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Significant numbers of bites and envenomations occur annually,¹ with bites and stings by arthropods accounting for about one-third of these. Surprisingly, the order Hymenoptera, which includes bees, wasps, and ants, is the source of most deaths from envenomations in the United States. Whether the creature inflicts a bite or sting that results in an anaphylactic reaction, impressive local effects, or a life-threatening systemic reaction, the emergency physician must be able to institute appropriate and effective treatment. Emergency physicians also must be able to recognize clinical envenomation patterns, since some critically ill patients may not be able to convey the details of the "attack." Since all areas of the country are represented in the envenomation statistics, all emergency physicians should be familiar with identification and stabilization of envenomated patients and know what resources are available locally for further management of these often complicated patients.

—The Editor

Snakes

Approximately 8000 bites from poisonous snakes occur each year in the United States, resulting in 5-15 deaths annually.¹⁻⁶ Venomous snakes are found in virtually every state. Two snake

families, Elapidae (coral snakes) and Viperidae (pit vipers), are found in the United States. Snakes in the Viperidae family, sub-family Crotalidae, include the rattlesnakes, copperheads, and moccasin snakes. This group accounts for about 90-95% of poisonous snakebites, with coral snakes accounting for 2-3% of bites and exotic snakes accounting for 3-5% of bites.^{1,2} This

report will concentrate on management of the crotalid snakebites.

Pit vipers have a number of characteristic features that distinguish them from other snakes. (See Figure 1 a-b.) A pit is located on each side of the head between the eye and nostril and contains heat-sensitive organs that assist in localizing prey. The pupils generally are elliptical and vertical in

nature, as opposed to the round pupil of a harmless snake. The head of a pit viper usually is triangular in shape, not round or narrow. A pair of long-hinged fangs are folded against the palate and move forward when the snake strikes.

Epidemiology. Snakes are poikilothermic and are most active during warm weather and in the daylight. Most bites occur between April and October. Males are bitten more frequently than females (9:1).^{1,2,5} Bites occur most often on the extremities, with upper extremities more common in adults (85% of bites) and lower extremities affected more frequently

From Stingers to Fangs: Evaluating and Managing Bites and Envenomations

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in children (70%).⁷⁻⁹ More than half of bites occur when a person is purposely handling a known venomous snake.¹⁰

The venom is a complex mixture of enzymes that function to immobilize, digest, and kill the snake's prey. Proteolytic enzymes, hyaluronidase, phospholipase, and thrombin-like enzymes contribute to the local and systemic effects seen following an envenomation.

Clinical Manifestations. The clinical presentation of envenomation is variable, depending on the type of snake, site of bite, host factors, and amount of venom injected. Up to 20-25% of bites may be described as "dry" with no envenomation taking place.³ Pit viper envenomation may cause both local and systemic symptoms. Intense, burning pain is seen at the bite site in most cases of envenomation. One or more puncture marks from fangs frequently are noted. (See Figure 2.) Edema occurs at the bite site and progresses at various rates, depending on the amount of venom injected. Erythema and ecchymosis often are noted. Over time, fluid-filled or hemorrhagic bullae

may form and eventually lead to necrosis. Extremities, especially digits, may become extremely swollen and tense, leading to possible vascular compromise.^{3,5,11-14}

Tender regional lymph nodes may be the first systemic sign of envenomation. Other signs include nausea, vomiting, perioral numbness, metallic taste in the mouth, muscle fasciculations, weakness, bleeding, hypotension, and shock. A Snakebite Severity Score has been developed and validated based on symptoms and signs in six areas: local wound, pulmonary, cardiovascular, gastrointestinal, central nervous system, and hematologic system.¹⁵ (See Table 1.) Death is an infrequent occurrence, and the patients frequently present with signs of severe massive systemic effects, suggesting direct venous injection of the venom. Anaphylaxis to the venom also may occur, especially in victims of previous bites, because of prior sensitization and development of IgE antibodies to venom.^{4,5,11,16,17} Laboratory evaluation frequently reveals a consumptive coagulopathy and thrombocytopenia. Fibrin degradation products often are elevated and PT and PTT are prolonged. Fibrinolysis is caused by snake venom activation of plasminogen and direct fibrinolysis.

Management. Pre-hospital Care. Pre-hospital treatment of snakebite victims, whether by medical personnel or lay bystanders, is the subject of much folklore and controversy. Many traditional first-aid measures actually have been proven to be of little benefit or even harmful to the patient.^{11,18} Pre-hospital care of snakebite victims should include assessment and maintenance of the "ABCs" (airway, breathing, and circulation); minimization of systemic venom effects without increasing the risk of local tissue damage; and rapid transport to a facility where definitive treatment can take place.

Several first aid measures recommended in the past that no longer are advised include cryotherapy, incision and suction, and electric shock. Cryotherapy involved packing or immersing the bitten extremity in ice or ice water. It was believed that this lowered enzyme activity and slowed absorption. However, no significant benefit has been noted in studies, and harmful effects (such as tissue loss or amputation) have been seen.^{18,19}

Incision and suction of the bite is controversial. Incision potentially can damage deeper structures, especially in the hand or neck.^{8,20} Oral suction increases the risk of infection. One device made for mechanical suction of snakebites is the Sawyer Extractor. Both animal and human studies have shown a minimal amount of venom recovered using this device with skin necrosis noted in one study.²⁰⁻²⁴ This therapy only could be recommended if applied within minutes of envenomation in a victim who is more than 30-40 minutes away from definitive care.

Electric shock therapy use has been reported since 1986, when high-voltage, low-amperage electric shock was used to treat a variety of bites and stings in native South Americans.²⁵ No animal models support the use of electric shock.^{18,24,25} Significant complications, such as burns, seizures, and myocardial infarction, have been reported.²⁷

Currently, the most controversial first aid measure is the use of a constricting band to slow systemic absorption of venom. Arterial tourniquets no longer are used because of the potential

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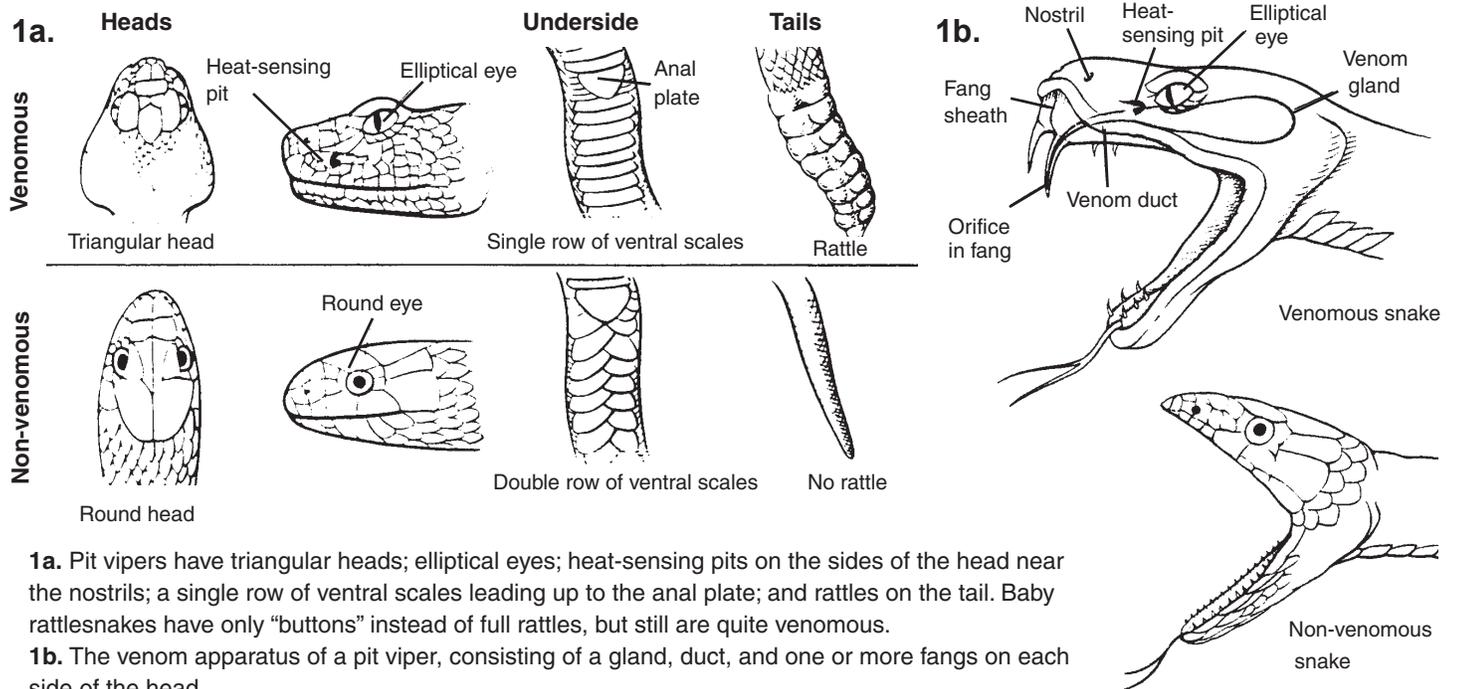
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Figure 1a-b. Identification of Poisonous Pit Vipers



1a. Pit vipers have triangular heads; elliptical eyes; heat-sensing pits on the sides of the head near the nostrils; a single row of ventral scales leading up to the anal plate; and rattles on the tail. Baby rattlesnakes have only “buttons” instead of full rattles, but still are quite venomous.

1b. The venom apparatus of a pit viper, consisting of a gland, duct, and one or more fangs on each side of the head

Adapted from: Sullivan JB Jr., Wingert WA, Norris RL Jr. North American venomous reptile bites. *Wilderness Medicine*. 3rd ed. St. Louis: Mosby; 1995:684,685.

for limb ischemia.⁸ A constricting band is a wide (2-4 cm), flat band that is applied tight enough to occlude superficial veins and lymphatics but loose enough to admit one or two fingers between the band and the extremity to permit deep venous and arterial flow. It has the advantage of delaying the onset of systemic toxicity until antivenin can be given.²⁸ However, some animal studies have shown that keeping the venom at the bite site may worsen the local necrosis.^{28,29} They also show the potential for “bolus effect” of venom into the systemic circulation, leading to rapid deterioration of the patient.^{28,30} For now, recommendations for the use of a constricting band would include severe or progressive envenomation in a patient with a prolonged transport time.

While patients are being transported, all nonessential movement should be minimized.¹⁸ The extremity should be splinted in a position of comfort, and constrictive clothing and jewelry should be removed.

Intravenous access should be obtained, vital signs monitored, and parenteral analgesia given if needed. The patient should not be given anything to eat or drink, supplemental oxygen therapy should be administered. Hypotension during transport should be treated vigorously with crystalloid fluid therapy.^{11,14,18}

Emergency Department Management. Once again, assessment and maintenance of ABCs should take place on patient arrival in the emergency department (ED). At least one large-bore intravenous line should be started. Recommended laboratory studies are listed in Table 2.^{7,12,14} Tetanus status should be determined and updated if needed. Progression of the swelling

should be monitored and documented. Antivenin therapy is the mainstay of medical management for moderate to severe envenomations. Surgery may be required in carefully selected patients. Prophylactic antibiotics currently are not recommended.^{7,11,31-34} Patients with minimal envenomation may be observed for six hours and sent home if there is no progression of symptoms. All others should be admitted to the hospital, and most should be admitted to an intensive care setting.^{11,14,35,36}

Antivenin Therapy. Antivenin administration is the mainstay of medical management of venomous snakebites.^{5,8,14} Antivenin (Crotalidae) Polyvalent (ACP) was introduced in 1954 and was the only antivenin available until October 2000. At that time, Crotalidae Polyvalent Immune Fab antivenin (FabAV) was approved for use.^{37,38}

ACP is derived from horse serum and carries with it the risk of immediate hypersensitivity reactions, estimated to occur in up to 33% of patients.^{8,39,40,41} Doses greater than 10 vials are associated with an almost 100% incidence of serum sickness.^{39,40,41} Although ACP has been in use for decades for treating crotalid snakebites, no prospective, randomized trials have been performed.

Indications for administration of antivenin include a progressive venom injury (worsening local injury), coagulation abnormalities, or systemic effects of the envenomation.^{11,14,40} Antivenin administration is expected to reverse the coagulopathy and systemic effects and prevent further local injury.^{5,7,8,37,42} It currently is recommended that bites from copperheads, the least toxic species of crotalids, not be treated with ACP.^{11,43-45} With the increased use and availability of FabAV, this restric-

Figure 2. Copperhead Snakebite



Hand of an 18-month-old child bitten near the thumb (see arrows) by a small copperhead snake. Note two fang marks and large amount of swelling.

tion may be reconsidered, as local swelling may be severe.

Dosage of ACP has been based on severity of envenomation. In general, 0-5 vials are used for minimal envenomation, 10-15 vials for moderate envenomation, and 15-20 vials for severe envenomation.^{14,46} The patient then is reassessed and additional vials administered when indicated.^{14,40,47}

ACP is diluted in a crystalloid solution, depending on the desired amount of volume to be infused. After skin-testing, a small amount of the antivenin is infused slowly, monitoring for anaphylactic reactions. If no adverse reactions occur, the rate of the infusion is increased to deliver the initial antivenin dose during approximately a two-hour period. Anaphylactic reactions are treated in the standard manner.^{14,47}

FabAV is produced by immunizing sheep with crotalid snake venom. The serum then is digested, using papain to produce antibody fragments (Fab and Fc). Fc is more immunogenic and is eliminated during the purification process.³⁷ When initially tested in animals, FabAV was found to be 5.2 times more potent than ACP against crotalid snake venoms.⁴⁶ Acute hypersensitivity rates are reported at 20%, with a 23% incidence of serum sickness.^{37,40,42,48}

Prospective trials of FabAV have been done and continue to be performed. An initial study of 11 patients who received 4-8 vials of FabAV showed resolution of symptoms with no allergic reactions.³⁷ However, recurrence of limb swelling and coagulation defects was noted in 27% of these patients. A study done shortly thereafter used a different dosing schedule.⁴² Patients initially were treated with six vials of FabAV, and a repeat dose given if needed. They then were randomized to a scheduled group that received two-vial treatments at 6, 12, and 18 hours after initial dose, or to an "as-needed" group. Total dosages were similar in the two groups, with no symptoms recurring in the scheduled group.

Recurrence is described as local or coagulopathy recurrence. Patients with an initial coagulopathy are more likely to experience a recurrence.⁴⁹ Recurrence is thought to be due to a num-

ber of factors, including failure to neutralize all venom initially and the more rapid clearance of unbound Fab in relation to venom components.^{49,50}

Newer recommendations for FabAV administration include an initial dose of 4-6 vials, repeated once for initial control.^{11,42,49} Additional two-vial dosages should be scheduled at 6, 12, and 18 hours. All patients should be re-evaluated at least once during the first five days post-treatment. Those with initial coagulation abnormalities should be reassessed approximately every 48 hours until parameters are stable. Retreatment with FabAV may be indicated for recurrence of the coagulopathy.^{11,49}

Surgical Management. Several surgical techniques have been used in the management of snakebite victims. The most common ones are incision therapy, excision of the bite site, fasciotomy, and digit dermatomy. Many of these techniques were used in the early management of snakebites to address the issues of tissue necrosis, decreased function, and limb loss,⁵¹⁻⁵⁴ in attempts to avoid the risk of antivenin-caused anaphylactic reactions.³⁹ No randomized, controlled, clinical trials exist comparing surgical procedures to appropriate use of antivenin.⁵⁵ A number of studies have shown good functional outcome with minimal or no surgical intervention in patients treated with early, adequate, intravenous antivenin.^{5,56-58} With the development and availability of better antivenin products, surgical therapy now is used only in a few carefully selected patients.⁵⁵

Excision of the bite site was used in the hope that significant amounts of venom could be removed.⁵¹ Excisional techniques range from local excision of a subcutaneous "plug" of tissue, to opening an entire extremity and removing all hemorrhagic tissue.^{38,51} There is no experimental data to support excision used in this way. It is recommended that debridement of hemorrhagic blebs or frankly necrotic skin take place 3-5 days after the bite occurs.^{8,55}

Fasciotomy often has been advocated as primary treatment of crotalid snakebites in the assumption that compartment syndrome is a common complication of the envenomation. The local and systemic toxic effects of crotalid venom mimic the signs and symptoms of compartment syndrome.⁵⁵ Massive local edema often is present after a snakebite. This edema, however, generally is confined to the subcutaneous tissue, and rarely is associated with elevated compartment pressures.⁵⁹ The only way to determine whether a compartment syndrome exists is to measure intracompartmental pressure.^{53,55,56} In cases in which compartment syndrome has developed, use of antivenin has been shown to resolve the majority of them.^{11,60,61} It would seem appropriate to proceed to fasciotomy only in those patients with persistently elevated compartment pressure even after antivenin administration.

The finger is an area with limited capacity for edema. Currently, there is no accurate method for measuring compartment pressure in the finger, so a clinical diagnosis is used. A finger that is tense, blue, or pale with absent or poor capillary refill time is a candidate for a digit dermatomy.^{53,55} This technique consists of a longitudinal incision through the skin only on the medial or lateral aspect of the digit, extending from the web to the mid-portion of the distal phalanx.⁵³ This is done using local anesthesia, and

Table 1. Snakebite Severity Score

CRITERION	POINTS
PULMONARY SYSTEM	
No symptoms/signs	0
Dyspnea, minimal chest tightness, mild or vague discomfort, or respirations of 20-25 breaths/min	1
Moderate respiratory distress (tachypnea, 26-40 breaths/min; accessory muscle use)	2
Cyanosis, air hunger, extreme tachypnea, or respiratory insufficiency/failure	3
CARDIOVASCULAR SYSTEM	
No symptoms/signs	0
Tachycardia (100-125 beats/min), palpitations, generalized weakness, benign dysrhythmia, or hypertension	1
Tachycardia (126-175 beats/min), or hypotension, with systolic blood pressure > 100 mmHg	2
Extreme tachycardia (> 175 beats/min), hypotension with systolic blood pressure < 100 mmHg, malignant dysrhythmia, or cardiac arrest	3
LOCAL WOUND	
No symptoms/signs	0
Pain, swelling, or ecchymosis within 5-7.5 cm of bite site	1
Pain, swelling, or ecchymosis involving less than half the extremity (7.5-50 cm from bite site)	2
Pain, swelling, or ecchymosis involving half to all of extremity (50-100 cm from bite site)	3
Pain, swelling, or ecchymosis extending beyond affected extremity (> 100 cm from bite site)	4
GASTROINTESTINAL SYSTEM	
No symptoms/signs	0
Pain, tenesmus, or nausea	1
Vomiting or diarrhea	2
Repeated vomiting, diarrhea, hematemesis, or hematochezia	3
HEMATOLOGIC SYMPTOMS	
No symptoms/signs	0
Coagulation parameters slightly abnormal: PT 20 sec; PTT 50 sec; plts 100-150,000/mL; or fibrinogen 100-150 mcg/mL	1
Coagulation parameters abnormal: PT 20-50 sec; PTT 50-75 sec; plts 50-100,000/mL; or fibrinogen 50-100 mcg/mL	2
Coagulation parameters abnormal: PT 50-100 sec; PTT 75-100 sec; plts 20-50,000/mL; or fibrinogen < 50 mcg/mL	3
Coagulation parameters markedly abnormal, with serious bleeding or the threat of spontaneous bleeding; unmeasurable PT or PTT; plts < 20,000/mL; or undetectable fibrinogen; severe abnormalities of other laboratory values also fall into this category	4
CENTRAL NERVOUS SYSTEM	
No symptoms/signs	0
Minimal apprehension, headache, weakness, dizziness, chills, or paresthesia	1
Moderate apprehension, headache, weakness, dizziness, chills, paresthesia, confusion, or fasciculation in area of bite site	2
Severe confusion, lethargy, seizures, coma, psychosis, or generalized fasciculation	3

Note: Points are assessed on the basis of manifestations caused by the venom itself (antivenin reactions not included). Total score ranges from 1 to 20. A higher score indicates more severe effects.

Key: **PT** = prothrombin time; **PTT** = partial thromboplastin time; **plts** = platelet count

Adapted from Dart RC, Hurlbut KM, Garcia R, et al. Validation of a severity score for the assessment of crotalid snakebite. *Ann Emerg Med* 1996;27:321-326.

the wound heals by secondary intention. This technique should not be used routinely in all finger bites, nor should it be used prophylactically to prevent a digital compartment syndrome.⁵⁵

Spiders

Spiders are in the class Arachnida, part of the phylum Arthropoda. All spiders are carnivores and have fangs that they use to

deliver venom to their prey. Most fangs are not strong enough to penetrate human skin. Only two clinically important spiders are found in the United States: the brown recluse and the black widow. These two spiders accounted for about 6% of reported bites and envenomations in 2000.¹

Brown Recluse. Brown recluse spiders (*Loxosceles*) are found in most of the United States, but are most common in the

Table 2. Recommended Laboratory Studies in Crotalid Envenomation

Complete blood count

- Platelet count

PT/PTT

- Fibrinogen and fibrin split products

Electrolytes

- Blood urea nitrogen, creatinine

Creatine phosphokinase

- Blood type and crossmatching

Urinalysis

midwestern and southern states.⁶² They are found in woodpiles, sheds, garages, and closets. They also can hide in bedding and piles of clothing. The brown recluse generally is nonaggressive except when threatened or trapped against the skin of a victim.

The spider averages about a centimeter in length and often is light brown to tan in color. There is a distinctive, dark, violin-shaped mark on the dorsal aspect of the cephalothorax. In contrast to most spiders, the brown recluse has six eyes rather than eight.

The venom contains several different enzymes and proteins. Sphingomyelinase D is the enzyme that is most active and the cause for the majority of toxic effects.⁶² It is cytotoxic to both endothelial cells and red blood cells.⁶³ The tissue necrosis is thought to be due to the induction of endothelial disruption, intravascular hemolysis, platelet aggregation, and thrombus formation by sphingomyelinase D. Polymorphonuclear leukocyte-induced vasculitis also contributes to the tissue necrosis.

Clinical Presentation. The bite initially may go unnoticed, but often is accompanied by a mild burning sensation that worsens over several hours.^{12,64,65} Pruritus, pain, and erythema occur, as well as a central blister at the bite site. The initial skin lesion then increases in size and develops a purplish discoloration over the next several hours to days.⁶⁵ As necrosis continues, the lesion develops into an ulcer of variable size. Extremities are the sites most often affected.^{65,66}

Systemic signs and symptoms of envenomation occur in up to 40% of patients, and may include fever, nausea, vomiting, arthralgias, myalgias, and rashes.^{62,64,65} Children are more likely to develop hemolysis, thrombocytopenia, hemorrhage, and renal failure.^{12,67} Death is rare. (See Table 3.)

Management. There currently are no specific tests to diagnose brown recluse spider envenomation, making the definitive diagnosis difficult. Laboratory tests that should be assessed, especially if systemic signs are present, include complete blood count, platelet count, coagulation studies, electrolytes, blood urea nitrogen, creatinine, and urinalysis.^{12,64}

All wounds should be cleaned thoroughly and tetanus administered if needed. Other measures should include elevation of the bitten extremity and the judicious use of analgesics.

A variety of treatments have been tried, including corticosteroids, antibiotics, dapsone, early excision of the bite, and hyperbaric oxygen therapy.⁶⁸⁻⁷⁸ No randomized, controlled stud-

Table 3. Systemic Effects of Brown Recluse Spider Bite

- | | |
|--|--|
| <ul style="list-style-type: none"> • Fever • Nausea • Vomiting • Arthralgias • Myalgias | <ul style="list-style-type: none"> • Rashes • Hemolysis • Thrombocytopenia • Hemorrhage • Intravascular renal failure |
|--|--|

Table 4. Unproven Treatments for Brown Recluse Spider Bites

- | | |
|--|---|
| <ul style="list-style-type: none"> • Corticosteroids • Antibiotics • Dapsone • Early excision of the bite • Hyperbaric oxygen therapy | <ul style="list-style-type: none"> • Cyproheptadine • Topical nitroglycerin • Anti-Loxosceles Fab fragments • Debridement and skin grafting |
|--|---|

ies exist supporting any of these therapies. Animal studies evaluating additional therapies, such as cyproheptadine and topical nitroglycerin, have shown no benefit.^{71,79,80} Dapsone, in particular, should be avoided in children as it can lead to methemoglobinemia and hemolysis. (See Table 4.)

Animal studies using intradermally administered anti-Loxosceles Fab fragments have shown promise in inhibiting venom-induced inflammation.⁸¹⁻⁸³ Further research, including human studies, is needed.

If hemolysis occurs, it is important to maintain good urine output. The urine should be alkalinized with the intravenous administration of sodium bicarbonate to keep the urine pH greater than 7. Close monitoring of renal function and hematocrit is important.

Debridement and skin grafting may be necessary if large areas of necrosis are present, but should be delayed until the area clearly has been demarcated.^{64,78} In general, skin lesions heal in weeks to months, depending on the size.

Patients with systemic symptoms should be admitted for further monitoring.

Black Widow. Black widow spiders (*Latrodectus*) are found throughout North America, with the exception of Alaska.⁶⁴ They can be found in attics, barns, storage sheds, garages, firewood, hay bales, and outhouses. They also may hide in clothing and shoes, with about 15% of bites occurring while the victim dresses.⁸⁴ There are fewer bites from the black widow than the brown recluse.

In the United States, the spider is shiny black, with a red hour-glass marking on the abdomen. The female is about 3-4 cm in diameter, and the male is about one-quarter this size. Only the female has fangs large enough to penetrate human skin. The black widow spider has eight eyes and legs.

The venom produced by this spider is one of the most potent venoms known.⁸⁵ Although it lacks a tissue toxin, minimizing local effects, it has a potent neurotoxin, alpha-latrotoxin. Its primary site of action is the neuromuscular junction. The venom causes release and inhibits the reuptake of acetylcholine and norepinephrine, resulting in overstimulation of the motor endplate.⁸⁶⁻⁸⁸

Clinical Presentation. The bite of the black widow may be painless or present as a pinprick sensation. The majority of bites occur on the extremities.⁸⁴ Regional lymph nodes become tender during the next 30 minutes to two hours. Within 1-2 hours, a target lesion may appear at the bite site with some surrounding erythema.^{84,89} The hallmark of envenomation is muscle cramping, usually involving the abdomen, chest, and back. This cramping has its onset 30-90 minutes after the bite and peaks in 3-12 hours, with a waxing and waning quality.⁸⁴ Autonomic symptoms often include nausea, vomiting, diaphoresis, hypertension, and tachycardia. Death is rare, but hypertension can be life-threatening.⁹⁰

In children, abdominal pain and rigidity are the most common symptoms. There are, however, no peritoneal signs. Marked hypertension is common, as well. Anxiety, agitation, and irritability may be the initial presenting signs, especially in younger children. Grunting and respiratory distress are due to chest and abdominal pain. Weakness, headache, and periorbital edema may be present and persist for days or weeks.^{12,84,89-91}

Management. There are no specific tests to diagnose black widow spider envenomation. Laboratory abnormalities rarely occur and are non-specific.^{84,89}

As always, the initial priorities should focus on stabilization and maintenance of ABCs, especially in children. All wounds should be cleansed thoroughly and tetanus administered, if indicated. The bitten extremity should be elevated, and a cold compress should be applied.

Treatment is directed at the relief of symptoms. Analgesia is an important component of this treatment. Mild cases may be treated with oral analgesics or narcotics such as codeine or hydrocodone. More severe cases usually require intravenous morphine (0.1-0.2 mg/kg every 2-4 hours). Benzodiazepines such as diazepam, lorazepam, or midazolam can be beneficial in relieving anxiety and providing muscle relaxation through centrally mediated responses. The combination of a narcotic and a benzodiazepine often will alleviate symptoms without further treatment required.^{64,89-92}

Calcium gluconate (10%) previously has been used as first-line treatment. Most controlled studies, however, have not shown a benefit to this treatment, and its use has fallen out of favor.^{84,90,93}

An antivenin is available for black widow spider envenomations. It generally is indicated only for the severe envenomations that are unresponsive to other treatments.^{64,84,89,90,94-96} Indications would include life-threatening hypertension and tachycardia, respiratory difficulty, refractory pain, and high-risk groups such as pediatric patients, pregnant women, and the elderly.⁹³ One vial of antivenin is diluted in 50-100 mL of normal saline and infused slowly over 30-60 minutes. Rapid, complete resolution of symptoms without relapses is the norm. Administration of the antivenin should be carried out as soon after envenomation as possible, although effective use up to three days after a bite has been reported.⁹⁴⁻⁹⁶ Immediate hypersensitivity reactions and serum sickness may occur, as the antivenin is derived from horse serum.

Patients with mild symptoms controlled by oral analgesics may be sent home with close follow-up; pain may recur or worsen. Most pediatric patients should be admitted, as well as those patients requiring intravenous analgesics and those exhibiting evidence of hypertension or autonomic symptoms.^{64,90,92}

Scorpions

Worldwide, scorpions account for many deaths annually, but in the United States, one death reported in 2000 was the only death reported in the last 30 years.¹ Only one species in the United States, *Centruroides exilicauda*, produces serious toxicity. Otherwise known as the “bark scorpion” because it resides in the bark of trees, this scorpion is found primarily in Arizona and the neighboring southwestern states. It has two pinching claws anteriorly and a tail that ends in a telson. The telson contains a pair of poisonous glands and a stinger. A scorpion grasps its prey with the pincers and stings its victim by arching its tail over its head. Scorpions also may be found in woodpiles, crevices, shoes, and clothing. Most envenomations occur at night.

The venom contains a neurotoxin that is excitatory and affects both autonomic and skeletal neuromuscular systems. Both sympathetic and parasympathetic systems are stimulated.

Clinical Presentation. Most patients will present with only local pain, tenderness, and tingling. Systemic symptoms rarely occur and are more likely to be severe in children.^{91,97,98} Sympathetic stimulation may cause tachycardia, hypertension, hyperthermia, diaphoresis, and agitation. Parasympathetic symptoms include hypotension, bradycardia, and SLUDGE (salivation, lacrimation, urination, defecation, and gastric emptying). Young children often present with disconjugate, roving eye movements, jerking of the extremities, and opisthotonus.^{64,91,97,99} Complications can include pancreatitis, upper airway obstruction causing respiratory failure, and rhabdomyolysis.⁹⁷

Management. The treatment of scorpion stings is supportive. Cold compresses and over-the-counter analgesics are used for local pain. All wounds should be cleaned thoroughly, and tetanus administered if indicated.^{64,91,97}

Assessment and management of ABCs is critical, especially in children. In severe cases, intubation and ventilation may be necessary.⁹⁸ Parenteral analgesics and benzodiazepines may be required for severe pain and agitation. Midazolam is preferred by many authors, often as a continuous infusion.¹⁰⁰ Severe tachycardia generally responds to beta-blockers, and hypertension can be treated with intravenous hydralazine.¹⁰¹

An antivenin is available for use in Arizona. It is derived from goat serum, and is not approved by the United States Food and Drug Administration. It effectively treats about 70% of cases within 1-3 hours of administration.⁹⁸ There is a risk of both immediate hypersensitivity reactions and serum sickness.¹⁰² It is indicated for patients with severe cardiorespiratory or central nervous system dysfunction. The dose is 1 vial mixed in 50 mL of normal saline and infused over 30-60 minutes. Antivenin use may allow discharge from the ED in a select group of patients.⁹⁸ Most pediatric patients and others with severe systemic symptoms should be admitted to the hospital.

Hymenoptera

Hymenoptera is an order of arthropods that includes bees, wasps, and ants. They are the leading cause of death from envenomation in the United States, with 40-50 fatalities per year.^{1,2} Apids (i.e., honeybees, bumblebees) possess a barbed stinger that remains in the victim after a sting. The vespids (i.e., wasps, hornets, yellow jackets) can sting multiple times and rarely leave the stinger behind.

Yellow jackets cause the majority of allergic reactions from insect stings. They nest in the ground or in walls, and are disturbed by lawn mowing, gardening, and other outdoor activities. Yellow jackets are attracted to food and garbage, as they feed on sugar-containing substances.

Vespids, in general, are more aggressive than bees. The exception would be the Africanized ("killer") honeybee. African bees were brought into Brazil in 1956 to help increase honey production. A few bees escaped and began mating with the established bees. These bees, which have aggressive tendencies, began migrating north, reaching Texas in 1990. They are now found in Texas, Arizona, and southern California.¹⁰³ The venom of the Africanized bee is no more toxic than that of other bees.^{104,105} However, these bees often attack in swarms, so a large dose of venom is delivered to the victim.

The venom apparatus is located in the posterior end of the abdomen. It consists of the venom glands, a reservoir, and a stinging structure. The venom contains a number of enzymes, including phospholipase A and hyaluronidase. Phospholipase A is thought to be one of the major allergens in the venom.¹⁰⁶ Melittin is a principal component of honeybee venom, which damages cell membranes through detergent-like action.¹⁰⁷

Clinical Presentation. Hymenoptera stings most often result in swelling, erythema, and pain at the site of the sting. This reaction generally subsides within several hours. Larger local reactions also are common. The swelling extends over a large area, usually peaks within 48 hours, and may last as long as seven days.¹⁰⁸ These probably represent a cell-mediated (type IV) immunologic reaction, although it may be mediated by IgE antibodies. Large local reactions may be confused with cellulitis, although this rarely occurs after a sting.

Serum sickness may occur within 7-10 days after a sting.¹⁰⁹ This is characterized by fever, arthralgias, and urticaria and appears to be immunologically mediated. Other unusual reactions include nephritic syndrome, seizures, Guillain-Barré syndrome, and progressive demyelinating neurologic disease.¹¹⁰⁻¹¹²

Anaphylaxis is the most serious complication of a hymenoptera sting. It is estimated that up to 4% of the U.S. population is sensitized to bee stings.¹¹³ Common symptoms include flushing, angioedema, generalized urticaria, pruritus, and nausea. Life-threatening manifestations may include bronchospasm, upper airway edema, hypotension, and shock. Symptoms generally begin within 10-20 minutes after the sting; however, reactions up to 72 hours later have occurred.¹⁰⁸ Most deaths occur within the first hour. This often is due to upper airway obstruction, hypotension, or both.¹¹⁴ Children suffering anaphylaxis who subsequently are stung tend to have

reactions that are similar to or less severe than the initial episode.¹¹⁵⁻¹¹⁸

Management. Mild local reactions can be treated by removing the stinger and cleaning the wound with soap and water. Application of an ice pack or cold compress often provides relief. Oral antihistamines, such as diphenhydramine or hydroxyzine, also are effective.

Traditionally, it has been taught that the stinger should be removed by flicking it or scraping it off, to avoid releasing more venom into the wound. Newer evidence shows that the venom sac continues to contract and inject venom for up to 20 seconds after the sting, so removal of the stinger should be expedited.¹¹⁹ The method of removal does not seem to affect the amount of venom delivered.

Corticosteroids may be used for the management of large local reactions, as they seem to hasten resolution of the symptoms. Serum sickness should be treated with a course of both oral corticosteroids and oral antihistamines.⁶⁴

Treatment of anaphylaxis starts with the administration of subcutaneous or intramuscular epinephrine. The dose is 0.01 mL/kg of the 1:1000 solution (up to 0.3 mL) and should be administered as quickly as possible.¹²⁰ If hypotension or shock is present, an intravenous line should be started and 20 mL/kg boluses of normal saline or lactated Ringer solution given. Intravenous epinephrine (1:10,000 solution) should be given. Multiple doses may be needed.¹²¹

Attention to airway and breathing occurs simultaneously. Oxygen, intubation, and ventilation may be needed. Inhaled beta-agonists, such as albuterol, may help alleviate bronchospasm. Diphenhydramine (1 mg/kg intravenous) and methylprednisolone (2 mg/kg intravenous) should be given to help block the delayed hypersensitivity reaction. An H₂ blocker such as cimetidine often is used, as well. Patients with life-threatening symptoms should be admitted to the hospital for at least 24 hours.

Patients experiencing allergic symptoms should be discharged with at least two epinephrine autoinjectors (EpiPen, Dey Inc., Napa, CA) and instructions on how to use them. Those patients having anaphylactic reactions should wear a medical alert bracelet and also be referred to an allergist for possible venom immunotherapy.⁶⁴

Conclusion

Envenomations can be frequent occurrences, depending on the area in which you practice. A high index of suspicion is needed to diagnose these conditions, as most do not have specific confirmatory tests. Numerous treatments have been advocated in the past, but supportive care is all that is needed in most instances.

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CE/CME Instructions

Physicians and nurses participate in this continuing medical education/continuing education program by reading the article, using the provided references for further research, and studying the questions at the end of the article. Participants should select what they believe to be the correct answers, then refer to the list of correct answers to test their knowledge. To clarify confusion surrounding any questions answered incorrectly, please consult the source material. **After completing this activity, you must complete the evaluation form provided and return it in the reply envelope provided in order to receive a certificate of completion.** When your evaluation is received, a certificate will be mailed to you.

CE/CME Questions

Please review the text, answer the following questions, check your answers against the key that appears following the questions, and then review the materials again regarding any questions answered incorrectly. **To receive credit for this activity, you must return the enclosed CE/CME evaluation in the enclosed envelope.** For further information, refer to the "CE/CME Instructions" on the previous page.

This testing procedure has proven to be an effective learning tool for adults. If you have any questions about the new testing method, please contact Customer Service at 1-800-688-2421.

- Pit vipers have all of the following characteristics *except*:
 - vertical elliptical pupils.
 - round head.
 - heat-sensing pit.
 - hinged fangs.
 - single row of ventral scales.
- Approximately what percentage of snakebites are "dry"?
 - Less than 5%
 - 5-10%
 - Up to 20-25%
 - 40-50%
 - 70-75%
- Cryotherapy is indicated as first-line treatment for victims of snakebites.
 - True
 - False
- Which of the following first-aid measures for snakebites is definitely of value?
 - Cryotherapy
 - Incision and suction
 - Electric shock
 - Tourniquet
 - Transport to hospital
- When should fasciotomy be done on snakebite victims?
 - As routine treatment
 - As prophylaxis for extremity bites

- When measured intracompartmental pressures remain elevated despite the use of antivenin
 - When there is massive local edema
- Which of the following is true?
 - FabAV appears less potent than ACP.
 - Recurrence of coagulopathy is more common with FabAV.
 - Serum sickness is more common with FabAV.
 - Scheduled doses of FabAV are probably not needed for the first 18 hours.
 - ACP is sheep-serum derived.
 - Which enzyme is thought to be responsible for most of the toxic effects of the brown recluse spider bite?
 - Sphingomyelinase D
 - Hyaluronidase
 - Thrombin-like enzymes
 - Phospholipase A
 - Alpha-latrotoxin
 - What is the hallmark of black widow spider envenomation?
 - Fever
 - Necrosis at bite site
 - Tachycardia
 - Headache
 - Muscle cramping
 - Which treatment for black widow spider envenomation is no longer recommended as first-line therapy?
 - Morphine
 - Valium
 - Lorazepam
 - Calcium gluconate
 - Codeine
 - Which is *not* a sign or symptom of scorpion envenomation?
 - Tachycardia
 - Local pain at bite site
 - Necrotic lesion
 - Roving eye movements
 - Hypertension

CE/CME Objectives

Upon completing this program, the participants will be able to:

- Quickly recognize or increase index of suspicion for envenomations;
- Be educated about how to correctly and quickly stabilize, and then to manage, envenomations;
- Understand various diagnostic modalities for envenomations; and
- Understand both likely and rare complications that may occur.

Answer Key

- | | | |
|------|------|-------|
| 1. B | 5. C | 9. D |
| 2. C | 6. B | 10. C |
| 3. B | 7. A | |
| 4. E | 8. E | |

In Future Issues:

Pediatric C-Spine