Laminitis

BY NANCY S. LOVING, DVM; CHRISTY WEST

Are Drugs Effective Treatment for Horses with Acute Laminitis?

Bill Moyer, DVM, professor of sports medicine and head of the Department of Large Animal Clinical Sciences at the Texas A&M College of Veterinary Medicine and Biomedical Sciences, presented a variety of considerations on the state of medical treatment for laminitis. He stressed that once clinical signs are evident, damage has already been done: Pain and lameness are preceded by vascular and structural damage within the hoof laminae (lamellae).

So, he posed the question to the audience, "Is any specific medical treatment for acute laminitis efficacious in altering the outcome after a horse has developed clinical signs?"

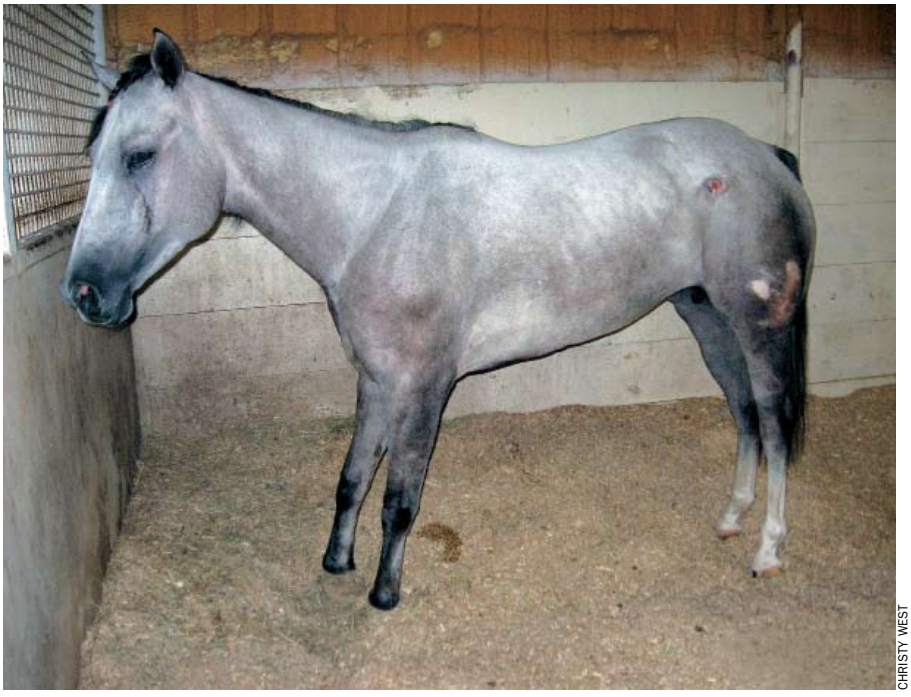
The current consensus on effective therapy revolves around addressing and resolving the initiating cause(s) of laminitis. Other strategies attempt to alter blood flow in the foot, decrease inflammation, and avert endotoxemia. Moyer addressed these in his talk.

He explained that evidence is lacking about blood flow-altering agents having any effect on increasing laminar circulation. While use of digital nerve blocks might improve blood flow by inhibiting constriction of blood vessels, numbing the pain stops the horse from protecting his feet. Increased weight bearing exacerbates laminitis.

Acepromazine increases digital blood flow by direct action on vascular smooth muscle, but studies have not shown improvement in lamellar blood flow.

Isoxsuprene has vasodilating properties, while pentoxyfylline requires weeks of administration to decrease blood viscosity. It does this by acting on platelets to increase red blood cell flexibility. Both these medications are absorbed poorly when administered orally.

Nitroglycerin placed over digital blood vessels might increase blood flow, but it has not been shown to increase lamellar blood flow after the onset of clinical signs. Coupling this ineffectiveness with potential risks to the person handling the drug makes nitroglycerin a poor therapeutic choice.



CHRISTY WEST

A variety of drugs have been used to treat acute and chronic cases of laminitis, but there are many complications to the disease and from the available treatments.

Heparin removes red blood cells from the system to decrease blood viscosity and thereby improve blood flow, but researchers have not examined its use in acute cases.

Inflammation is not always a component of laminitis, but when it is, non-steroidal anti-inflammatory drugs (NSAIDs) have been used. Moyer said there is humane justification for judicious use of NSAIDs, but one should be aware of downsides. Pain relief might increase mobility that exacerbates tearing of the lamellae.

Phenylbutazone (Bute) might reduce inflammation and pain, and it is affordable, but it does not prevent laminitis if given during the developmental stage and has not been shown to alter the course of acute cases.

Flunixin meglumine (Banamine) provides both anti-inflammatory and anti-endotoxin effects. However, if flunixin and phenylbutazone are given together, there is an increased risk of loss of serum protein, gastric ulcer disease, and/or colitis.

There is anecdotal support for use of dimethyl sulfoxide (DMSO) for its anti-inflammatory properties and ability to scavenge oxygen-derived free radicals, which form during hypoxia (deprivation of an adequate supply of oxygen) and reperfusion (restoration of blood flow to tissues following an incident or hypoxia). Damage can occur when blood flow is restored to tissues following an incident of reduced blood and oxygen supply. However, Moyer noted there is no evidence of hypoxia or reperfusion in this disease.

Anti-endotoxin drugs (flunixin meglumine, ketoprofen, and polymyxin B) might be warranted as there is an association between endotoxemia and the development of laminitis. Endotoxin causes insulin resistance with decreased use of glucose by the lamellar tissue. While they might not necessarily be effective in treatment of laminitis, anti-endotoxic drugs might be life-saving.

Moyer said caretakers and veterinarians should address environment and ground surface, housing, causes of obesity, and management of the foot itself. He recom-

mends explaining to clients that the pathogenic mechanisms of laminitis are not well-understood and that a horse's clinical appearance might correlate with the outcome, but it is not always an accurate predictor due to potential for complications.

In general, controlled studies do not exist regarding the efficacy of various treatments for laminitis, and some therapies have additional risks beyond their failure to improve the situation.

Causes of Laminitis

Nicholas Frank, DVM, PhD, Dipl. ACVIM, associate professor in the Department of Large Animal Clinical Sciences at the University of Tennessee's College of Veterinary Medicine, presented a thorough review of precipitating causes of laminitis. Obesity is a primary predisposing factor, with some horses and breeds having a genetic susceptibility. Individuals might have efficient energy metabolism and/or nutrient digestion or absorption, or they might have an insatiable appetite. Diet and management practices that lead to obesity include overfeeding (particularly grain), lack of exercise, and varied perceptions of what is considered "good" body condition. In the wild horses would have scarcer forage supply during the winter, so weight would fluctuate with season; in domestic life horses are often fed more in the winter, thereby eliminating seasonal weight loss.

Equine metabolic syndrome describes a syndrome of obesity with regional fat deposits in the neck, prepuce or udder, rump, and subcutaneous tissues. There can be a genetic and/or breed predisposition coupled with insulin resistance (IR) and high risk for laminitis. Bouts of laminitis are not always apparent other than visible divergent growth rings of the hoof or radiographic evidence of coffin bone rotation.

Part of the equine metabolic syndrome picture includes insulin resistance, which describes reduced response to insulin to take up glucose in the tissues (skeletal muscle, fat, and liver). Frank explained that the body's capacity to store fat is finite; then fatty acids are mobilized for fat storage in other tissues where it isn't as well-tolerated. There it disrupts actions of insulin, particularly in skeletal muscle and liver. It is thought that certain fat deposits, like a cresty neck, are metabolically active, with fat cells secreting chemical mediators that increase insulin resistance. Equine Cushing's disease might also be accompanied by insulin resistance.

Studies have shown that IR raises the risk of pasture-associated laminitis in ponies. Insulin slowly dilates blood vessels, so an insulin-resistant horse might experience vessel constriction. This phenomenon might connect insulin resistance with laminitis due to changes in vascular tone in vessels in the feet; then a horse has less ability to adapt when experiencing a triggering event. One such trigger might be alterations in the composition of pasture grass coupled with lowered threshold due to insulin resistance. Frank again stressed that obesity is a harmful state for the horse.

Progression of obesity and insulin resistance exacerbates laminitis risk. As a horse gets fatter, insulin sensitivity decreases. Insulin resistance worsens with chronic obesity, making a horse more susceptible to laminitis and less tolerant of triggering events. The longer a horse is obese, the more other tissues are affected.

Dietary changes amplify susceptibility to laminitis as a horse consumes seasonal increases in sugars and starches on pasture—a horse's threshold is lowered when pasture grass challenges are the greatest. In horses older than 15 to 20 years of age, equine Cushing's disease poses an additional risk since high levels of circulating cortisol (associated with equine Cushing's disease) antagonize actions of insulin. For middle-aged and geriatric horses, it is important to control this disorder.

Laminitis triggers include exacerbation of an insulin resistance crisis due to increased starch and sugar in green grass or other stresses, such as diet and grain supplements, change in pasture, stress of transport, management or weather, disease, hospitalization, and/or surgery. The crisis might be related to seasonal hormonal changes. Another trigger develops in the intestine, particularly when a horse is turned out on new pasture with a sudden increase in starches, sugars, and fructans that creates a carbohydrate overload in the large intestine. This alters bacterial flora, lowers the pH, increases intestinal permeability, and results in endotoxemia, which increases multiorgan inflammation, increases vascular constriction, and induces IR.

Frank recommended the following preventive strategies for avoiding these laminitis scenarios:

- Manage and treat obesity and insulin resistance;
- Treat equine Cushing's disease and monitor regularly;
- Provide consistent farrier care;
- Regulate starch, sugar, and calorie intake;
- Avoid sudden feed changes;
- Gradually introduce a horse to new pasture; and
- Treat endotoxemia and systemic inflammation.

Managing Acute/Chronic Laminitis

With a packed room of veterinarians facilitators Jim Belknap, DVM, MS, Dipl. ACVS, PhD, an associate professor in the Department of Veterinary Clinical Sciences at The Ohio State University, and Rob Boswell, DVM, of Palm Beach Equine Clinic in Wellington, Fla., opened discussion about preventing and treating laminitis. Belknap remarked on the latest research showing that laminitis is an intense inflammatory injury of the foot and is no longer believed to be solely a blood flow problem. It is known that even though a horse with imminent laminitis might look normal and as yet show no lameness, inflammatory mediators are already elevated by up to 1,000-fold in the laminae.

With that in mind, Belknap is an advocate of administering very high levels of anti-inflammatory medications (500 mg three times per day of flunixin meglumine) within the first 72 hours. Belknap realizes that this high dose is more likely to lead to some gastrointestinal (GI) ulceration and, thus, it should not be used on every horse. But he stresses that it is critical to get foot inflammation under control and ulcers might be the lesser of two evils. Once the acute stage has settled down, it might be desirable to switch to phenylbutazone for better pain relief.

Ice can be beneficial for the same reason that hypothermia is used in some types of inflammatory injury in human medicine: hypothermia is anti-inflammatory and slows down the metabolic rate (i.e., enzyme activity) of injured tissue.

There might be a great benefit to getting the feet on ice immediately to decrease the activity of deleterious enzymes, such a MMPs (matrix metalloproteinases), and to decrease inflammation. Studies show that the best means of cooling the feet is by using a bucket arrangement or wrapping the hoof in a 5-liter plastic bag or truck inner tube filled with ice and water. Refresh ice continually as needed. The table topic facilitators stressed that no harm can come of keeping feet in ice for 72 hours—as much ice therapy as possible is desirable in averting the inflammatory effects related to acute laminitis. After 72 hours no ice is necessary and, in fact, it might be counterproductive to soften the foot with water soaks. The horse should not be walked during the acute phase.

Dimethyl sulfoxide (DMSO) is used commonly, but there is very little research to support this drug's use. In an already laminitic horse, DMSO might have anti-inflammatory properties due to it being a superoxide radical scavenger, and it might work as a vasodilator. It can be given either orally or intravenously (IV) with good absorption.

Equioxx is a new NSAID that targets COX-2 inflammatory mediators. Belknap advised that this drug needs five to seven days to reach a steady state of effect, but if given at a triple dose initially, the steady state can be reached in 24 hours. Until research is performed on its effects in the early stages of laminitis, it might be best used on nonacute cases due to concerns about its potential to exacerbate deleterious vascular events (like Vioxx did in at-risk humans) in the horse at risk or in the acute case of laminitis. Equioxx should be very advantageous for treating chronic cases, as there should be many fewer side effects due to a lower incidence of gastrointestinal ulceration or kidney lesions when compared to the other non-steroidal anti-inflammatory medications (NSAIDs). However, it was also mentioned that COX-2 mediators are needed to heal gastric ulcers, so there is some concern about giving the drug to horses that are known to already suffer from GI ulcers.

Blood flow might not play as predominant a role as once thought in laminitis, so vasodilator therapy is not necessarily as important as some of the other treatment choices. Acepromazine only opens vascular beds for about 40 minutes following intramuscular (IM) administration, so if giv-

en, it should be administered at least four times a day. Another possible vasodilator to use is IV lidocaine. Both practitioners feel that a single dose of dexamethasone (a steroid analog) in a horse at risk of laminitis might help decrease inflammation considerably in the feet, but they are resistant to use it due to litigation regarding steroid use and laminitis.

The facilitators and audience next examined foot support of laminitic horses. Boswell prefers the two-part putty mixture material placed generously from the tip of the frog to the back of the frog and into the sulci. This recruits not only the frog but also the sulci for support. There was mention that "Soft-Ride" pads give a horse with acute laminitis a good measure of relief, but these only provide contact with the frog, so it also helps to use impression material within the sulci.

Lidocaine nerve blocking of the front feet on the initial visit allows the veterinarian to assess any hind limb involvement, pull the shoes, and take radiographs. Belknap suggested that veterinarians use lidocaine for the nerve block due to its short period of action. Shoes left in place might apply too much pressure on the hoof wall and laminae. Removal of the shoes also allows the practitioner to obtain good X ray images to evaluate the internal components of each hoof. Prognosis of foot health and integrity is achieved by comparative views of radiographs (both lateral and dorsopalmar views) taken within the initial three to five days of a laminitic attack. Measurements of the distance from the dorsal hoof wall (the outside of the hoof wall at the toe) to the dorsal border of the coffin bone assist the practitioner in evaluating the integrity of the laminae within the hoof capsule and in determing if there is any displacement or rotation of the coffin bone.

Boswell suggests serial radiographs every week for four weeks. If there is a 25-30% decrease in sole depth during this time, this is not considered a good prognosis for the horse and the situation is likely to end up as terminal. If there is less than 6-7 mm of sole, treatment may fail to alleviate the crisis. If a horse is not progressing well despite aggressive therapy, a venogram might be a helpful tool to determine if there is remaining circulation in the front of the hoof and, if not, then euthanasia might be indicated. However, not all veterinarians agree, and it was stated that some horses have been saved that appeared to have no chance on venogram results.

If the shoes are left on, the back of each foot should be filled with cushion support substance (such as the two-part putty) from the tip of the frog back. The hoof should be placed on the ground so the material fills the spaces within the frog and any extra oozes out to avoid applying excess pressure. In the early stages a horse undergoing rotation can be placed in a temporary raised heel shoe, such as the Nanric modified Ultimate (taped on), but both practitioners recommend unscrewing one wedge from this shoe to make it shorter for horses whose coffin bones have both rotated and undergone sinking. The objective is to stabilize and derotate the coffin bone as much as possible to relieve forces, while providing support to internal structures of the foot. Both clinicians emphasized that you need to watch the horse's response to the shoeing, and they said there is not one type of foot support that works for every horse.

In their discussion on chronic laminitis, the practitioners noted that such horses have a mechanical problem that can't be fixed chemically at this point. The best approach is using special shoes. A great deal of audience discussion centered around using the wooden clog shoe—either a "homemade" shoe with 1 $^{1}/_{8}$" plywood, beveled 45 degrees all the way around, or the commercially available EDSS (equine digital support system) product. These are screwed in on the side of the hoof wall, and just enough cushion impression material is placed in the frog area to give relief without too much pressure. Such a shoe is purported to absorb concussion and allow the horse to adjust how he wants to stand, possibly more than other shoeing options do. Again, Belknap and Boswell pointed out that they use many different types of shoes in chronic cases, and one shoe does not work on all cases.

Belknap has noticed that previously 10% of laminitis cases were linked to pasture-associated obesity, while now this has increased to 60-70% of cases. He cannot find an explanation for that trend, and no one in the audience had any suggestions.

Foot Casts for Acute Laminitis

There are many ways to support a laminitic horse's foot; one common European method is to use plaster of paris foot casts. Hans Castelijns, DVM, CF, of Cortona, Italy, showed attendees how to apply these foot casts.

"(These casts) are quick (taking less than two minutes to apply with practice), cheap, clean, simple to apply, easy to change, and moldable to the required shape," he said. "They help us recruit the back parts of the foot for weight bearing to release some tension on the laminar apparatus."

Castelijns begins the process by removing the shoe (if present) and trimming the foot as needed, with special care to shorten the toe if it is too long. He then soaks a roll of plaster and molds it into a ball under the rear part of the foot, which, he notes, helps ease breakover when the horse is moving forward or turning. The remaining cast material is applied around the foot only up to the coronary band.

"Horses usually show a marked degree of instant relief, probably because the weight is redistributed away from the most painful structures (dorsal laminae) to the rear areas of the hoof," he reported. He added that casted horses can be walked more comfortably (for exams or for walking to a radiography unit in a hospital, for example). A rigid, synthetic pad can be attached to the end of the cast (as long as it doesn't touch the sole) to reduce wear on the cast of the horse is fairly mobile.

"Laminitis is a medical and mechanical emergency," Castelijns stated. "This cast is a mechanical emergency measure that can be used until the acute problem has been stabilized (one to three weeks). After that time, a more durable shoeing solution should be found."

Open-Sole Casts for Laminitis

Casting a laminitic foot for treatment has gained popularity in recent years. The cast might be applied only to the foot, or it might include the limb above as well. Then there's the newest variation—an open-sole cast that allows monitoring and medication (as needed) of the sole. James Belknap, DVM, PhD, Dipl. ACVS, associate professor of veterinary clinical sciences at The Ohio State University, discussed the open-sole casting technique and selected cases.

"We designed this cast out of desperation," he began. "Our objective was to provide noninvasive support for severe, chronically laminitic feet with subsolar sepsis (infection) and instability (of the coffin bone within the hoof) that was unresponsive to conventional shoeing and

required access to the sole for assessment and treatment."

He explained that the casts are generally applied in the stall under short-acting general anesthesia (the procedure takes 15-20 minutes). The cast is set with the foot in slight extension, and like most half limb casts it covers the limb from just below the knee to the bottom of the foot. Immediately after the cast is applied, it is cut out over the sole, leaving about a one-inch-thick rim around the entire foot. The rim and cast material over the hoof wall are then covered with thick acrylic resin for support. Lastly, impression material (silicon putty) is placed wherever solar support can be tolerated (i.e., nonaffected parts of the sole) and taped into place (using elastic bandage tape or duct tape) to provide soft solar support for the digit.

The cast is applied a bit more tightly than a routine cast, and it transfers some weight bearing to the distal (lower) fetlock and the flare at the top of the cannon bone. Cast sores can result when casts are used on both forelimbs, but Belknap reported success with improving foot health in selected cases.

"The use of open-sole casts has had the most dramatic effect on chronic cases with concurrent sepsis and laminar instability," he reported.

The specific cases he discussed included the following:

1) Bilateral forelimb laminitis in a 16-year old pony mare with a severe subsolar abscess in the non-weight-bearing left forelimb. Casting of left forelimb/foot allowed weight-bearing immediately and for the two weeks the cast remained in place. This foot improved and the abscess cleared up, but complications in the non-casted foot eventually led to euthanasia of the mare.

2) Severe laminitis in a 9-year-old pregnant Thoroughbred broodmare who lay down most of the time. The day after surgical debridement of necrotic coffin bone in one foot and bilateral casting the mare began standing up more. She was maintained in open-sole casts for six weeks, then in Steward clogs (with small paddock turnout, article #11718 on TheHorse.com) until foaling six months later. She was later euthanized due to a poor long-term prognosis.

3) An overweight Miniature Horse with penetration of the coffin bones through both front soles. The gelding lay down most of the time, but he stood immediately after application of bilateral open-sole casts and remained standing for several hours each day. He was even noted bucking and trotting with them in the stall. He went home mobile and without casts after about one month and has remained sound.

"The advantages (of this cast) are that it can allow weight-bearing quickly to help save the other limb (in a supporting-limb lameness scenario), and it can get a recumbent (lying down) bilateral case up," he said. "It allows assessment and treatment of the bottom of the foot, and they usually grow a lot of foot under the cast. It provides an alternative when conventional shoeing won't provide adequate support or pain relief.

"Disadvantages are cost (approximately $600 to $800 with cast application and anesthesia) versus the chance of failure, cast sores (especially with bilateral casts), and laminitis in the opposite limb (most likely a result of excessive weight bearing on

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> DR. JAMES BELKNAP

the supporting limb prior to cast application) with unilateral cast application," he added.

"This technique is certainly not a panacea for approaching every case of laminitis, but it provides another option when dealing with the case that does not respond to conventional shoeing," he concluded.

Supporting Limb Laminitis Review

The publicity given to supporting limb laminitis by horses such as Barbaro showed that success with these tough cases often remains elusive. At the convention, Gary Baxter, VMD, MS, professor of equine clinical sciences at Colorado State University, presented a review of what we know about this devastating disease.

Supporting (also called contralateral) limb laminitis strikes a previously healthy hoof when it bears excessive weight for long periods because the other front or hind foot is extremely painful (such as from a fracture, surgery, severe infection, etc.). It is "the most common and significant complication of excessive unilateral (on one front or hind foot) weight bearing in adult horses," said Baxter. "In many of these horses, the lack of a 'good foot to stand on' creates a very difficult management situation."

He noted that unlike with most other forms of laminitis, there is usually no systemic disease present (such as Cushing's disease, colitis, or carbohydrate overload), which points to mechanical overload and possibly the resulting reduction in blood flow as the cause. Additionally, constant deep digital flexor tendon tension might contribute to pulling the foot apart in these painful cases.

Risk Factors

Baxter noted the two consistent research-supported risk factors for supporting limb laminitis are the length of time a horse spends standing on one front or hind foot (resting the painful one) and the severity of the lameness. "Horses that are unwilling to bear any weight on the diseased limb for even small periods of time seem to be more prone to develop support limb laminitis than horses that can shuffle or hobble around to periodically relieve … the contralateral limb," he explained.

He said several other factors might increase a horse's risk, based on his and others' experience, such as increased body weight and poor foot quality (i.e., thin walls/soles, low heels, hoof wall defects) before the lameness/injury.

Detecting Supporting Limb Laminitis

"Any horse with unilateral weight bearing should be monitored closely for signs of laminitis in the contralateral limb," Baxter advised. Lameness might not be a good indicator, as the horse will stand on the previously healthy foot, perhaps with only momentary rests on the injured limb, until progressive laminitis makes it the more painful one. "If you look at the horse and think, 'Wow, we're doing really good on that surgical limb,' a bell should go off and tell you to pay attention to the opposite leg."

He suggested monitoring digital pulses and heat in the foot and palpating the coronary band to check for sinking of the bony column. Radiographs can also help diagnose this condition; he noted that baseline films (taken as early as possible in the disease process) are important for detecting subsequent changes in the foot. Here's what he said one should look for on repeated films (he takes them weekly on at-risk cases).

- A horn-lamellar (HL) zone that's abnormally thick (more than 15-18 mm for light-breed horses) or thickened as compared to previous measurements.
- One study reported that an HL zone greater than 29% of the palmar (lower) surface length of the coffin bone was suggestive of contralateral laminitis.
- Rotation of the coffin bone within the hoof (evidenced by an increasing angle with the outer hoof wall marker).
- Increased coronary band-extensor process distance compared to previous measurements.
- Decreased sole depth.

However, "If you wait to treat the horse until you see radiographic changes, you're well behind the curve," he commented. He noted that veterinarians can apply several treatment options preventively and/or once the disease is detected to make the horse more comfortable and, ultimately, try to save his life.

Prevention/Treatment

Baxter reported that while there's no "magic bullet" for preventing or treating supporting limb laminitis, several options might help reduce load on the laminitic foot and minimize the disease's effects.

- Reduce the horse's body weight if possible.
- Try to get the horse comfortable bearing weight on the initially injured limb as soon as possible to unload the laminitic or at-risk one.
- Evenly distribute the horse's weight between the lame and sound foot. Often the injured limb will be casted and effectively "longer" than the sound limb, so the horse leans into the "shorter," sound limb. Adding a block or thick shoe to the sound foot to even up the horse's knees can be helpful.
- Encourage the horse to lie down with soft, deep stall bedding. Sedation might help.
- Slings can help reduce weight on the sound foot. The horse doesn't need to be lifted off the floor, he just needs to be able to rest weight into the sling.
- Shoeing should redistribute weight bearing to the rear half of the foot (impression material can be helpful). Reducing breakover forces by beveling the toe can also help, as can elevating the heels up to 10° to reduce deep digital flexor tendon tension.
- Anti-inflammatory medication and cryotherapy (cold therapy) can help reduce inflammation, particularly early in the case.
- Some practitioners have found foot casts help stabilize the foot.
- Pain management with non-steroidal anti-inflammatory drugs (NSAIDs, such as phenylbutazone) or more aggressive measures will help improve the horse's comfort level.

Regardless of the treatments applied, they should be initiated early and aggressively. "Time is important; you can't just wait and see how he is next week if he has significant lameness," Baxter said.