Introduction-
Snakebites are not uncommon in Arkansas, particularly in the late spring, summer, and early fall. While some patients may need referral to a Level I trauma center, most patients can be safely treated at Level IV, III, and II trauma centers without the need for emergent transfer. In Arkansas, snakes in the Crotalinae family of snakes are the only poisonous snakes, and include the copperhead, water moccasin, and rattlesnake. These snakes can be identified by the wedge-shaped head, elliptical pupils, and presence of fangs. Non-poisonous snakes have oval or round heads and round pupils and lack poisonous fangs. Non-poisonous snake bites can be handled similar to other bites with local wound care, tetanus immunization, etc. We will deal only with poisonous Crotalinae family snake bites in this document. See [Figure A] for an illustration of poisonous and non-poisonous snakes.

Pre-hospital EMS evaluation and treatment- Snakebite
Evaluation of the patient for snakebite: Always assure the ABC’s of trauma: airway, breathing, and circulation with a rapid, but careful primary assessment. The paramedics /EMS personnel are the first to assess the trauma patient and it is critical that important markers of significant injury are detected early, and those findings transmitted to ATCC and the destination ED, so that proper arrival preparations are made.

1. Does the patient have a patent and adequate airway? This is important to note and intervene for snakebites to the head and neck area, or for severe bites to the extremities or body.
2. If there is a good airway, is the patient breathing and ventilating adequately?
3. Is the patient in shock &/or not perfusing adequately? Are there any signs of bleeding?
4. Are breath sounds equal and adequate?
5. If there are any rings, bracelets, constricting clothing, etc. on an extremity that has been bitten, be sure to remove those before swelling worsens.
6. For extremity bites, check the pulse and perfusion of the extremity, as well as the neurologic function (ex- feeling and movement in fingers) initially, and frequently enroute to the trauma center.
7. Avoid tourniquets, pressure bandages, etc. for extremity bites.
8. Immobilize the extremity (if bitten) at heart level and avoid both elevation or dependent position.
Emergency Department (ED) evaluation and treatment- Snakebite

Initial and Subsequent Evaluation and Management

Always assure the ABC’s of trauma: airway, breathing, and circulation with a rapid, but careful primary assessment, that also includes a quick neurologic assessment (D) and exposure and examination (E) of the patient. Repeat frequent monitoring of both vital signs as well as neurovascular function of any bitten extremity will alert the ED physician to the degree of envenomation (or lack thereof).

As in the Pre-Hospital EMS section (above) attention should be paid (and action taken early on) for snake bites of the head or neck for subsequent airway compromise, or extremity bites for development of swelling and compartment syndrome. Repeated examination of the patient is important, and if the patient is found to move from minimal to moderate or severe degrees, then prompt aggressive therapy is indicated.

Initial evaluation revolves around determining the degree of envenomation and this can be done by the initial history and physical examination, plus laboratory tests, and repeat examinations and testing of the patient. Envenomation is typically divided into minimal, moderate, and severe classes. [See Figure B] It is important to note that approximately 25% of Crotalinae bites are “dry” bites where no venom was injected, and will only present with local trauma, but no evidence of swelling, pain, etc. seen in bites where venom was injected. A recent review article noted that only 14% of Crotalinae bites fell into the severe category, and that copper head and water moccasin bites were much less likely to create a severe reaction, as opposed to rattlesnake bites. ⁴

Initial laboratory tests typically include the following:

- Complete blood count
- Serum electrolytes and creatinine and blood urea nitrogen
- Serum creatine kinase (CK)
- Prothrombin time (PT) and partial thromboplastin time (PTT)
- International normalized ratio (INR)
- Fibrinogen
- Urinalysis
- Electrocardiogram (ECG)
Figure A: Characteristics of Poisonous and Non-poisonous Snakes

Comparison of venomous snakes (pit vipers) and nonvenomous snakes in the United States

Poisonous
- Triangular head (arrowhead)
- Elliptical pupil
- Fangs
- Anal plate
- (Rattlesnakes)
- Single row subcaudal plates
- No rattles (copperheads and cottonmouths)

Harmless
- Oval head (egg-shaped)
- Snout
- Round pupil
- Teeth
- Anal plate
- Double row subcaudal plates

Figure B: Degrees of Envenomation 3

<table>
<thead>
<tr>
<th>Category</th>
<th>Tissue effect</th>
<th>Systemic signs</th>
<th>Coagulopathy and bleeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>Swelling, pain, and ecchymosis adjacent to the bite site</td>
<td>None</td>
<td>Normal coagulation parameters(^\d); no bleeding</td>
</tr>
<tr>
<td>Moderate</td>
<td>Swelling, pain, and ecchymosis less than full extremity or less than 50 cm if bite on head, neck, or trunk</td>
<td>Present but not life-threatening (eg, nausea, vomiting, diarrhea, oral paresthesia, unusual tastes, tachycardia, tachypnea, mild hypotension [eg, systolic BP &gt;90 mmHg in an adult or &gt;5th percentile for age in children])</td>
<td>Abnormal coagulation parameters(^\d); no bleeding or minor hematuria, gum bleeding, and/or epistaxis</td>
</tr>
<tr>
<td>Severe</td>
<td>Swelling, pain, ecchymosis involving more than the entire extremity; greater than 50 cm if bite on head, neck, or trunk; threatens the airway; OR signs of compartment syndrome</td>
<td>Present and life-threatening (eg, respiratory insufficiency, marked tachycardia for age with severe hypotension, obtundation, seizures)</td>
<td>Markedly abnormal coagulation parameters(^\d) with serious bleeding</td>
</tr>
</tbody>
</table>

FabAV: polyvalent Crotalidae ovine immune Fab (Crofab, Protherics); BP: blood pressure.
* Includes bites by rattlesnakes, water moccasins (cottonmouths), and copperheads.
\(^\d\) Coagulation parameters include platelet count, prothrombin time (PT), partial thromboplastin time (PTT), international normalized ratio (INR), fibrinogen, and fibrin degradation products (eg, D-dimer or fibrin split products [FSP]).

**Treatment: Mild, Moderate, and Severe Envenomation**

In general, mild envenomation requires close monitoring and wound management, **but does not require antivenom, pressor agents, or treatment with blood products—or transfer to a higher level of trauma center.**

Moderate to severe classes of patients will require more aggressive therapy. See [Figure C- two pages] for a recent expert consensus document and algorithm on treatment, when to refer the patient to a higher level of care, or call a physician expert, and treatments to avoid.  

[Figure D- two pages] is from Up To Date, and contains much the same information, but in a more detailed format regarding antivenom dosing and follow-up.  

**Consultation with a medical toxicologist is recommended prior to antivenom administration unless the physician has experience with snakebite treatment.**

**Phone consultation with a medical toxicologist is available through a United States regional poison control center by calling 1-800-222-1222.**
Figure C: Unified treatment algorithm for the management of Crotalinae snakebite in the United States

Emergency Department and Hospital Management of Pit Viper Snakebite
Includes: Rattlesnakes, Copperheads, and Cottonmouths (Water Moccasins)

1. Assess Patient
   - Mark leading edge of swelling and tenderness every 15-30 minutes
   - Immobilize and elevate extremity
   - Treat pain (IV opioids preferred)
   - Obtain initial lab studies (protime, Hgb, platelets, fibrinogen)
   - Update tetanus
   - Contact poison control center (1-800-222-1222)

2. Check for Signs of Envenomation
   - Swelling, tenderness, redness, ecchymosis, or ecchymosis at the bite site, or
   - Elevated protime; decreased fibrinogen or platelets, or
   - Systemic signs, such as hypotension, bleeding beyond the puncture site, refractory vomiting, diarrhea, angioedema, neurotoxicity
   - None
   - Present

3. Check for Indications for Antivenom
   - Swelling that is more than minimal and that is progressing, or
   - Elevated protime; decreased fibrinogen or platelets, or
   - Any systemic signs
   - None
   - Present

4. Administer Antivenom
   - Establish IV access and give IV fluids
   - Pediatric antivenom dose = adult dose
   - Mix 4-6 vials of crotolyte Fab antivenom (CnFab®) in 250 ml NS and infuse IV over 1 hour
     - For patients in shock or with serious active bleeding
       - Increase initial dose of antivenom to 5-12 vials
       - Call physician expert (see box 12)
       - Initiate first dose of antivenom in ED or ICU
       - For suspected adverse reaction: hold infusion, treat accordingly, and call physician expert
       - Re-examine patient for treatment response within 1 hour of completion of antivenom infusion

5. Determine if Initial Control of Envenomation has been Achieved
   - Swelling and tenderness not progressing
   - Protime, fibrinogen, and platelets normal or clearly improving
   - Clinically stable (not hypotensive, etc.)
   - Neurotoxicity resolved or clearly improving
   - No
   - Yes

6. Monitor Patient
   - Perform serial examinations
   - Maintenance antivenom therapy may be indicated
   - Read Box 13 (Maintenance Antivenom Therapy)
   - Observe patient 16-24 hours after initial control for progression of any venom effect
   - Follow-up labs 6-12 hours after initial control and prior to discharge
   - If patient develops new or worsening signs of envenomation, administer additional antivenom per box 4

7. Determine if Patient Meets Discharge Criteria
   - No progression of any venom effect during the specified observation period
   - No unfavorable laboratory trends in protime, fibrinogen, or platelets
   - No
   - Yes

8. See Post-Discharge Planning (box 14)

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Figure C: Unified treatment algorithm for the management of Crotalinae snakebite in the United States

- **When to Call a Physician-Expert**
  - Direct consultation with a physician-expert is recommended in certain high-risk clinical situations:
    - Life-threatening envenomation
      - Shock
      - Serious active bleeding
      - Facial or airway swelling
    - Hard to control envenomation
      - Envenomation that requires more than 2 doses of antivenom for initial control
    - Recurrence or delayed-onset of venom effects
      - Worsening swelling or abnormal labs (protime, fibrinogen, platelets, or hemoglobin) on follow-up visits
    - Allergic reactions to antivenom
    - If transfusion is considered
    - Uncommon clinical situations
      - Bites to the head and neck
      - Rhabdomyolysis
      - Suspected compartment syndrome
      - Venom-induced hives and angioedema
    - Complicated wound issues
      - If no local expert is available, a physician-expert can be reached through a certified poison center (1-800-222-1222) or the antivenom manufacturer’s line (1-877-377-3784).

- **Maintenance Antivenom Therapy**
  - Maintenance therapy is additional antivenom given after initial control to prevent recurrence of limb swelling
  - Maintenance therapy is 2 vials of antivenom Q6H x 3 (given 6, 12, and 10 hours after initial control)
  - Maintenance therapy may not be indicated in certain situations, such as:
    - Minor envenomations
    - Facilities where close observation by a physician-expert is available.
  - Follow local protocol or contact a poison center or physician-expert for advice.

- **Post-Discharge Planning**
  - Instruct patient to return for:
    - Worsening swelling that is not relieved by elevation
    - Abnormal bleeding (gums, easy bruising, melena, etc.)
  - Instruct patient where to seek care if symptoms of serum sickness (fever, rash, muscle/joint pains) develop
  - Bleeding precautions (no contact sports, elective surgery or dental work, etc.) for 2 weeks in patients with
    - Rattlesnake envenomation
    - Abnormal protime, fibrinogen, or platelet count at any time
  - Follow-up visits:
    - Antivenom not given:
      - PRN only
    - Antivenom given:
      - Copperhead victims: PRN only
      - Other snakes: Follow up with labs (protime, fibrinogen, platelets, hemoglobin) twice (2-3 days and 5-7 days), then PRN

**Notes:**
- All treatment recommendations in this algorithm refer to crotalid polyvalent immune Fab (on live) (CroFab®).
- This worksheet represents general advice from a panel of US snakebite experts convened in May, 2010. No algorithm can anticipate all clinical situations. Other valid approaches exist, and deviations from this worksheet based on individual patient needs, local resources, local treatment guidelines, and patient preferences are expected. This document is not intended to represent a standard of care. For more information, please see the accompanying manuscript, available at www.biomedcentral.com.
### Figure D: Antivenom Therapy for Crotalinae Snake Bites

**Antivenoms for bites by rattlesnakes, water moccasins (cottonmouths), and copperheads in North America**

<table>
<thead>
<tr>
<th>Approved indication(s)</th>
<th>Antivenom</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rattlesnakes, water moccasins (cottonmouths), and copperheads</td>
<td>Polyvalent Crotalinae ovine immune Fab (FabAV, CroFab)</td>
<td>Known allergy to papain, papaya, or FabAV during prior administration</td>
</tr>
<tr>
<td></td>
<td>Crotalidae Immune equine Fab' (Fab') 2 (Fab2AV, AnaFab)</td>
<td>Known allergy to horse protein or Fab2AV during prior administration</td>
</tr>
<tr>
<td><strong>Precautions</strong></td>
<td> </td>
<td> </td>
</tr>
<tr>
<td> </td>
<td> </td>
<td> </td>
</tr>
<tr>
<td><strong>Initial dose (same for pediatric and adult patients)</strong></td>
<td> </td>
<td> </td>
</tr>
<tr>
<td> </td>
<td>Moderate envenomation: 4 to 6 vials; repeat dose if initial control of local and systemic venom effects not achieved</td>
<td>Moderate or severe envenomation: 10 vials; repeat dose if initial control of local and systemic venom effects not achieved</td>
</tr>
<tr>
<td> </td>
<td>Severe envenomation: 8 to 12 vials; repeat with higher number of vials if insufficient response</td>
<td> </td>
</tr>
<tr>
<td> </td>
<td>Call physician expert if initial control not achieved after 2 loading doses</td>
<td>Call physician expert if initial control not achieved after 2 loading doses</td>
</tr>
<tr>
<td><strong>Routine maintenance doses</strong></td>
<td> </td>
<td> </td>
</tr>
<tr>
<td>2 vials every 6 hours for 3 doses</td>
<td> </td>
<td>Not recommended; may give 4 additional vials for recurrent local or systemic effects</td>
</tr>
<tr>
<td><strong>Reassessment of coagulation status at 2 to 3 days and 5 to 7 days after antivenom administration?</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Consultation with a medical toxicologist or other physician with expertise and prior experience treating venomous snake bites is strongly encouraged before initiating antivenom therapy for bites by Crotalinae snakes found in North America (rattlesnakes, water moccasins [cottonmouths], and copperheads). Emergency consultation with a medical toxicologist in the United States is available at 1-800-222-1222. Antivenom administration is associated with potentially severe allergic reactions; it should only occur in a continuously monitored emergency or intensive care unit setting. During administration, the physician should ensure the immediate availability of epinephrine ([concentration 1 mg/mL] 0.3 to 0.5 mg intramuscularly in the anterolateral thigh, [concentration 0.1 mg/mL] prepared for continuous intravenous infusion), diphenhydramine or similar antihistamine, intravenous corticosteroids, and inhaled albuterol during antivenom administration.
Figure D: Antivenom Therapy for Crotalinae Snake Bites

* For indications regarding when to administer antivenom, refer to UpToDate topics on management of Crotalinae snakebites in the United States.

† When precautions are present, antivenom should only be administered when the benefit outweighs the risk. These patients warrant pretreatment for anaphylaxis and adjustment of the rate of infusion. Refer to UpToDate content on treatment of acute allergic reactions to Crotalinae snake antivenom.

△ Dose is the same for children and adults. Reconstitution depends upon the antivenom used:

- For FabAV (CroFab), the manufacturer suggests the modified method for reconstitution: inject 18 mL sterile normal saline into the vial and manually invert about 2 times per second (do not shake) until completely dissolved by visual inspection. The resulting antivenom should appear weakly yellow and opalescent. Typical reconstitution time is 3 minutes.
- For Fab2AV (Anavip), reconstitute each vial of lyophilized powder with 10 mL of sterile normal saline and mix with continuous, gentle swirling. Typical reconstitution time is less than 1 minute per vial. The resultant material is yellow/green and opalescent.

For both antivenoms, do not use if otherwise discolored or turbid.

Once either FabAV or Fab2AV is reconstituted, combine contents of all vials and further dilute to a total of 250 mL sterile normal saline. Infuse within 4 hours of preparation: administer the antivenom as an intravenous infusion at an initial rate of 25 to 50 mL/hour for the first 10 minutes. If tolerated, increase the rate to finish the infusion over 1 hour.

If signs of adverse effects (e.g., urticaria, lip or tongue swelling, difficulty breathing, or hypotension) develop, immediately stop the infusion. Refer to UpToDate content on treatment of acute hypersensitivity caused by North American Crotalinae snake antivenom for further recommendations.

◊ Coagulation testing should include complete blood count with a focus on the platelet count, prothrombin time (PT), activated partial thromboplastin time (aPTT), international normalized ratio (INR), plasma fibrinogen, and either D-dimer or fibrin split products. Fibrin degradation testing should occur at least 4 hours after envenomation, which is usually after antivenom is given; antivenom therapy does not affect the results of these tests. Refer to UpToDate topics on treatment of recurrent coagulopathy after management of Crotalinae snakebite.

References:

References


2 Up to Date: Prehospital care of the adult trauma patient 2020.


5 Up to Date: Bites by Crotalinae snakes (rattlesnakes, water moccasins [cottonmouths], or copperheads) in the United States: Management. https://www-uptodate-com.libproxy.uams.edu/contents/bites-by-crotalinae-snakes-rattlesnakes-water-moccasins-cottonmouths-or-copperheads-in-the-united-states-management?search=snake%20bite%20management&source=search_result&selectedTitle=2~49&usage_type=default&display_rank=2