Treating Burn Injuries in Horses

Column Editor

Debra Deem Morris, DVM, MS
Banfield Pet Hospital
401 Palisade Avenue
Cliffside Park, NJ 07010
• phone 201-942-2400
• fax 201-944-3244
• email stretchdeem@aol.com

Update on Equine Therapeutics features current medical protocols used to treat a variety of conditions in horses.

Send comments/questions via email **editor@CompendiumVet.com** or fax **800-556-3288**.

Visit **CompendiumVet.com** for full-text articles, CE testing, and CE test answers.

R. Reid Hanson, DVM, DACVS, DACVECC
Auburn University

Most equine burns heal quickly and are superficial, easily managed, and inexpensive to treat. However, serious burns can result in rapid, severe burn shock or hypovolemia with associated cardiovascular changes.[1,2] The large surface area of a burn dramatically increases potential loss of fluids, electrolytes, and calories. Burns covering 50% or more of the body are usually fatal, although the depth of the burn also influences mortality. Long-term care includes measures to prevent continued trauma because burn wounds are often pruritic and self-mutilation is common. Before treatment, equine burn patients must be carefully examined with particular attention to cardiovascular function, pulmonary status, ocular lesions, and the extent and severity of the burns. Cost of treatment and prognosis should be thoroughly discussed with owners.[1–3]

Burns are classified by the depth of the injury.[1–3] First-degree burns involve only the most superficial layers of the epidermis but are painful and characterized by erythema, edema, and desquamation of the superficial layers of the skin. The germinal layer of the epidermis is spared, and these burns heal without complication.[3]

Second-degree burns involve the superficial and/or deep portion of the epidermis. Superficial second-degree burns involve only the stratum corneum, stratum granulosum, and a few cells of the basal layer. Tactile and pain receptors remain intact. Because most of the basal layers remain uninjured, superficial second-degree burns heal rapidly (i.e., within 14 to 17 days) with minimal scarring. Deep second-degree burns involve all layers of the epidermis, including the basal layers. These burns are characterized by erythema and edema at the epidermal–dermal junction, necrosis of the epidermis, accumulation of leukocytes at the basal layer of the burn, eschar (i.e., slough produced by a thermal burn) formation, and minimal pain.[1,3] The germinal cells of the ducts of sweat glands and hair follicles are generally spared. Deep second-degree wounds may heal spontaneously in 3 to 4 weeks if care is taken to prevent further dermal ischemia leading to full-thickness necrosis. In general, deep second-degree wounds, unless grafted, heal with extensive scarring.[4]

Third-degree burns involve all layers of the epidermis and dermis, including the adnexa. The wounds range from white to black and are nonpainful. There is fluid loss, marked cellular response at the margins and deeper tissue, eschar formation, shock, wound infection, and possible bacteremia and septicemia. Healing is by contraction and epithelialization from the wound margins and is frequently complicated by infection. Skin grafting improves wound healing in these cases.

Fourth-degree burns involve all of the skin and underlying muscle, bone, ligaments, fat, and fascia.[4]

CLINICAL EXAMINATION FINDINGS

The extent of a burn depends on the size of the area exposed to fire, whereas the severity relates to the maximum temperature the tissue attains and the duration of overheating. Because heat is slow to dissipate from burn wounds, it is often difficult to accurately evaluate the amount of tissue damage in the early phase of injury, which

Figure 1. Superficial second-degree burns of the nose, with epiphora and cervical neck swelling, indicating more severe damage. This horse suffered smoke inhalation injuries and corneal ulceration. The skin of the cervical neck region sloughed because of latent burn injuries.

Figure 2. Deep second-degree burns and third-degree burns of the dorsum and left hindlimb 8 days after injury. Marked erythema and eschar formation are present.

explains why skin injury often extends beyond the original burn[5] (Figure 1). Only after the patient's condition is stable should the burn wound be assessed. Physical criteria used to evaluate burns include erythema, edema, pain, blister formation, eschar formation (Figure 2), presence of infection, body temperature, and cardiovascular status.[5] To accurately evaluate burn severity, time must often elapse to allow further tissue changes. The percentage of total body surface area involved usually correlates with mortality, whereas the depth of the burn determines morbidity.[6] The rule of nine is commonly used in humans to evaluate the total body surface area involved. With this method, an approximate extent of the burn can be used to estimate prognosis. Body surface area can be estimated as follows: each forelimb (9%), each hindlimb (18%), the head and neck (9%), the thorax (18%), and the abdomen (18%).[4] Special attention should be given to identify injury to the eyes, perineum, tendon sheaths, joints, and major vessels of the lower limbs.

TREATING SMOKE INHALATION

Patients with suspected significant smoke inhalation should be observed closely for several hours and hospitalized if there are extensive burns. Maintenance of airway patency, adequate oxygenation and ventilation, and stabilization of hemodynamic status are the cornerstones of therapy for smoke inhalation injury. Early intervention and respiratory support are essential. Nasal or tracheal insufflation with humidified 100% oxygen counteracts the effects of carbon monoxide and facilitates clearance by decreasing the carbon monoxide half-life in the blood. Oxygen insufflation rates of 15 to 20 L/min can be achieved through a tracheostomy and should be continued until the patient is able to maintain normal oxygenation. Humidification can relieve exces-

sive airway drying or mucous plugging. Nebulizing with *N*-acetylcysteine and heparin in humidified air can reduce formation of pseudomembranous casts and aid in clearing airway secretions.[7] Nebulized dimethyl sulfoxide (DMSO) can help decrease lung fluid formation,[7] and the addition of heparin may further protect against airway damage.[8] The β-adrenergic agonist albuterol can be aerosolized to reduce bronchospasm. Maintaining optimal fluid status is essential: To support adequate cardiac and urine output, patients with concurrent surface burns and inhalation injury require 2 ml/(percentage of burned skin area)/kg more fluid than do patients with cutaneous burns alone.[8]

Antibiotics and corticosteroids do not influence survival rates and should not be routinely administered to smoke inhalation patients. Systemic antimicrobials are indicated only for proven infections, the incidence of which increases 2 to 3 days after smoke inhalation. Intramuscular penicillin is effective against oral contaminants colonizing the airway. If signs of respiratory disease worsen, transtracheal aspiration should be submitted for culture and sensitivity testing and the antibiotic regimen adapted accordingly.[8]

The extent of a burn depends on the size of the area exposed to fire, whereas the severity relates to the maximum temperature the tissue attains and the duration of overheating.

TREATING BURN SHOCK

Large volumes of balanced electrolyte solution are generally indicated in treating burn shock, unless serum electrolyte analysis dictates otherwise. Patients with burns exceeding 15% of the total body surface area require intravenous fluid therapy to avoid circulatory collapse.[8] Inadequate fluid resuscitation results in decreased renal and gastrointestinal (GI) perfusion that could lead to renal failure and/or GI bacterial translocation and sepsis.[8] Administering isotonic fluids at a rate of 2 to 4 ml/kg for each percentage of surface area burned is recommended, but fluid resuscitation is best titrated to maintain stable and adequate blood pressure.[9] For example, an 1100-lb (500-kg) horse with 20% of its body surface area burned would receive a suggested initial intravenous fluid volume of 20 L (i.e., 500 kg × 2 ml/kg × 20 = 20,000 ml = 20 L). An alternative is to use hypertonic saline solution (4 ml/kg) with plasma, hetastarch, or both, followed by additional isotonic fluids. It is extremely important to remember that if there has been smoke or heat inhalation injury, crystalloids should be limited to the amount that normalizes circulatory volume and blood pressure. The same continued rate of administration of electrolyte solutions following resolution of burn shock results in edema rather than improvement in cardiovascular dynamics.[9] Two to 10 L of plasma are an effective albumin source and an exogenous source of antithrombin III for coagulopathies. Hydration, lung sounds, and cardiovascular status should be carefully monitored during fluid administration.

Flunixin meglumine (0.25 to 1 mg/kg IV q12–24h) is an effective analgesic, and pentoxifylline (8 mg/kg IV q12h) can improve blood flow in the small capillary networks of the feet. DMSO (1 g/kg IV for the first 24 hours) may decrease inflammation and pulmonary edema. If pulmonary edema is present and unresponsive to DMSO after furosemide treatment (1 to 2 mg/kg once, or 0.25 to 1 mg/kg q12–24h [maintenance]), dexamethasone may be administered once at 0.5 mg/kg IV.

WOUND CARE

The most effective and practical therapy for large burns in horses is the open method, which involves leaving the eschar intact and continuously applying antibacterials.[1,2,5] Initially, the surrounding hair should be clipped and the wound debrided of all devitalized tissue.[6] The affected skin should be cooled using an ice or cold-water bath. Copious lavage with a sterile 0.05% chlorhexidine solution should be performed.[6] A water-based antibiotic ointment should be applied liberally to the affected areas to prevent heat and moisture loss, protect the eschar, prevent bacterial invasion, and loosen necrotic tissue and debris (Figure 2). This slow method of debridement allows removal of necrotic tissue as it is identified, thereby preventing possible removal of healthy germinal layers by mistake. The eschar should

be allowed to remain intact with gradual removal, permitting it to act as a natural bandage until it is ready to slough. Although bacterial colonization of large burns in horses is not preventable, the wound should be cleaned two or three times daily and a topical antibiotic reapplied to reduce the bacterial load to the wound.

The most commonly used topical antibacterial for treating burns is silver sulfadiazine in a 1% water-miscible cream. It is a broad-spectrum antibacterial that can penetrate the eschar. Silver sulfadiazine is active against gram-negative bacteria, especially *Pseudomonas* spp, with additional effectiveness against *Staphylococcus aureus, Escherichia coli, Proteus* spp, Enterobacteriaceae, and *Candida albicans*.[5,6,9] It causes minimal pain during application but must be used twice daily because it is inactivated by tissue secretions. Although pseudoeschar formation that may preclude wound evaluation, transient leucopenia, skin hypersensitivity, and development of bacterial resistance have all been reported in humans treated with silver sulfadiazine, good results and few systemic effects seem to occur in horses.[5,9,10]

The most effective and practical therapy for large burns in horses is the open method, which involves leaving the eschar intact and continuously applying antibacterials.

Aloe vera is a gel derived from a yucca-like plant and has antithromboxane and antiprostaglandin properties.[10] It reportedly relieves pain, decreases inflammation, stimulates cell growth, and kills bacteria and fungi. Although aloe has been successfully used in the acute treatment of burns, it may actually delay healing once the initial inflammatory response has resolved.[10] Aloe vera and silver sulfadiazine are good first choices in antibiotic therapy for burns and are used extensively in human medicine.

Full-thickness grafts from a cadaver donor can be used early in the clinical course of the burn to encourage healing, whereas split-thickness autogenous mesh grafts can be applied once healthy granulation tissue has formed. Early excision and grafting may also benefit horses that do not tolerate daily wound debridement and cleaning.

COMPLICATIONS

Because many equine burns are pruritic, measures must be taken to prevent self-mutilation of the wound. The most intense pruritic episodes occur in the first weeks during the inflammatory phase of repair and during eschar sloughing. Reserpine (4 to 6 mg per an 1100-lb [500-kg] horse) can be effective in decreasing the urge to scratch by successfully breaking the itch–scratch cycle. Horses vary greatly in their sensitivity to this drug. Common side effects include colic, GI upset, mild diarrhea that may last for days, and sweating over the back and hind legs. Signs of sedation include depression, droopy eyes, and a dropped penis.

Other complications include habronemiasis, keloid-like fibroblastic proliferations, as well as sarcoids and other burn-induced neoplasia.[2] Delayed healing, poor epithelialization, and complications of second-intention healing may limit an animal's previous uses. Therapy should be adjusted based on the patient's clinical response and the clinician's knowledge of the events related to the burn injury in the horse. Successful treatment depends on continuous patient reassessment and early, aggressive patient care.

REFERENCES

1. Fubini SL: Burns, in Robinson NE (ed): *Current Therapy in Equine Medicine 2.* Philadelphia, WB Saunders, 1987, pp 639–641.
2. Fox SM: Management of a large thermal burn in a horse. *Compend Contin Educ Pract Vet* 10:88–95, 1988.
3. Baxter GM: Management of burns, in Colahan PT, Mayhew IG, Merritt AM, Moor JN (eds): *Equine Medicine and Surgery*, ed 4. Goleta, GA, American Veterinary Publication, 1991, pp 1843–1847.
4. Provost PJ: Thermal injuries, in Auer JA, Stick JA (eds): *Equine Surgery*, ed 2. Philadelphia, WB Saunders, 1999, pp 179–186.
5. Geiser D, Walker RD: Management of large animal thermal injuries. *Compend Contin Educ Pract Vet* 7:S69–S78, 1985.
6. Fox SM: Management of thermal burns, part 1. *Compend Contin Educ Pract Vet* 7:631–642, 1985.
7. Nguyen TT, Gilpin DA, Meyer DA: Current treatment of severely burned patients. *Ann Surg* 223:14–25, 1996.
8. Muller MJ, Herndon DN: The challenge of burns. *Lancet* 343:216–220, 1994.
9. Orsini JA, Divers TJ: Burns and acute swelling, in Orsini JA, Divers TJ (eds): *Manual of Equine Emergencies*, ed 2. Philadelphia, WB Saunders, 2003, pp 300–304.
10. Monafo WW, Freedman B: Topical therapy for burns. *Surg Clin North Am* 67:133, 1987.