day basis and when problems arise. We hope this issue brings some perspective the next time you are heading down the centerline, making a short turn to an oxer, crossing a bridge, or even loading your horse in a trailer.

Best wishes,

Carrie J. Finno, DVM, Ph.D., Diplomate ACVIM
CEH Director

EQUINE OPHTHALMOLOGY AT UC DAVIS

The Equine Ophthalmology Service at the UC Davis veterinary hospital provides advanced diagnostics and routine, complex, and emergency medical and surgical care to horses with various ocular disorders. With expertise in treating corneal ulcers, corneal and eyelid cancer, equine recurrent uveitis (ERU), cataracts, glaucoma, and more, the Ophthalmology Service regularly receives equine patients as referrals from veterinarians and veterinary ophthalmologists, as well as direct owner-booked appointments.

The Center for Equine Health (CEH) works closely with the Ophthalmology Service to care for client-owned horses through our layup program, as well as our own CEH Teaching Herd Horses. The center supported the acquisition of a new A.R.C FOX 810nm diode laser for use in the Equine Ophthalmology Service to expand treatment options for cancer on and around the eye and various ulcerative and non-ulcerative corneal diseases with photodynamic therapy (PDT).

Specialized tests and diagnostics include:

- Slit lamp biomicroscopy
- Tonometry (measurement of intraocular pressure)
- Corneal cytology and culture
- Electroretinogram (ERG - a specialized test of retinal function)
- High-frequency ultrasound
- Optical coherence tomography (OCT) imaging for the cornea and retina (see box above)
- Computed tomography (CT)
- Magnetic resonance imaging (MRI)

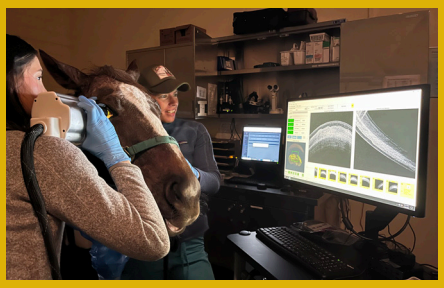
Surgical and microsurgical procedures include:

- Corneal grafting procedures for deep corneal ulcers
- Surgery and photodynamic therapy, cryotherapy, or radiation therapy for tumors of the eye and eyelids
- Photodynamic therapy for corneal diseases such as immune-mediated keratitis (IMMK)
- Suprachoroidal cyclosporine implants for ERU
- Cataract surgery

The faculty, residents, and technicians offer a team approach to each patient's care and provide 24/7 emergency coverage for equine patients. To schedule an appointment with the Equine Ophthalmology Service, contact the UC Davis veterinary hospital's Large Animal Clinic at (530) 752-0290.

Equipment to conduct OCT imaging

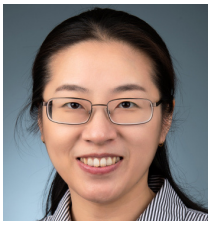
is new to the Ophthalmology Service since fall of 2023. The technique uses light waves to capture cross-section images of the cornea and retina at nearly microscopic levels. This non-invasive approach can assess deep ulcers in the eye, informing diagnostic decisions and enabling ophthalmologists to track healing. UC Davis is one of the only equine services in the country that offers this technology.



Dr. Mills using OCT imaging to examine a case of non-ulcerative keratitis in CEH Teaching Herd Horse Dusty.

Kathryn Good, DVM, DACVO, Professor - Chief of Service

Lauren Charnock, DVM, MS, DACVO, Assistant Professor



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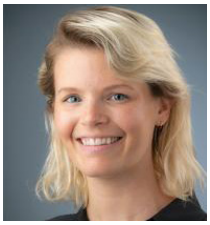

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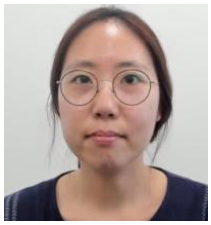


Sangwan Park, DVM, Resident II

Karolina Roszak, DVM, Resident II

Brett Story, DVM, Resident III

COMPLEX SURGERY

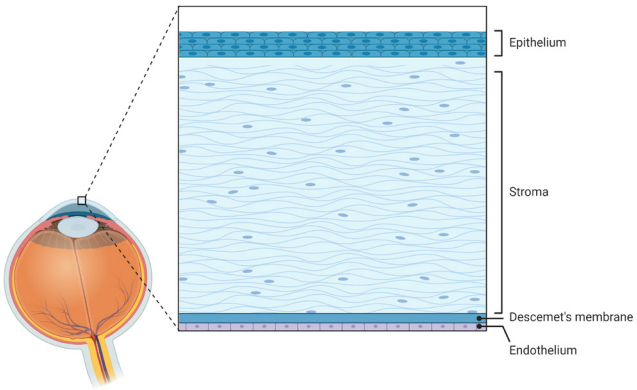
Saves Horse's Eye after Fungal Infection

Cassie with Drs. Kim (L) and Adelman (R).

Cassie, a 17-year-old Oldenburg mare, was referred to the UC Davis veterinary hospital's Ophthalmology Service for a stromal abscess in the left eye. Stromal abscesses can result in significant inflammation and pain and often require complex (and expensive) surgery to prevent blindness or the need to surgically remove the eye. Thanks to the combined expertise of the Ophthalmology, Equine Internal Medicine, and Anesthesiology Services, Cassie was able to undergo specialized surgery that resolved the issue and preserved her vision.

The corneal stroma, the thickest layer of the cornea (the clear part at the front of the eye), is essential for vision. A stromal abscess can occur when bacteria or fungi penetrate through an injury to the outer layer of the cornea (the epithelium). As the body tries to heal the wound, it can trap bacteria or fungi in the deeper layers, causing inflammation of the cornea, as well as inside the eye. The abscess often appears as a white or yellow-colored focal cloudiness in the cornea.

Corneal Anatomy



Layers of the cornea showing the location of the stroma, the thickest layer. Created with BioRender.com.

In Cassie's case, the infection was due to a fungus that is common in California and spreads easily, particularly on windy days. Although they can advance quickly and result in serious problems in just a few weeks, fungal infections in the eye take a long time to treat. The fungus likes to grow deep into the cornea, where it is hard to treat effectively with eye drops. In some cases, the affected eye has to be removed because the fungus is so aggressive, and treatment cannot control it. For cases that respond to medical treatment, the total treatment time can be weeks to months.

The corneal stromal abscess in Cassie's left eye showed a characteristic cloudy appearance.

A subpalpebral lavage (SPL) catheter was placed to make it easy to deliver medications after surgery.

When Cassie came to UC Davis, she was suffering from severe inflammation in her eye due to the infection. Instead of medical management, the team opted for surgery, performing a deep lamellar endothelial keratoplasty (DLEK) to remove the infection and stabilize the cornea so it could heal. The success of this complex surgery required significant team effort.

"The surgery can save the eye, and, when successful, the treatment time is greatly reduced compared to medical treatment," said Dr. Soohyun Kim, an assistant professor of ophthalmology who was involved with the case.

The procedure includes dissecting up the front half of the cornea (that is healthy), removing the deep area of the cornea that contains the fungus and replacing it with a "button" of equine donor corneal tissue, and then suturing the front half of the cornea back down into place.

"This procedure is a big undertaking," said ophthalmology resident Dr. Sara Adelman, who was part of the surgical team. "Time was of the essence."

Cassie's left eye two months after surgery. It is normal for corneal edema (blue color) to persist for up to a few months after surgery.

After the surgery, a subpalpebral lavage (SPL) catheter was placed in Cassie's lower eyelid to facilitate treatment with ophthalmic solutions. She stayed at the layup facility at the Center for Equine Health, where the Ophthalmology Service closely monitored her recovery over the following weeks.

The process of corneal remodeling generally continues for weeks to months. Cassie will have a small circle of scar tissue in her cornea, but it should not significantly affect her vision. The team credits the swift action of the client and the referring veterinarian with giving the treatment the best chance of success.

Cassie has recovered and is back at home with her owner.

Equine VISION AND PERFORMANCE

It can be frustrating when your horse spooks at something outside of the arena while you are going to the right, and then again to the left as if he's never seen it before. Your horse is not trying to be difficult; he just sees things differently than you do. Whether heading to a jump, negotiating a turn to a barrel, or navigating the trail, aiming to understand how horses see the world can benefit their performance and welfare.

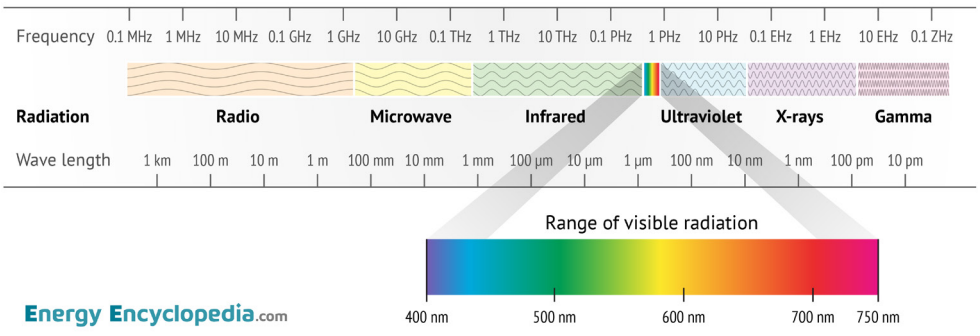
Mammals can typically only detect a tiny portion of the electromagnetic spectrum - between approximately 400 and 750 nanometers.

Horses' large eyes are set wide apart on the sides of their heads, providing them with both monocular (each eye works independently and has different views) and binocular (both eyes overlap) vision. This enables them to see almost a full circle around themselves, minus blind spots directly in front of and behind them. With comparatively small eyes on the front of our heads, humans can see the world in a lot of detail, but only in small slices (about 45 degrees on each side of the nose). Horses have a much broader view (about 350 degrees), but likely in less detail. They generally have to be 50% closer to something to see it in the same level of detail.

Since horses cannot explain what or how they see, vision assessment is subjective and largely extrapolated from human ophthalmology. Three aspects of vision that are important to horse performance are light, color, and depth perception.

Light

The most basic aspect of vision is the ability to perceive light. Mammals can typically only detect a tiny portion of the electromagnetic spectrum - between approximately 400 and 750 nanometers. Even within this spectrum, not all photons are detected equally well, with significant variation from one individual to another.

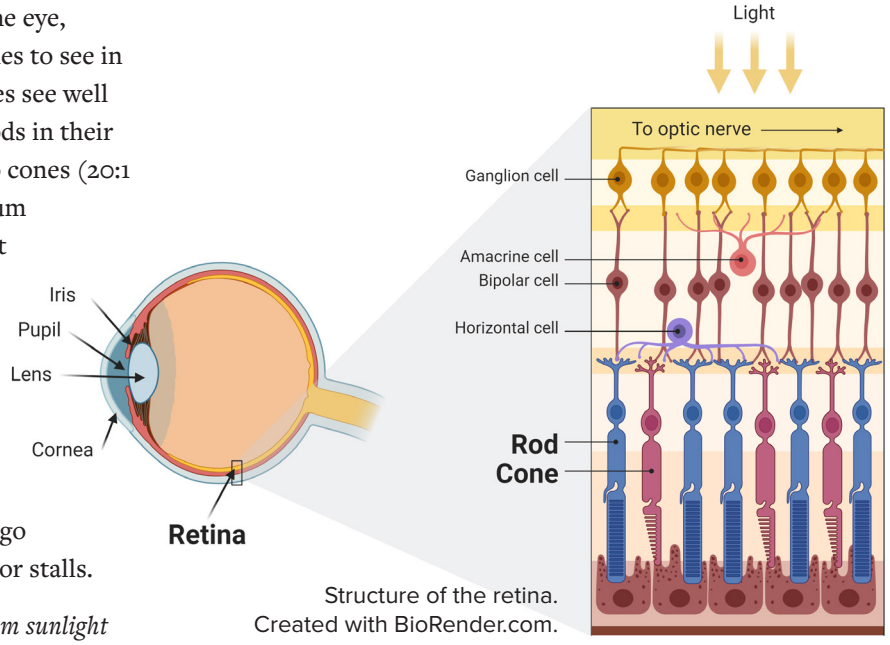


Electromagnetic spectrum of radiation. Some birds can see in the ultraviolet range and some snakes can use infrared imaging to find prey, but most mammals can only see the wavelengths between approximately 400 nanometers (nm) and 750nm. Credit: EnergyEncyclopedia.com

The retina, a multi-layered tissue in the back of the eye, contains specific cells called photoreceptors - cones to see in bright light and rods for vision in dim light. Horses see well in dim light, and at night, since they have more rods in their eyes than humans, a greater proportion of rods to cones (20:1 in horses versus 9:1 in humans), and have a tapetum lucidum, a structure in the eye that increases light to photoreceptors.

However, horses may have difficulty transitioning quickly between brightly lit and dark locations. It takes their eyes about twice as long (approximately 45 minutes) to adjust than it takes ours (about 20 minutes). This can explain resistance to crossing visual barriers that go from light to dark, such as when entering trailers or stalls.

Think about this the next time you take your horse from sunlight into an indoor arena. Consider walking in the shade or standing at the in-gate for a while before entering to ease the transition.



Structure of the retina.
Created with BioRender.com.

Color

Horses can perceive color, but not in the same way that we do. The ability to perceive color is based on cone pigments. Horses, like other non-primate mammals, have two types of cone pigments (dichromatic), whereas humans have three (trichromatic). Horses likely see hues similar to what we see as blue and yellow, but they cannot see red or shades of red. Behavioral studies have demonstrated that horses can distinguish blue and yellow from gray, whereas they are less accurate when it comes to differentiating green and red from gray. Practically, we can think of horses as having a form of red-green color-blindness. The color that horses likely see best is yellow.

Think about this the next time you ride in an arena with colored banners hanging on the rail. Your horse may be most likely to spook at the yellow one and ignore the red one (unless it is flapping).

Depth Perception

Depth perception relies on binocular vision. Whereas a horse's monocular field of vision is very wide, the binocular field of vision is much smaller. Horses have a smaller field of depth perception than people do, meaning that they have a harder time determining relative distances. Humans have better depth perception because our eyes are close together. Since horses' eyes are set far apart, in most instances they cannot see both the right and left eye views in one glance. They can improve their depth perception by raising their heads.

Think about this the next time you ask your horse to jump an obstacle. Allowing some freedom in movement of the head may improve their view.

Vision and Behavior

As with many other aspects of horse management, we often do not think in depth about our horses' vision until there is a problem. A veterinarian may be called to examine a horse with new behavioral issues, such as excessive shying or head shaking, and find an ocular issue. Eye exams are an important part of routine veterinary care.

Horses see colors, but not the same way that we do.

Meeting in the Middle: TWO FORMS OF EQUINE UVEITIS

Diseases of the middle layer of the eye, the uvea, are among the most common ocular conditions in horses. Depending on the disease severity and duration, vision can be significantly compromised. For this reason, regular eye examinations are an essential part of routine care.

Inflammation of the uvea (iris, ciliary body, and choroid) is known as uveitis. It can occur once, such as with trauma or infection, and never again. Other forms are caused by an immune-mediated response to a systemic infection, autoimmune disease, or other triggers and may be chronic or recurring.

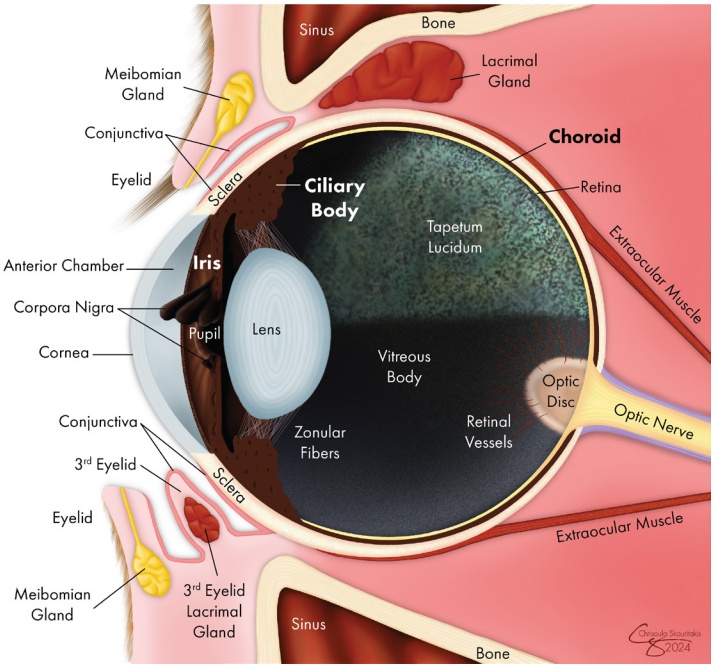
The most common form of uveitis in horses is equine recurrent uveitis (ERU). Recently, another form has been documented, heterochromic iridocyclitis with secondary keratitis (HIK).

Equine recurrent uveitis

Equine recurrent uveitis (ERU), or moon blindness, is the most common cause of blindness in horses worldwide. It affects 2 - 25% of horses globally, with 56% becoming blind. There is no cure for ERU.

During an episode, horses may be painful and exhibit clouding of the cornea, tearing, squinting, and redness, which can increase in severity with repeated occurrences. A subclinical form, insidious uveitis, consists of a constant, low level of inflammation that causes cumulative damage to the eye, but is not outwardly painful. The absence of outward signs can cause severe vision damage before an issue is recognized. Cumulative damage caused by ERU can lead to cataracts, glaucoma, and blindness.

Infectious organisms, particularly *Leptospira*, can trigger ERU, but genetic risk factors are also important. Appaloosas, draft breeds, and warmbloods are predisposed to ERU,



Cross section illustration of the equine eye. The uveal structure labels are bolded. Illustration by Chrisoula Toupadakis Skouritakis, PhD.

but it can affect horses of any breed. Appaloosas are eight times more likely to develop ERU than other breeds and significantly more likely to become blind in one or both eyes. Researchers at the UC Davis Veterinary Genetics Laboratory were involved in the identification of LP, the allele causing the white leopard complex spotting pattern, as an ERU risk factor in the breed, with homozygotes (LP/LP) being at highest risk. Research into genetic factors that influence ERU risks in other breeds is ongoing.

Treatment for ERU focuses on eliminating or reducing inflammation in the eye(s), preserving vision, alleviating pain, and minimizing recurrence. Topical corticosteroids and non-steroidal anti-inflammatory drugs can reduce inflammation and minimize damage during an active episode, but are not necessarily effective at preventing recurrence.

Severe or frequent flare-ups may require injections of medications directly into the eye(s) and/or the surgical placement of a cyclosporine implant, a sustained-release device that provides therapeutic dosages of cyclosporine for up to three years to control inflammation and minimize recurrences. Surgery to remove the eye (enucleation) is often recommended for ERU-affected eyes that are painful or have become blind (see box).

Heterochromic iridocyclitis with secondary keratitis

Uveitis is also one of the hallmarks of a more recently identified progressive ocular disease, heterochromic iridocyclitis with secondary keratitis (HIK). Like ERU, HIK is likely immune-mediated. Cases have been reported in a variety of breeds.

Affected animals can exhibit cloudy corneas and excessive tearing and blinking, similar to ERU. In fact, horses with HIK were often previously diagnosed with ERU. Distinct characteristics of HIK include pigmented cellular deposits on the inside of the cornea, thickening of parts of the cornea due to fluid accumulation, and the appearance of fibrous membranes behind the cornea. Clinical signs of HIK are progressive, but not episodic, as observed with classic ERU. As a result, the causes and processes of disease development are thought to be distinct for these conditions.

Like ERU, treatment for HIK consists of medication injections, cyclosporine implants and/or topical medications. Outcomes are variable and affected horses need frequent follow-up examinations and aggressive local immune suppression for disease control. There is no cure for HIK and cases that do not respond to therapy require enucleation to ensure long-term comfort.

Enucleation

Despite the most advanced treatments, some horses require removal of one or both eyes (enucleation) for humane and medical reasons. It is important to acknowledge that ocular pain usually does not stop when vision is lost. For this reason, vision-impaired horses often show significant improvements in comfort after enucleation, which can also result in positive changes in temperament.

Enucleation is a common procedure, and the surgery is often performed in horses with standing sedation, as opposed to general anesthesia. This reduces costs, avoids anesthesia-associated complications, and is safer for older horses and those with certain medical conditions.

Environmental and management modifications may be required, and it is important to allow horses time to adjust after the surgery. Many partially, and even fully, blind horses adapt well, with many returning to a similar level of performance. Success ultimately involves many factors, with the horse's temperament being one of the most significant variables.

CEH Teaching Herd member Bubbles had her left eye removed due to complications from congenital cataract. She lives a happy, healthy life at CEH and does a fantastic job teaching our veterinary students about handling vision-impaired horses.

10 THINGS
You Might Not Know About Equine Ophthalmology

Interpretation of equine vision is complicated and highly subjective. Understanding how your horse sees the world, and being able to identify when vision is compromised, will enable you to work with your veterinarian to manage the health of your horse's eyes. We collaborated with the UC Davis Ophthalmology Service to draw attention to some things you might not know about equine ophthalmology.

1 An equine eye issue is often urgent. When it comes to your horse's eyes, it is best not to take any chances. If you notice an eye problem, contact your veterinarian right away. Do not administer any medications without talking to your veterinarian. Using the wrong medication can result in serious complications.

2 Horse eyes are among the largest of all land mammals. Only whales, seals, and ostriches have larger eyes. Horses' large eyes, with large corneas, allow a significant amount of light to enter. Their pupils can dilate to an area three times larger than a cat or dog and six times that of a human. Since horses are prey animals, their large eyes enable them to detect even slight motion, including that plastic bag blowing outside of the arena!

3 Horses have both monocular and binocular vision. Horses' eyes are located on the sides of their heads, providing them with extensive monocular vision that allows for a panoramic view of up to 350 degrees - almost a complete circle. Horses raise their heads to enable binocular vision with both eyes ahead of them, with a visual field of 55-80 degrees.

Horses raise their heads for binocular vision.

4 Horses have small blind spots in their field of vision. These are about the width of the horse's body and include areas above and perpendicular to the forehead, directly below the nose, and directly behind the horse. This is important to remember when working around horses on the ground, as well as when riding.

5 Horses have better vision in low light conditions than humans, but not quite as good as cats. Horses have a reflective tapetum lucidum, a structure that lies behind the retina and increases the light available to photoreceptors, enabling them to see in dim light. It has a slightly different structure from the tapetum of carnivores, like cats, which are highly reflective. Human eyes lack a tapetum altogether. Studies have shown that horses can readily discriminate between different shapes and successfully navigate in a room with such low light levels that humans could not see at all!

6 The menace response is learned; foals develop it at one to two weeks of age.

The menace response is a protective blink reflex, sometimes accompanied by movement of the head and/or neck, to avoid a threat. It is assessed by moving an object towards the horse's eye. It is important, however, to avoid touching the eyelashes or creating a significant current of air, which could interfere with the results. A decreased menace response, or lack of a response, can indicate an issue with vision anywhere from the eye all the way to the cerebral cortex of the brain.

Foals develop a menace response around two weeks of age.

7 Pioneer 100 Horse Health Project horses underwent ophthalmologic examinations and electroretinograms (ERGs).

The "Pioneer 100 Horse Health Project", a first-of-its-kind precision medicine study in horses, included evaluations by the UC Davis Ophthalmology Service. Results from these examinations showed lipofuscin deposits in some horses, which are associated with aging in horses affected with equine motor neuron disease (EMND).

8 Horses' prominent eyes are prone to injury from foreign bodies and corneal ulcers.

In many cases, foreign bodies occur in the form of plant matter, such as a piece of hay, cactus spine, or seed awn. Foreign bodies in the eyes can cause corneal ulcers (ulcerative keratitis), lacerations, and infections, which can result in serious trauma and loss of vision.

9 Bacteria and fungi can cause eye infections.

Both thrive in the environment and can enter horses' eyes through cuts and scratches (even small ones). Infections can occur on the surface or deeper into the eye. Fungal infections often cause painful ulcers and abscesses that can result in vision loss if not properly treated. The specific type of fungus involved, which is influenced by geographic location and environmental factors, can affect disease severity, but ALL fungal eye infections are serious.

10 Many equine ophthalmological procedures can be performed on standing, sedated horses.

This reduces the need for many horses to undergo general anesthesia, opening up procedures such as cyclosporine implants, enucleations, and corneal-conjunctival grafts to horses that otherwise are at risk of complications from general anesthesia. It also reduces costs. The UC Davis Ophthalmology Service works closely with the UC Davis Anesthesia Service to offer these procedures for eligible patients.

Horses' prominent eyes are prone to injury and infection.

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TREATING CORNEAL ULCERS

The cornea, the clear tissue at the front of the eye, provides a window for the horse to see through and focuses light on the retina, making it essential for proper vision. Wounds in the cornea, or corneal ulcers, are common in horses. They have several potential causes, including injury, infection, and autoimmune disease. If not treated quickly with the correct therapy, they can affect vision permanently and even result in the loss of the eye.

The good news is that the cornea has significant capacity to heal. With appropriate treatment, small, superficial corneal ulcers often resolve within one to two weeks. Ulcers that are deeper in the cornea or otherwise more complicated may require much longer treatment, and could require surgery. The appropriate therapy depends on the cause of the ulcer, along with any secondary factors.

Medical therapy

Medical treatment may consist of various drugs and topical therapies. When multiple treatments are required several times a day, a subpalpebral lavage (SPL) may be placed to make it easier to administer medications. A SPL is a small catheter placed through the eyelid that allows delivery of medication to the surface of the eye through long tubing braided into the mane. A port at the end of the tubing, near the base of the neck, allows medication to be administered far away from the eye. Horses typically tolerate this system much better than applications directly into the eye. At UC Davis, the use of SPLs has facilitated the successful treatment of complicated cases that would have been nearly impossible to treat otherwise.

Surgery

Surgery for corneal ulcers may be required to remove unhealthy tissue from the eye and provide structural support to the cornea (which is less than 1mm thick in a horse). Surgical grafts utilizing natural or synthetic/biosynthetic tissues may be used to increase the blood supply to the area and promote healing. Procedures for corneal transplantation are still evolving, but to date have largely been successful for preserving vision.