

CHAPTER 41

Flood Injury in Horses

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Introduction

- Floods are common weather-related disasters threatening the lives of people and horses.
- The yearly financial loss due to floods in the United States averages multiple billions of dollars causing damage to infrastructure and loss of economic activity.
- Flood-related livestock injuries and death make up a major part of these losses, impacting the economic and emotional welfare of livestock producers including horse owners.

Planning/Prevention

- Horse owners must take a fundamental and proactive role in protecting the livestock under their care.
- Advanced planning can help horse owners minimize the loss of life and the health problems associated with disasters such as floods.
- Horses that undergo evacuation relating to a disaster response associated with floods are stressed and likely to commingle with other horses and livestock.
- Herd biosecurity is breached, which makes increasing herd immunity imperative.
- Pneumonia and abortions should be anticipated and can be minimized with proper herd nutrition and vaccination.
- **Practice Tip:** Before storm seasons, horses should be vaccinated with current strains for equine herpesvirus 1 and 4 and appropriate equine influenza Clade(s) in addition to the encephalitides (eastern equine encephalomyelitis [EEE], western equine encephalomyelitis [WEE], West Nile virus [WNV]), rabies, and tetanus.
- Individual identification is important, because it is important to be able to identify the herd of origin if horses are evacuated and commingled, or escape and are later captured. Many horses look alike, so brands, lip tattoos, or electronic identification unique to each individual horse or farm/ranch is vital.
- Single microchips should be implanted deep in the horse's nuchal ligament halfway between the poll and the withers on the left side. Pictures and/or videos of horses may also help identify them later.
- Horses should have two forms of identification:
 - Permanent microchip, lip tattoo, or brand
 - Visible tag or marking with owner name and current contact information

- Guidelines for predisaster identification marking of horses should include, as a minimum: a legible current contact telephone number or e-mail address with the owner's name that is plainly visible. Copies of herd records, proof of ownership, and registration papers should be stored in a safe and secure location.

Response

- In flood situations, horse owners are often frantic and demanding. It is important for communities to have a "livestock plan" that includes trained personnel and resources so that reasonable decisions can be made quickly to save lives and meet the urgent health-related needs of flood-affected horse victims.
- Horse owners should do their part to evacuate ahead of a flooding situation and be sure their horses are haltered and lead.
- Equine emergency response personnel should be current in medical triage; the response should be executed by an experienced team of individuals including veterinarians, first responders, and trained animal technician handlers.
- With equine rescue, responders are at risk for injury, and the horse may sustain additional injuries during the rescue activities.
- **Practice Tip:** A basic guideline is to use the simplest, safest, and a "low tech" approach to minimize injury to horse and rescuers.
- Stressed and injured horses are unpredictable and can significantly endanger people.
- Decisions regarding the appropriate type of response (rescue, field medical treatment, sheltering, or simply provision of feed and water) should be made with the primary objective being the safety of response personnel (see Chapter 37, p. 634).

Triage and Medical Treatment

- When horses are stranded in a flood, stress is an important contributor to flood-related medical problems. These conditions commonly include:
 - Colic
 - Diarrhea
 - Dehydration
 - Neurologic disease
 - Respiratory disease

- Laminitis
- Sole abscesses
- Skin abrasions
- Cellulitis
- Lacerations
- Fractures
- Corneal injuries
- The innate equine “fight or flight” response often accentuates even minor medical problems into life-threatening conditions. If possible, injured horses are examined by a field veterinarian and stabilized before transporting.
- Stabilization may include sedation to prevent further traumatic injury to the patient and handlers. Transporting fractious patients makes the situation worse, especially if the horse is improperly restrained.
- Horses that are severely dehydrated or exhibiting signs of cardiovascular shock may benefit from large-volume bolus of intravenous fluid therapy in the field before transporting (isotonic polyionic fluids, 50 mL/kg IV initially; 20 to 30 L/450-kg adult horse).
- During heightened stress, such as floods and rescue, it is important to move the patient to a quiet area for initial triage and assessment as soon as possible.
- Equine flood victims should be decontaminated by bathing with a detergent soap and thorough rinsing to remove toxins, debris, or microorganisms from the skin and to identify other sites of injury.
- Recommended bathing products include Dawn or Ivory dishwashing soap, or human or animal shampoos without additives.
- The hooves should be cleaned and examined for puncture wounds.

Handling and Restraint

- Chemical restraint is generally indicated to calm a horse, safely manage the rescue, or medically evaluate and treat the flood-stranded horse.
- Chemical restraint minimizes further injury to the patient and prevents human injury to allow rescue activities, including trailer extraction or helicopter sling rescue. Sedative agents used judiciously include:
 - Acepromazine (0.02 to 0.08 mg/kg IV)
 - Xylazine (0.5 to 1 mg/kg IV)
 - Detomidine (5 to 20 µg/kg IV)
 - Butorphanol (0.01 to 0.02 mg/kg IV)
- Adverse response to sedation and tranquilization produces:
 - Hypotension
 - Decreased gastrointestinal motility
 - Exacerbation of cardiovascular shock
- Experienced veterinarians recommend detomidine sedation (5 to 20 µg/kg) followed by butorphanol (0.01 to 0.02 mg/kg IV) for sedation if needed for air lift or trailer extraction.
- Yohimbine (0.1 to 0.15 mg/kg slowly IV) is indicated for α_2 -agonist reversal in the event of significant bradycardia and hypotension.

- **Practice Tip:** Horses rescued by flat or pontoon boats require general short-acting anesthesia using the “triple-drip” method—guaifenesin/ketamine/detomidine. (See Chapter 47, p. 744.)
 - Triple drip is commonly comprised of:
 - Guaifenesin 5%
 - Ketamine, 2 mg/mL
 - Detomidine, 5 µg/kg
 - The horse or pony is premedicated with detomidine (10 to 20 µg/kg), induced with detomidine (10 µg/h and ketamine (2 mg/kg) IV bolus, and maintained on the triple drip (2 mL/kg/h) (see Chapter 47, p. 738).
 - If a 15 drop per milliliter infusion set (typical primary IV set) is used, the rate is one to two drops per second of the triple drip solution to maintain the 500-kg horse under general anesthesia. This needs to be titrated in response to the individual patient’s level of anesthesia.
 - Recovery usually occurs 35 to 40 minutes after discontinuing the infusion. Providing a safe space for recovery is important and adds to the challenge of a disaster flood recovery.

Typical Injuries in Flood Victims

Integument and Musculoskeletal Injury

- Extremity, head, neck, and trunk lacerations and abrasions are commonly seen in equine flood victims.
- Limb lacerations are especially common and may be complicated by fractures and/or tendon lacerations.
- A horse exhibiting moderate to severe lameness requires a comprehensive examination to localize the lameness and prevent further exacerbation whether it is due to a fracture, soft tissue injury, nail penetrating the foot, or a combination of injuries.
- It is beneficial to have splinting devices, such as a Kimsey splint for lower limb splinting, readily available (see Chapter 21, p. 319).
- Flood-affected horses may develop dermatitis and cellulitis from breaks in the skin and standing in contaminated water for long periods.
 - Contaminants include:
 - Chemicals associated with an oil spill
 - Sewage
 - Minerals from mining or rock quarries
 - Elevated salinity—gulf, ocean, or brackish waters
 - Flood waters with high saline content are more likely to cause diseases associated with ingestion and inhalation of water such as colitis, pneumonia, or neurologic disease.
 - Mild to moderate cases of dermatitis and cellulitis can lead to more serious complications such as septic tenosynovitis or septic arthritis, and if *not* treated appropriately may result in severe lameness, loss of use, and even be life threatening.
 - Early recognition and diagnosis of cellulitis enables rapid aggressive intervention for an improved outcome.

- Horses with cellulitis have swelling and heat in affected areas, show signs of pain and lameness, and often are febrile (102° to 104° F [39° to 40° C]).
- Horses with more severe infections become anorectic and painful.
- Cellulitic limbs are painful when touched and the horse may display moderate to severe lameness.
- Systemic antimicrobial therapy is indicated in cases of cellulitis and should provide broad-spectrum coverage with good tissue penetration.
- Beta-lactam antimicrobials are recommended because of the possibility of clostridial and other anaerobic bacterial infections.
- Dosing of ceftiofur sodium (2.2 to 4.4 mg/kg IV or IM q6 to 12h), procaine penicillin G (22,000 IU/kg IM q12h), or penicillin G potassium (22,000 IU/kg IV q6h) combined with an aminoglycoside *and* oral metronidazole (20 to 25 mg/kg PO or per rectum q8h) offers excellent coverage for the vast majority of bacterial organisms.
- Antimicrobial treatment for cellulitis should continue for 10 to 14 days, and possibly longer if necessary.
- Proper tetanus vaccination should be administered.
- Horses exposed to flood waters are also at increased risk for extremity dermatitis and cellulitis-associated fungal or fungal-like diseases such as equine pythium or basidiobolus.
 - In horses, fungal skin infections can be invasive, rapidly progressive, and result in proliferative pyogranulomatous disease.
 - Lesions can be ulcerative and oozing with a foul odor.
 - The growing “mass” may be especially pruritic, and affected horses are stressed and agitated, leading to self-mutilation in an attempt to relieve the discomfort.
 - The lesions grossly may be confused with exuberant granulation tissue. Fungal skin disease requires definitive diagnosis by biopsy and fungal culture¹ for determination of appropriate treatment.
 - If skin lacerations, dermatitis, or cellulitis fail to respond to standard care, including systemic antibacterial therapy, fungal infection needs to be ruled out by skin biopsy and fungal culture.
 - Treatments include a combination of surgery, antifungal treatments, and immunotherapy.

Hoof Problems

- Horses that have been standing in mud or water for long periods may suffer from thrush, soft soles, and loss of the frog compromising the integrity of the hooves’ support structures and resulting in sole bruising and other hoof problems.
- When dried, the hooves may be more susceptible to separation of the laminae and subsequently white line disease, laminitis, or foot abscesses.
- The horse’s feet should be cleaned using a hoof pick and brush as soon as possible to remove sharp objects capable of puncturing the hoof wall or sole.
- These horses may require “medical” farriery (podiatry) to treat thrush, hoof/sole defects, coronitis, or laminitis.
- Application of iodine-based hoof preparations can help to toughen soft soles and remove some of the moisture from soft hooves.
- Thrush-fighting products found in farm supply and tack stores can effectively treat minor cases of thrush if used as directed. See Chapter 42, p. 693, for more information on foot emergencies.
- Proper tetanus vaccination should be administered.

Ophthalmic Injuries

- Ophthalmic injuries, especially traumatic and foreign body corneal ulceration and uveitis, are common medical emergencies seen in equine flood victims due to flying storm debris and damaged stable and pasture environment.
- Animal handlers and first responders may *not* initially recognize ophthalmic injuries because they are concentrating on the more obvious injuries and rescue activities.
 - **Practice Tip:** *This is especially true for foals that may be hard to catch and examine; foals do not demonstrate eye pain to the same degree as adult horses.*
- A thorough ophthalmic exam with early recognition of injury and treatment are important for preventing more serious conditions. Please see Chapter 23, p. 396, for a comprehensive coverage of ophthalmic injuries such as:
 - Corneal defects
 - Corneal abrasions
 - Fungal keratitis
 - Corneal ulceration
 - Uveitis
- Ocular pain is also managed using the nonsteroidal anti-inflammatory drugs phenylbutazone, flunixin meglumine, and firocoxib (see Chapter 23, p. 414).
- Corticosteroid therapy should *not* be included in treating traumatic corneal ulceration in the horse.

Gastrointestinal Dysfunction

- Horses that are stressed from being stranded, injured, or unattended during a flood situation or have ingested contaminated water can develop colitis, colic, and systemic toxemia requiring medical care. Salmonella outbreaks have occurred in flood-stranded horses.
- Frequently, affected horses show signs of lethargy, inappetence, and colic, and some may develop mild to severe diarrhea. Death is possible from peracute colitis without the horse exhibiting diarrhea.
- Physical examination may reveal increased respiratory rate and heart rate due to abdominal discomfort and an increased body temperature due to toxin absorption.
- Signs of abdominal pain range from mild (such as recumbency or inappetence) to severe (rolling, thrashing); see

¹Fungal culture (Pythium Lab, Louisiana State University).

Chapter 18, pp. 185 and 231, for a comprehensive coverage of colic and colitis in adult horses, respectively.

- Cases of colitis may be confused with other large-bowel disorders including large-colon torsion or volvulus.
- Systemic absorption of endotoxin can result in peripheral arteriovenous shunting and classic “brick red” mucous membranes.
- Hypovolemia and subsequent circulatory shock causes congested mucous membranes and weak peripheral pulses.
- Treatment for colitis is supportive and aimed at:
 - Plasma volume replacement (crystalloid fluid replacement)
 - Analgesic and anti-inflammatory therapy
 - Anti-endotoxin therapy
 - Antimicrobial therapy if indicated
 - Nutritional support
- Aggressive intravenous polyionic fluid therapy should be instituted immediately in horses showing signs of toxemia, colic, clinical dehydration, and/or colitis.
- **Practice Tip:** Total fluid deficits should be calculated based on clinical assessment of dehydration (e.g., for 8% or moderate dehydration, $0.08 \times 450 \text{ kg body weight} = 36 \text{ L}$) and replacement fluids should be administered rapidly (up to 6 to 10 L/h per 450-kg adult horse).
- Many horses with colic, dehydration, and electrolyte imbalances voluntarily drink electrolyte mixtures. Electrolyte mixtures in water should be offered in addition to a clean water source. Plain water must always be available!
 - Mixtures to consider providing include:
 - Water with baking soda (10 g/L)
 - Water with NaCl/KCl (“Lite” Salt) 6 to 10 g/L
 - Water with a commercial electrolyte solution
 - Horses with nasogastric reflux should *not* be offered water until normal transit of fluid and ingesta is reestablished.
- Horses unresponsive to symptomatic treatment should be referred to a surgical facility capable of intensive care and treatment.
- Horses with signs of toxemia (elevated heart rate, brick red mucous membranes, and clinical dehydration) absorb large amounts of endotoxin from the diseased intestinal mucosal barrier and therefore are at increased risk for:
 - Laminitis
 - Thrombophlebitis
 - Disseminated intravascular coagulation (DIC)
- Specific treatment for endotoxemia is important for patient survival (Table 41-1).
- The choice of treatment is based on:
 - Severity of disease
 - Renal function
 - Hydration status
- Goals of anti-endotoxin treatment include:
 - Neutralization of endotoxin before it interacts with inflammatory cells

Table 41-1 Anti-Endotoxin Therapy

Product	Dosing Information
Endoserum or	1.5 mL/kg body weight IV diluted 1:10 or 1:20 in sterile isotonic saline or lactated Ringer's solution
Hyperimmune (endotoxin) plasma	1-3 LIV
Polymyxin B	1000-6000 IU/kg body weight IV q8-12h for up to 3 days. Because of the possibility of causing nephrotoxic side effects, polymyxin B should be used judiciously and its use in azotemic patients is NOT recommended.
Flunixin meglumine	0.25 mg/kg IV q6-8h
Corticosteroid therapy	A single dose of a short-acting corticosteroid (prednisolone sodium succinate [1 mg/kg IV]) may be effective during acute endotoxemia without increasing the risk of laminitis
Dimethyl sulfoxide	0.1 g/kg IV q12-24h diluted to less than 10% solution (higher doses have been associated with exacerbating intestinal reperfusion injury in horses)
Allopurinol	5 mg or more/kg IV q4-6h for 1-2 days
Pentoxifylline	8 mg/kg PO q8h

- Prevention of the synthesis, release, or action of mediators
- General supportive care
- The use of broad-spectrum intravenous antibiotics in colic and colitis cases is *not* always indicated.
- Mild and transient neutropenia or fever may *not* justify the use of broad-spectrum antimicrobials unless concurrent problems needing treatment are identified and a persistent neutropenia is present that increases the risk for:
 - Peritonitis
 - Pneumonia
 - Cellulitis
 - Thrombophlebitis
 - Disseminated intravascular coagulation
- Oral broad-spectrum antimicrobial medications are *not* recommended because they may disrupt the normal intestinal microbial population.
- Oral metronidazole (10 to 15 mg/kg q8h) is indicated when *Clostridium* spp. are suspected in the pathogenesis of the disease; metronidazole may also have local anti-inflammatory effects and may be effective in treating acute equine colitis of unknown etiology.
- Horses with diarrhea may benefit from treatment with oral adsorbents such as activated charcoal or smectite powder (see Chapter 18, p. 235).
- Flood-affected and injured horses often have a ravenous appetite and should be allowed to eat good-quality hay and fresh green grass, if available.
- Fresh water should be provided in small amounts initially then ad libitum.

- Reestablishment of normal feeding and watering should occur over 48 to 72 hours.

Neurologic Disease

- Equine flood victims are at increased risk of developing head and neck injuries and are more susceptible to infectious diseases such as viral encephalitides or clostridial infections (tetanus and botulism).
- Physical examination findings suggestive of central neurologic disease during patient triage requires immediate action, including:
 - Prevention of further progression of neurologic abnormalities
 - Emergency treatment aimed at treating inflammation (corticosteroid or nonsteroidal anti-inflammatory therapy)
 - Additional nursing and supportive care
- Vaccinating against encephalitides or viral and bacterial respiratory diseases may be contraindicated because the immune response in a stressed horse is minimal and vaccination may contribute in raising the stress level even further. Tetanus prophylaxis is the *only* vaccine indicated in rescued horses; it should be administered if the vaccination status of the patient is unknown or questionable.
- If ingested water contains elevated salt levels from a coastal storm surge, treating potentially salt-intoxicated horses must be done with caution to prevent exacerbation of the salt poisoning.
 - **Practice Tip:** *Ingestion of water containing over 7000 mg/L of total dissolved salt has the potential to cause acute salt poisoning.*
 - Salt poisoning may occur secondarily to water deprivation when horses are left unattended for several consecutive days.
 - **Practice Tip:** *The basic principles of treating salt intoxication include:*
 - *Replenishing plasma volume hydration more slowly than in standard cases of hypovolemia*
 - *Close monitoring of serum Na⁺ or osmolality*
 - *Close monitoring of clinical neurologic signs*
 - Treatment with systemic anti-inflammatory medications including corticosteroid therapy (dexamethasone phosphate at 0.05 to 0.1 mg/kg q24h) may minimize signs of cerebral edema.
 - Hyponatremia may occur if the horse ingests a large volume of fresh water.

Respiratory Disease

- Aspiration in horses exposed to flood waters may cause acute pulmonary edema, acute lung injury, and pneumonia is usually life-threatening.
- Small amounts of aspirated water may cause inflammation, loss of surfactant, atelectasis, and lung consolidation. Seawater aspiration may pull fluid into the alveolus by osmosis, causing noncardiogenic pulmonary edema. If the

water is grossly contaminated with bacteria or debris, a primary pulmonary infection can occur.

- Secondary severe septic pneumonia or pleuropneumonia is not uncommon.
- Horses stranded or “stuck” in ponds, deep mud, or flood waters and struggling and flailing for periods of time can develop upper respiratory tract (URT) inflammation (see Chapter 25, p. 461), such as:
 - Chondritis
 - Pharyngitis
 - Laryngitis or laryngospasms
- Emergency tracheostomy may be needed in horses that develop URT obstruction secondary to struggling (see Chapter 25, p. 456).
- Aspiration pneumonia may also occur secondary to laryngeal dysfunction.
- Treatment of these acute cases includes:
 - Aggressive anti-inflammatory therapy
 - Systemic broad-spectrum antibiotics
 - Furosemide, if *not* dehydrated
 - Systemic intravenous therapy with 10% DMSO (1 g/kg IV q24h) is believed to be effective in treating respiratory tract edema.
- Horses that are evacuated or rescued following a flood event may be commingled and become infected with respiratory infections such as:
 - Equine influenza virus
 - Equine herpes virus
 - *Streptococcus equi* subspecies *equi*
- **Practice Tip:** *Preventative health programs aimed at optimizing herd immunity before storm season help minimize herd outbreaks in the event of a disaster.*
- Complete submersion of a horse into a body of water causes asphyxia and severe cerebral hypoxia.
 - Cold-water submersion causes an immediate reflex shunting of blood to the heart and brain in addition to lowering the metabolic demand of these organs. Therefore the chances of survival may be increased in a horse quickly removed from a cold body of water.
- Treatment for these cases includes:
 - Antimicrobials
 - Anti-inflammatories
 - Bronchodilators
 - Diuretics
 - Humidified oxygen
 - Surfactant transplant

Summary

- The majority of horses evacuated/rescued simply need good footing, water, hay, and to be dried off.
- There is no way to prepare for every situation that occurs in a flood situation.
- Veterinarians working closely with other producers and agricultural leaders can lessen the impact of a disaster on an equine operation.

- Preparation and detailed planning are the most important aspect of preventing flood-related injuries to horses.
- It is critical to encourage the horse-owning public and animal care professionals to have an evacuation plan for their families, including pets and other animals, and knowledge of local and regional disaster authorities (see Chapter 37, p. 634).
- Educational programs that empower communities to be responsible for caring for their own people and horses are needed for the future of a successful disaster response.

References

References can be found on the companion website at www.equine-emergencies.com.