

Venomous Animals in North America

Jacob Cobi Assaf MD*

* *Judy & Sydney Swartz Center for Emergency Medicine, Hadassah Medical Center, Jerusalem*

Abstract

This review addresses the emergency medicine presentations relating to three species of venomous animals: snakes, scorpions and spiders. Three points have to be addressed: what is the type of the offending animal, grading of the bite/sting, and indications for observation, supportive care, and/or antivenin treatment.

MeSH Words: Spider Bite; Snake Bite; Scorpion Bite; Envenomation

Bites and stings of venomous animals carry the risk of significant mortality and morbidity. This review will address three species of venomous animals: snakes, scorpions and spiders. According to the 2002 annual report of the American Association of Poison Control Centers (AAPCC) there were 98,585 reported bites and envenomation; 15,687 of them were scorpion stings 6,733 snake bites (2,325 native venomous snakes), and 18,646 spider bites (2,786 Black Widow and 2,944 Brown Recluse), in the USA.

The patient may report about identified animal injury, yet a significant number of patients will identify the type of animal (snake, scorpion or spider), while not specifying the species, or even just speak of a sting, a prick or just a sudden pain

without any description of an animal. In the absence of a specific identification, one must distinguish the venomous animal bite or sting from a non-venomous snake bite, a bite from another animal (e.g. rodent), or a puncture wound caused by an inanimate object. The diagnosis will be based upon the symptoms, signs and laboratory results.

Three points have to be addressed: what is the type of the offensive animal, was the bite/sting effective, and does the injury dictate observation, supportive care, and/or antivenin treatment.

Spider bites often go unnoticed and the diagnosis is usually made retrospectively based on symptoms and signs. Scorpion stings feel like a

painful prick and snake bites feel like an excruciating, stabbing pain.

The two most important prehospital actions after venomous animal injury are: immobilization of the victim and the injured organ, and a quick evacuation to the nearest healthcare facility where antivenin treatment can be given.

Snakebites

Venomous snakebite is a medical emergency and occurs approximately 8,000 times a year in the United States. Mortality is rare and ranges from 1 to 15 deaths a year, these occurring mainly in children and elderly and are attributed to delayed, or lack of treatment, or to insufficient dosage of antivenin.

The venomous snakes in North America belong to two families: the Elapidae (the coral snakes) and the Viperidae (the pit vipers).

Pit vipers are characterized by their triangular-shaped head, a pair of heat sensing pits located between each eye and the nostril, elliptical pupils, a pair of fangs and a single row of subcaudal plates. These details are contrary to the nonvenomous snakes, which have a rounded head, round pupil, no fangs and a double row of subcaudal plates. Coral snakes can be identified by their color pattern, which differentiates them from the nonvenomous king snake. The nose of the coral snake is black and the red and yellow bands are adjacent, whereas on the king snake they are separated by a black band. This pattern recognition brought the well known rhyme "Red on yellow – kill the fellow. Red on black – venom lack."

Over 95% of the US native snake bites are caused by pit vipers and about 4% by coral snakes. About 25% of all Pit Viper bites and 50% of Coral Snake bites are considered "Dry bites" since there are no signs or symptoms of envenomation.

Crotaline Snake Envenomation: Family *Viripidae*, Subfamily *Crotalinae*, Genera: *Crotalus* – Rattlesnakes; *Agkistrodon* – Copperhead and Cottonmouth (water moccasin); *Sistrurus* – Pygmy rattler and *Massasauga*

Crotaline venom is a complex mixture of a variety of enzymes, peptides, low molecular

weight substances and minerals; the venom causes consumption coagulopathy and increased capillary and red blood cell membrane permeability. These processes result in hemolysis, tissue edema and necrosis, hypovolemic shock, acidosis and renal failure.

The clinical signs and symptoms of Crotaline envenomation emerge within 30 to 60 minutes.

(Clinical presentation of Crotaline envenomation indicated in Table 1).

(Guidelines for assessing the severity of North American Pit Viper envenomation indicated in Table 2).

The ultimate grade of any envenomation is determined on the basis of the most severe sign, symptom or laboratory test. The type A Mojave snake venom differs from other pit vipers. It contains primarily the neurotoxin that acts presynaptically. The severity of the envenomation depends on the species and size of the snake, the site of bite, the amount of venom injected, and host factors.

Severity of Crotaline envenomation	Grade
Non-grade	0
Minimal	1
Moderate	2
Severe	3

Treatment considerations

a) Prehospital treatment

Prehospital treatment of Crotaline envenomation is based mainly on stabilization, immobilization, and rapid evacuation to the nearest health care facility that has antivenin. The effectiveness of pressure wrap has been examined only for coral snake envenomation, and then only when applied within one minute from the bite. If a pressure wrap has been applied, it should be removed only in a health care facility. During the transportation, vital signs should be closely monitored. Additional measures include: establishing intravenous access (not on the injured limb), positioning the bite site below the level of the heart, removing watches and rings and releasing constricting clothing. The extent of local swelling should be marked on the skin to enable monitoring of progression.

The immediate risk for mortality in Crotaline envenomation is anaphylactoid shock (hypotension and laryngeal edema), and should be treated with epinephrine and H1 and H2 histamine receptors blockers.

Traditional measures that are not recommended are: cryotherapy, electric shock, arterial tourniquet, excision and incision.

b) ED Treatment

The basic ED management of snake bite includes: intravenous line insertion, maintenance of airway, full life support as necessary, wound cleansing and tetanus prophylaxis. Obtain detailed history concerning time of the bite, description of the snake – where possible, comorbid medical conditions, allergy to horse and sheep products and history of snake bites. Mark the edge of the swelling and repeat this measurement every 30 minutes to monitor progression of local venom effect. Consider antibiotics.

The indications for the use of antivenom are: progression of local signs, development of coagulation abnormalities and systemic effects. Two commercial antivenins are available. Wyeth laboratories produce the equine Antivenin (Crotalidae) Polyvalent (ACP), and Savage Laboratories produce the ovine Crotalidae Polyvalent Immune Fab (CroFab). The recommended treatment is 4-6 vials of Crotaline Polyvalent, Immune Fab, antivenin. If initial control is not achieved additional dosage may be administered. Skin test is not recommended prior to treatment owing to the high rate of false positive and false negative returns. The skin test neither guarantees lack of hypersensitivity, nor does it predict development of acute reaction.

The treatment for Mojave rattlesnake does not depend on the clinical presentation, because the early signs and symptoms are either mild or absent, and when they do develop antivenin treatment might be too late. Patients who have clearly been bitten by Mojave rattlesnake, or who have developed symptoms or signs of envenomation, should be given at least five vials of 4-6 vials of CroFab (Crotalidae Polyvalent Fab Immune Ovine). The dose may be repeated if symptoms progress.

Recommended laboratory tests are:

- Complete blood count
- PT, PTT, fibrinogen and D dimer
- Electrolytes, urea, creatinine and creatine kinase
- Urinalysis
- Blood typing and cross match
- CXR – according to respiratory symptoms and signs; ECG

Observe for at least 8 hours in cases of dry bite (no envenomation signs or symptoms). Two exceptions are young children and patients bitten by Mojave rattlesnake. Both should be observed for 24 hours.

Elapid Snake Envenomation: Family *Elapidae*, Genera: *Easter coral snake – Micrurus fulvius fluvius*; *Texas coral snake – Micrurus fulvius tenere*; *Western (Sonoran) coral snake – Micruroides euryxanthos*.

The coral snake is small, rarely aggressive, has a small mouth and fixed anterior fangs, thus, when biting, has to hold on or chew in order to envenomate. This makes effective envenomation of humans difficult. The major components of coral snake venom are alpha neurotoxins. These block acetylcholine nicotinic receptors, causing weakness and paralysis.

Clinical Presentation

Coral snake envenomation results in minor early signs and symptoms that include minor pain and fang marks without swelling. In about half of the envenomation there is no redness or edema, and bullae are seen only in 5%. The progression of the envenomation syndrome may result in numbness and weakness of the affected part. Systemic symptoms include drowsiness, apprehension, weakness, fasciculation, tremor, dysphagia, dyspnea, salivation, nausea and vomiting. Further signs and symptoms include weakness of extraocular muscles, miotic pupils, bulbar paralysis, respiratory depression and convulsions.

Differential diagnoses include poisoning by botulism toxin, heavy metals, and central nervous system depressant medications.

Signs and symptoms in coral snake envenomation

- Fang marks
- Local swelling
- Paresthesia
- Nausea, vomiting
- Euphoria
- Weakness, dizziness
- Diplopia
- Dyspnea
- Diaphoresis
- Muscle tenderness
- Fasciculation
- Confusion

*Treatment considerations**a) Prehospital treatment*

Prehospital treatment of coral snake envenomation is based mainly on stabilization, immobilization, and rapid evacuation to the nearest health care facility that has antivenin. The effectiveness of pressure wrap was examined only for coral snake envenomation, and was found to improve outcome, only when applied within one minute from the bite. If a pressure wrap has been applied, it should be removed only in a health care facility. During the transportation, vital signs should be closely monitored. Additional measures include: establishing intravenous access (not on the injured limb), positioning the bite site below the level of the heart.

b) ED treatment

The basic ED management includes: intravenous line insertion, maintenance of airway, full life support as necessary, wound cleansing and tetanus prophylaxis. The only significant laboratory test is for blood gases to assess respiratory function. The antivenin treatment for coral snake bites does not depend on the clinical presentation because the early signs and symptoms are either mild or absent, and when they do develop antivenin treatment might be too late. Patients who have clearly been bitten by coral snake, or who have developed strongly suspicious symptoms or signs of coral snake envenomation, should be given at least five vials of *M. fulvius* antivenin intravenously. The dose may be repeated if symptoms progress.

Scorpion Bites

The scorpions belong to the class Arachnida. Their venomous apparatus is located at the end of the tail. The last segment, the telson, contains a venom gland and a stinger. There are approximately 30 species of scorpions in the US, but the only native species that is dangerous and can cause death to humans, is *Centruroides* (bark scorpion). The *Centruroides* venom is primarily neurotoxic. It acts by binding the voltage-dependent sodium channels causing calcium and sodium influx, which results in prolonged depolarization of nerve cells. The venom affects both somatic and autonomic nerve cells.

Clinical presentation

Cardiovascular effects with hyper/hypotension, arrhythmia and decreased LV function.

Pulmonary effects may be expressed by pulmonary distress with, or without, stridor and wheezing. The autonomic effects are severe perspiration, salivation and lacrimation, urge for urination and defecation, and priapism. Severe CNS effects are: altered mental status and convulsions.

Clinical symptoms in scorpion envenomation

Local symptoms:

- Resting pain
- Paresthesia
- Muscle cramping
- Hyperesthesia
- Pruritis

Systemic symptoms:

- Apprehension
- Headache
- Dizziness
- Nausea
- Palpitation
- Shortness of breath
- Dyspnea

Clinical signs in scorpion envenomation

Local signs:

- Pain on movement
- Erythema
- Puncture site
- Edema
- Induration

Systemic signs:

- Tachycardia (>100)
- Hypertension (>130/90)
- Perspiration
- Wheezing
- Rales
- Emesis
- Mydriasis
- Salivation
- Lacrimation
- Bradycardia (<60)
- Roving eye movement
- Hypotension (<90/60)
- Stridor, nystagmus, priapism
- Altered mental status, seizures

Recommended laboratory tests

- Glucose
- WBC 20,000 – 70,000
- SGOT
- Troponin/CPK

ECG Changes in scorpion envenomation

- Tachycardia
- Bradycardia
- ST changes
- AV block
- Atrial fibrillation
- AV dissociation

Severity of intoxication depends upon

- Amount and composition of venom
- Scorpion: species, age, nutritional state and stinger integrity
- Seasonal variations
- Geographic area
- Size & age and comorbid conditions of the victim

Grades of Scorpion Envenomation	
Grade I	Local pain and/or paresthesias
Grade II	Remote pain and/or paresthesias
Grade III	Cranial/autonomic or somatic skeletal dysfunction: Blurred vision, roving eye movement, salivation, tongue fasciculations, dysphagia, dysphonia and involuntary jerking
Grade IV	Combined cranial/autonomic and somatic

Treatment considerations**a) Prehospital treatment**

Prehospital treatment of scorpion stings consists of: calming the victim, immobilization, applying ice bag to the area of the sting, light compression wrapping, and transportation of the victim to a hospital. Some authors recommend the use of Sawyer extraction device, although this has not been tested for scorpion envenomation and studies in snakebites have failed to demonstrate any effectiveness.

b) ED treatment

ED treatment of scorpion sting is mainly symptomatic/supportive and may include: establishing of airway and breathing support as necessary, vasodilators (prazosin, hydralazine, nitroprusside), anticholinergic (atropine) calcium blockers, betablockers, anti-epileptics and anti-emetics. Narcotic analgesics and barbiturate have been reported to increase the effects of the venom and should be avoided. Acetaminophen should be used for analgesia.

Antivenin is recommended to all patients with grade III and IV envenomation. The antivenin resolves systemic symptoms but has no effect on pain and paresthesia. The dosage is 1 vial (5 ml) which is administered intravenously in 50 ml saline over 30 minutes. If symptoms persist or progress, the dose may be repeated once. Goat-derived antivenin was produced in the past by Arizona State University, but is not FDA approved and is no longer produced.

Spider bites

Spiders belong to the class Arachnida. The two clinically significant spiders are the Black Widow and the Brown Recluse. The Black Widow spider represents the species that causes predominantly systemic symptoms and minimal tissue injury, whilst the Brown Recluse spider represents the species that causes extensive tissue necrosis and systemic symptoms.

Black Widow spiders (*Latrodectus sp*)

The adult Black Widow female is a small (about 2.0 cm in length) shiny, black spider with red/orange hourglass or spot on the ventral side of the abdomen. The male is much smaller and

not dangerous to humans. The Black Widow venom opens cation channels in the presynaptic membrane, causing calcium influx that stimulates release of neurotransmitters and stimulation of the motor endplates.

Local signs are minimal or absent and the symptoms appear within 1-2 hours, ranging between immediately to 12 hours.

Common signs and symptoms associated with Latrodectus Hesperus

- Generalized abdominal or back pain
- Local or extremity pain
- Hypertension
- Diaphoresis
- Isolated abdominal pain
- Isolated chest pain
- Nausea and/or vomiting
- Tachycardia
- Headache
- Isolated back pain
- Shortness of breath
- Paresthesias

The most common laboratory abnormality is leukocytosis. In cases with severe muscular pain, creatine kinase may be elevated.

Grading scale of signs and symptoms following Latrodectus envenomation

Grade	Description
1	Asymptomatic Local pain at envenomation site Normal vital signs
2	Muscular pain at envenomated extremity Extension of muscular pain to the abdomen or chest. Local diaphoresis of envenomation site or involved extremity normal vital signs
3	Generalized muscular pain in back, abdomen or chest Diaphoresis remote from envenomation site. Abnormal vital signs: hypertension, tachycardia. Headache

Treatment considerations

The treatment of Latrodectus envenomation is based upon: Calcium gluconate intravenous, benzodiazepines and opioids (morphine or meperidine). Patients with grade 3 envenomation and some with grade 2 should receive antivenin that is very effective at relieving pain and systemic symptoms in a mean time of 31 minutes (ranging from immediately to 120 minutes).

Loxosceles (Brown Recluse spider)

The brown recluse spider is a small (about 1 cm) brown spider with three pairs of eyes.

The major toxin of the Loxosceles venom is sphingomyelinase D. Other components include hyaluronidase, esterase, protease and collagenase. The clinical effect of the Brown spider envenomation is necrosis of local tissues resulting in a slowly healing wound. The major dermonecrotic factor of the venom is the sphingomyelinase D that acts by disrupting cell membranes and occasionally causes also intravascular hemolysis.

Clinical presentation

As with other envenomation, the factors associated with the clinical presentation are: the amount of venom injected, the site of injection and host factors. The majority of the Brown spider bites go with very mild symptoms or even unnoticed. The minority of the bites will be manifested with more significant signs and symptoms. Only a very small minority will suffer severe systemic manifestations that may include hemoglobinuria leading to renal failure, disseminated intravascular coagulation, convulsions and coma.

Symptoms and signs in Loxosceles envenomation

Local:

- Local pain
- Pruritis
- Swelling
- Erythema
- Blister and pustule formation
- Target like necrotic lesion with dark center erythematous surroundings separated by bright vasoconstricted band.
- Severe bites develop into necrotic wound that may last a few months before healing.

Systemic:

- Fever
- Malaise
- Headache
- Anorexia, nausea, vomiting
- Chest and abdominal pain
- Arthralgia
- Maculopapular rash
- Convulsions

The diagnosis is based upon the clinical picture. Auer's classification has been suggested as a means of assessing the clinical condition following Brown spider bite. The clinical presentation can be confused with Lyme disease.

Auer's classification of patient condition following Brown Recluse spider bite:

Grade	Characteristic
1	Mild local erythema at puncture site
2a	Necrotic area less than 1cm in diameter
2b	Lesion as in 2a accompanied by mild systemic reaction (nausea, vomiting)
3	Necrosis measuring 1-4 cm accompanied by moderate systemic reaction (chills, fever, petechiae, generalized rash)
4a	Necrosis measuring more than 4cm, accompanied by coagulopathy, severe hemolysis, and hemoglobinuria.
4b	Findings as in 4a, plus renal failure, secondary infection and shock

Treatment considerations

Mild bites are treated with ice, rest and elevation of the bite site. Antibiotic therapy should be considered whenever secondary infection is suspected. In more complicated cases, hyperbaric oxygen and dapsone 50-100 mg BID have been recommended. Early surgery is not advised. Steroids do not have any benefit for local lesions but can be helpful in treating systemic symptoms.

References

1. Alberts MB, Shalit M, LoGalbo F: Suction for venomous snakebite: A study of "mock venom" extraction in a human model. *Ann Emerg Med* 2004; 43(2):181-186.
2. Bush SP: Snakebite suction devices don't remove venom: they just suck. *Ann Emerg Med* 2004; 43(2):187-188.
3. Gold BS, Dart RC, Barish RA: Current concepts: Bites of venomous snakes. *N Engl J Med* 2002; 347:347-356.
4. Gold BS, Barish RA, Dart RC: North American snake envenomation: diagnosis, treatment and management. *Emerg Med Clin N Am* 2004; 22:423-443.
5. Hals GD, Brittain E: Bites and stings: An overview of close encounters with nature. Part I. *Emerg Med* 2005; 26(9):95-113.
6. Hals GD, Brittain E: Bites and stings: An overview of close encounters with nature. Part II. *Emerg Med* 2005; 26(10):112-130.
7. Lavons EJ, Gerardo CJ, O'Malley G et al: Initial experience with crotalidae polyvalent immune Fab (ovine) antivenom in the treatment of copperhead snakebite. *Ann Emerg Med* 2004; 43(2):200-206.
8. LoVecchio F, Klemens J, Welch S, Rodriguez R: Antibiotics after rattlesnake envenomation. *J Emerg Med* 2002; 23(4):327-328.
9. Osterhoudt KC, Zaoutis T, Zorc JJ: Lyme disease masquerading as brown recluse spiderbite. *Ann Emerg Med* 2002; 39(5):558-561.
10. Otten EJ, Blomkalns AL: Venomous animal injuries. In: *Rosen's Emergency Medicine: concept and clinical practice*. ed: Marx JA, Mosby, pp. 785-799, 5th edition, 2002.
11. Ruha A-M, Curry SC, Beuhler M et al: Initial postmarketing experience with crotalidae polyvalent immune fab for treatment of rattlesnake envenomation. *Ann Emerg Med* 2002; 39(6):609-615.

12. Saucier JR: Arachnid envenomation. Emerg Med Clin N Am 2004; 22:405-422.

13. Swanson DL, Vetter RS: Bites of brown recluse spiders and suspected necrotic Arachnidism. N Engl J Med 2005; 352:700-707.

14. Watson WA, Litovitz TL, Rodgers GCJr et al: 2002 Annual Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System. Am J Emerg Med 2003; 21(5):353-421.

Competing Interests: None declared.

This manuscript has been peer reviewed

Correspondance:

Jacob Cobi Assaf MD
Judy & Sydney Swartz Center for Emergency
Medicine
Hadassah Medical Center, Jerusalem

e-mail: jassaf@hadassah.org.il