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Approach and management of venomous snake bites: a guide for the primary care physician

John Ashurst, DO,[a] Robert Cannon, DO[b]

From the [a]Lehigh Valley Health, Network, Department of Emergency Medicine, Bethlehem, PA; and [b]Lehigh Valley Health Network, Department of Toxicology, Bethlehem, PA

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Approximately 10,000 snake bites occur each year in the United States. Although rarely fatal, 70% of envenomations require antivenom therapy. The rattlesnake, a member of the Crotalinae family, causes the most bites and fatalities each year. First aid techniques such as arterial tourniquet, mechanical venom removal, and icing the wound—which are ineffective and actually cause more harm—have been replaced with immobilization of the affected extremity at a gravity-neutral position and aggressive antivenom therapy. Patients with snake bite injuries should be seen in the emergency department and antivenom therapy should be initiated if indicated. Fasciotomies are reserved for rare cases, although prevention and education of snake bites should be the goal of all physicians.

Venomous snakes inhabit the foothills and mountains of every continent except Antarctica.[1] Of the current 120 species of snakes indigent to the United States (US), only 20 are venomous and none can be found in Alaska, Maine, or Hawaii.[1-3] With the exception of the coral snake, a member of the Elapidae family, the Crotalinae (pit viper) family makes up the majority of venomous snakes indigenous to the US. The vast majority of venomous snake bites are from the pit viper family, with 99% caused by the rattlesnake, cottonmouth, or copperhead.[4]

Although indigenous snakes cause the majority of bites in the US, several non-native species have emerged as threats because of the increase in professional collectors, illegal importation, and zoos. Recent research has shown that the most popular non-native venomous snake is the cobra because of its availability in the animal trade.[1,2]

The last comprehensive study completed on snake bites in the US was done between 2001 and 2004. During that time, 10,000 snake bites were treated annually in emergency departments, with more than one quarter of these patients requiring hopsitalization.[3] Estimations have also shown that approximately 12 people will die each year as a result of venomous snake bites, and approximately 95% are caused by either the eastern or western diamond back rattlesnake.[3] However, both of these numbers seem to be an underrepresentation because there is no mandatory reporting of snake bites to any health care agency. The misrepresentation can be related to the lack of reporting and also because many victims will never seek treatment at a health care facility.

Snake bites typically occur between April and October, and victims are usually males between the ages of 17 and 27 years.[2,5] Alcohol intoxication plays a large role in the victim being bitten as well as in the location of the bite[5]; 98% of all bites occur on an extremity and are usually the result of deliberate attempts to handle or harm the snake.[5]

Knowledge of the habitat, venom, and physical description of the snake, if available, may aid the primary care physician toward making a diagnosis. These aspects cou-

Corresponding author: John Ashurst, DO, Lehigh Valley Health Network, Department of Emergency Medicine, 2545 Schoenersville Road, Bethlehem, PA 18017.
E-mail address: ashurst.john.32.research@gmail.com

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pled with a detailed treatment plan will be discussed to aid the primary care physician in developing a comprehensive medical care plan.

Snake envenomation symptoms and signs

The most common characteristics of pit viper bites are the presence of one or more fang marks as well as scratches and puncture wounds around the original bite.[1,2] Local tissue findings emerge within one hour after the majority of pit viper envenomations.[1,2] These findings include localized pain, edema, erythema, and ecchymosis at the site of the bite as well as in the adjacent tissues, and the findings are directly related to the hemotoxic affect of the venom.[1,2] Edema from small-vessel injury usually appears within 30 minutes but may not become apparent for several hours. Serous or hemorrhagic bullae may be noted within several hours after the bite.[1,2] Also, there may be signs of lymphangitis, with tender regional lymph nodes if the bite is on an extremity.

However, the bite from a coral snake is often overlooked as being that of a nonvenomous snake. Typically, the bite from a coral snake consists of several tiny painless puncture wounds as well as negligible surrounding tissue damage.[2,6] The venom from the coral snake is neurotoxic and will produce localized numbness instead of pain, cranial nerve palsies, respiratory depression, hyporeflexia, and even death.[2]

Many people believe that any bite from a venomous snake will cause envenomation. However, 25% of all pit viper bites are considered "dry" bites, in which no venom is injected through the fangs.[7] Because of this misconception, the most common reaction a physician will see in the patient is terror. The symptoms that a patient may present with include the systemic symptoms of nausea, vomiting, clammy hands, syncope, and tachycardia.[7] These are known as autonomic reactions and must be carefully differentiated from true systemic symptoms.[7]

True systemic symptoms usually occur soon after a snake bite and include nausea, vomiting, perioral paresthesia, myokymia, and weakness.[1] Some victims of rattlesnake bites may also describe a "metallic" or "minty" taste after envenomination.[1] Bites by rattlesnakes may result in intravascular hemolysis.[1] Lab values may also show hypofibrinogenemia, the presence of fibrin-degradation products, and thrombocytopenia.[1]

More severe systemic symptoms will include hypovolemic shock, respiratory distress, altered sensorium, acute renal failure, and even death.[8] These symptoms are a direct result of the hemolytic nature of the venom injected by most pit vipers. The altered permeability of the red blood cell membranes will result in hemolysis.[1] Hemolysis is subsequently followed by edema and hypoalbuminemia, which results in pooling of body fluids in the microcirculation with an end result of hypovolemic shock.[1,8]

First aid

Initial treatment of a venomous snake bite should include basic life support, safety from other snake bites, and a complete secondary survey.[9] Physical activities, such as walking, should be avoided because it may hasten systemic absorption of the venom, the affected extremity should be immobilized, and the patient should be emergently rushed to the nearest emergency department.[9]

In the field, all rings, watches, and constricting clothing should be removed. The leading edge of the wound should be outlined and re-examined every 15 to 30 minutes to follow the progression of the local inflammation.[2,9] Current research does not recommend the use of pressure immobilization for the management of North American pit viper envenomation because it increases compartment pressures in an affected extremity. However, when an exotic snake envenomation is suspected or when a prolonged transit time is expected, a wide, flat constriction band can be placed proximal to the site of the wound to slow the systemic spread of the venom.[2,9] Two fingers should easily slide under the band, which would represent approximately 20 mm Hg of pressure.[2,9] This allows adequate arterial blood flow but blocks superficial venous and lymphatic drainage. The extremity should then be splinted and allowed to hang in a gravity-neutral position.[2,9]

Recent evidence has drastically changed the protocol used in the field for snake bites. Tight arterial tourniquets, aggressive wound incisions, and debridement and ice are no longer recommended.[10-12] In human models, no benefit has been shown from the use of commercially available suction extraction devices. These devices can actually lead to increased wound destruction, nerve damage, and tendon injury.[10-12]

Treatment of venomous snake bites

Any patient bitten by a venomous snake should be seen by a physician at a location from which an immediate consultation to the poison control center or local toxicologist should be placed. The wound should be cleaned thoroughly and the patient should be questioned about their immunization history. Tetanus toxoid or tetanus immunoglobulin should be administered to those who are not immunized or for those who need an update. All patients should have intravenous fluids as well as basic labs drawn from an unaffected extremity. Lab work should include a complete blood count with platelet count; coagulation profile (international normalized ratio, prothrombin time, activated partial thromboplastin time, and fibrinogen level); measurement of fibrin degradation products, electrolytes, blood urea nitrogen, and serum creatinine; and urinalysis. After six hours, repeat lab studies should be obtained and if there is no proximal progression of the original outline or if there is no thrombocytopenia and laboratory evidence of hemolysis,

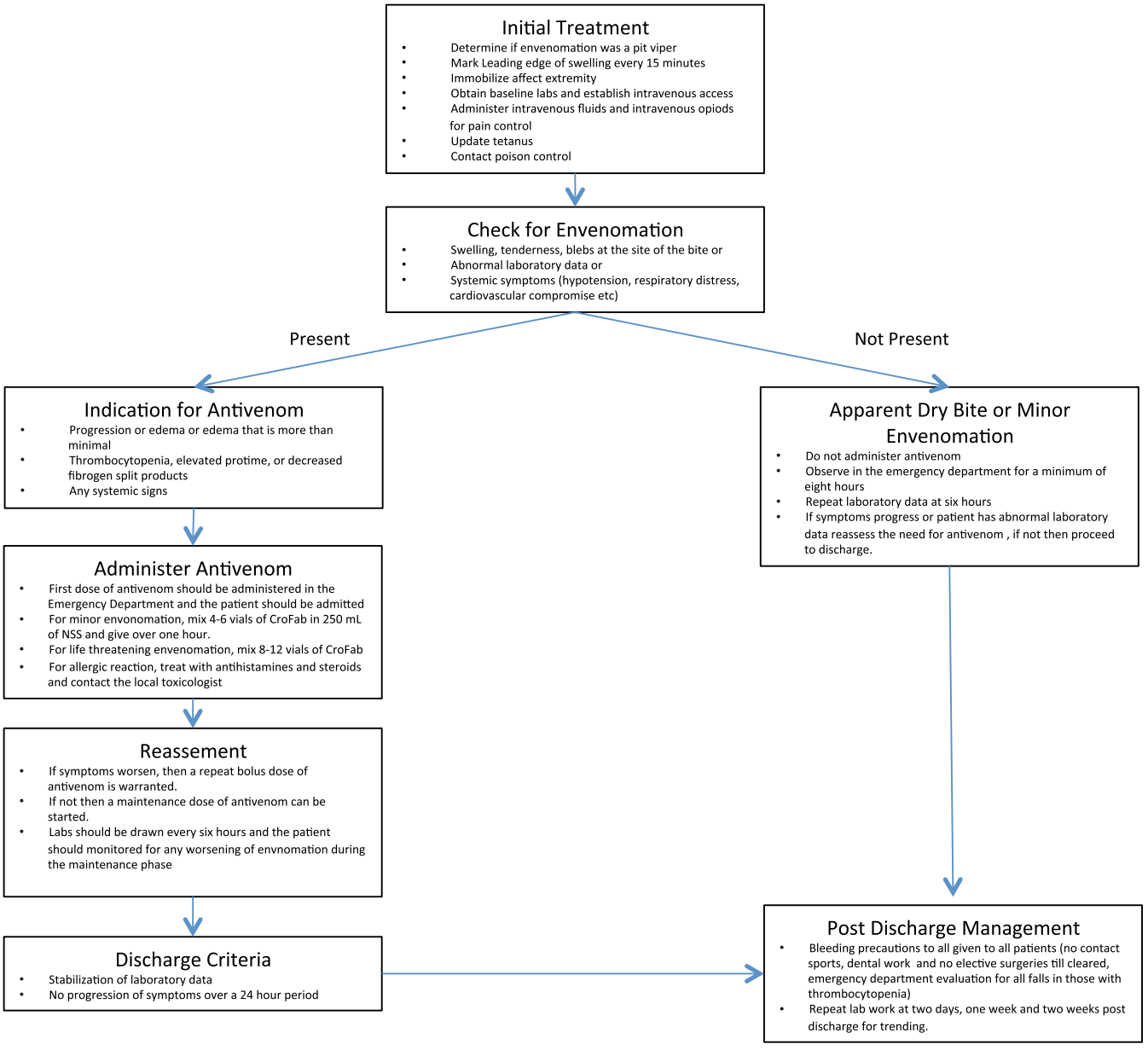

Figure 1 Basic pit viper treatment algorithm.[26]

the patient can be discharged with close follow-up (see Figure 1 for a treatment algorithm).[13]

However, bites from non-native species of snake pose not only a problem in treatment but also in determining a discharge plan. These patients may need an extensive work-up and possibly admission because of the relative low frequency of these bites. The American Association of Zoological Parks and Aquariums contains an in-depth Antivenom Index and should be contacted regarding availability and treatment options.

Upon discharge, the patient should be given strict instructions to return to the emergency department if they develop fever, dark urine, shortness of breath, sweating, or an increase in pain. Typically, methicillin-resistant *Staphylococcus aureus* is the most common secondary infection resulting from a venomous snake bite.[14] However, the rate of secondary infection from pit viper bites is only 3% and prophylactic antibiotics are currently not recommended.[14] The primary care physician should follow the patients' complete blood count results at two days, one week, and two weeks post envenomation to look for for any thrombocytopenia and to monitor wound management.

Antivenom therapy

Since the inception of antivenom therapy in 1954, the rate of mortality from snake bites has decreased from 25% in the early 19th century to less than 0.5% today.[15-17] Equine-developed antivenom has been the mainstay of hospital treatment and is used to treat approximately 75% of all

venomous snake bites in the US annually.[15] However, in a retrospective study of the antivenin Crotalidae polyvalent (ACP) vaccine, 23% to 56% of patients had an acute allergic reaction that included hypotension and anaphylaxis.[18,19] Also, research has shown that six of eight patients who received ACP developed a delayed serum sickness.[20]

The Crotalidae polyvalent immune fab (CroFab), an ovine-derived antivenom, received approval from the US Food and Drug Administration in 2000 and has drastically decreased the amount of acute allergic reactions in patients. A prospective study using CroFab reported a 14.3% incidence of acute allergic reaction and only 16% serum sickness.[18] However, more recent data by Cannon et al has shown that the incidence of acute allergic reaction is only 5.4%.[21] The decrease in acute allergic reaction may be a result of the original CroFab antivenom being contaminated with Fc fragments.[21] In animal studies, CroFab has been reported to be fives times more potent than the original ACP vaccine and has led to almost the complete abandonment of the ACP vaccine in emergency departments.[22]

Although there has been a decrease in allergic reactions, several key reactions that the physician must be familiar with still exist. The most important is that the effects of the venom could recur after completion of antivenom treatment.[23] One study reported that limb swelling recurred in some patients within 18 hours after treatment ended, and recurrence of hypofibrinogenemia was found in one patient during a follow-up visit seven days after treatment was completed.[23]

Currently, the antivenom that has been distributed for coral snakes is no longer in production in the US. However, the Food and Drug Administration granted an extension on the expiration date through October 31, 2012.[24]

Antivenom administration and indications

Administration of antivenom halts the progression of local tissue effects, reduces hematologic effects, and decreases systemic effects from crotaline envenomations.

Antivenom should be administered within four hours of a snake bite but can be effective for as many as 24 hours post envenomation.[1,2] Because CroFab is a lyophilized antivenom, each dose must be reconstituted and then diluted to a volume of 250 mL in a crystalloid fluid before being administered.[1,2] The initial dose is given by slow infusion for the first 10 minutes, and the infusion of the rest of the dose is completed over the course of one hour.[1,2] A physician should be present at the bedside when the initial dose of anitvenom is administered.[1,2,23]

Some research has suggested that a skin test with horse serum should be performed before antivenom therapy. However, this technique has been highly controversial recently and is not currently recommended. Studies have shown that there is a 36% false-negative rate and a 33% false-positive rate with skin testing.[25] Current recommendations mandate infusing the antivenom initially at a slow rate to monitor for signs of anaphylactoid reactions. If no reaction occurs, the remainder of the antivenom can be given over one hour.

Surgical management

Envenomation may mimic compartment syndrome by producing distal paresthesia, pain upon passive muscle stretch, muscle weakness, and massive localized edema. A fasciotomy should only be performed in patients with symptoms of compartment syndrome and compartment pressures exceeding 30 mm Hg. Blebs, vesicles, and necrotic tissue may require surgical debridement.[1,2]

Prevention and follow-up

Many bites can be prevented easily by exercising common sense, and physicians should educate their patients in these matters. Patients should be instructed that an injured extremity should be maintained in a functional position and the wound should be cleaned and covered with a sterile dressing. Assessment and follow-up treatment should be aimed at the preservation of joint mobility and muscle strength.

Conclusion

Although envenomations by snakes are rare, the primary care physician must be aware of their presentation and treatment. The differential diagnosis is extensive and should include arthropod bites, reptile bites, skin infections, and an exposure to an unknown chemical or toxin. Antivenom therapy is available once the patient is in a hospital setting but the best treatment may be that of properly educating patients to avoid handling any snake species unless they are properly trained to do so.

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