Rattlesnake Bite
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Target Audience: Emergency Medicine Residents (junior and senior level postgraduate learners), Medical Students

Primary Learning Objectives:
1. Recognize signs and symptoms of a venomous snakebite.
2. Recognize the indications for antivenom administration.
3. Recognize potentially dangerous complications of a snakebite and antivenom administration.

Secondary Learning Objectives: detailed technical/behavioral goals, didactic points
1. Obtain medication history and evaluate for use of anticoagulant medications
2. Discuss importance of reevaluation of local effects
3. Describe the importance of removing tourniquets that may have been placed prior to arrival in ED
4. Describe the types of toxicity that can result from rattlesnake envenomation

Critical actions checklist:
1. Obtain peripheral IV access (in contralateral arm)
2. Order coagulation studies (CBC, platelets, INR, fibrinogen)
3. Administer antivenom
4. Stop antivenom infusion when anaphylactic/anaphylactoid reaction to antivenom develops
5. Provide volume resuscitation for anaphylactic/anaphylactoid reaction
6. Administer medications for anaphylaxis
7. Consult Poison Center/Toxicologist
8. Admit to the MICU

Environment: Emergency Department treatment area
    1. Room Set Up – ED critical care area
        a. Manikin Set Up – Mid or high fidelity simulator
        b. Props – Standard ED equipment
    2. Distractors – ED noise, alarming monitor

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CASE SUMMARY

SYNOPSIS OF HISTORY/ Scenario Background

This is a case of a 32-year-old man who is brought to the emergency department reporting a snakebite by a prairie rattlesnake while working in the local zoo that afternoon. He reports severe pain at the site and progressive swelling up his arm since the bite 2-3 hours ago. Exam will show local tissue damage and swelling. Ideally, tissue necrosis should lead to antivenom administration early. If not, initial bloodwork (if sent) will show a coagulopathy and thrombocytopenia requiring antivenom, and the local tissue destruction and swelling will continue to progress. Following administration of antivenom, the patient develops an anaphylactic response that responds to initial drug cessation, antihistamines, steroids, and epinephrine use.

PMHx: None

PSHx: None

Medications: None

Allergies: penicillin (rash)

SocHx: Lives on his own. Social drinker. Denies drug use. Non-smoker.

SYNOPSIS OF PHYSICAL

- Tachycardia
- Regarding site of injury:
    - Severe pain at site
    - Bite marks with extensive swelling, ecchymosis and erythema
    - Intact distal neurovascular function
    - Pain with range of motion

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HISTORY

A 32-year-old male is brought to your community emergency department reporting a snakebite to the right forearm while working in the local zoo that afternoon. He reports severe pain at the site that has been worsening since the bite 2-3 hours ago. He appears upset and agitated.

Onset of Symptoms: 2-3 hours ago

Background Info: While working at the local zoo that afternoon he was accidentally bitten on the right forearm by a snake while cleaning the cage. The snake was a prairie rattlesnake. He stayed at work initially because the pain was mild, and he thought it was a dry bite. As the pain increased and spread up his arm, he decided to seek medical attention.

Chief Complaint: Snake bite

PMHx: None

PSHx: None

Medications: None

Allergies: Penicillin (rash)

FamHx: None

SocHx: Lives on his own. Social drinker. Denies drug use. Non-smoker.

ROS: As per HPI. CNS: Agitated, but no specific complaints. CVS: He thinks his heart may be beating faster. MSK: Complains of severe pain to his forearm which has started spreading from the bite site up his arm. He denies paresthesias but feels like he is weaker in that arm now.

Required Actions within the First Two Minutes

- Obtain HPI and essential ROS
- Establish safety net (IV, oxygen, cardiac monitor, two large bore IVs, draw blood for labs)
- A/B – Provide supplemental oxygen
- C – Cardiac monitor; NS IV bolus; ECG
- D/E - Extremity elevation and local wound care (e.g., irrigation, dressings, tetanus immunizations, splinting)

CASE CONTINUATION - PHYSICAL EXAM

General Appearance: Agitated and uncomfortable, complaining of severe pain

Vital Signs: **BP: 124/86 mmHg P: 98/minute R: 22/minute T: 37C (98.6F) POx: 98% (FiO_2=0.21)**

HEENT: Normal

Neck: No tenderness or deformity on exam, full range of motion, no JVD

Skin: Warm and well-perfused, no rash.

Chest/CVS: Tachycardic. Perfusing well.

Lungs: Breath sounds present in all anterior and posterior lung fields. No adventitious sounds.

Heart: Bradycardic rate with irregular rhythm, normal S1 and S2, no murmurs, rubs

Back: Normal

Abdomen: Soft, non-tender, and non-distended. No guarding, rebound, or rigidity.

Extremities: Right mid forearm examination shows bite marks with extensive swelling to the limb with ecchymosis and erythema surrounding the area for >15cm in diameter. Distal pulses are intact. Distal sensation is intact. The patient can move the limb and his digits, but reports severe pain with the attempt.

Neurologic: Awake and alert. No deficits.

Required Actions within the Next Two Minutes

- Laboratory studies (especially CBC, fibrinogen, INR, and platelets) should be ordered and sent by this time
- Resuscitation with IV crystalloid fluids should have started by this time
- Analgesics for pain should be administered at this time
- Poison Center/Toxicologist consultation regarding indications and dosing for antivenom should be considered and obtained at this time

Branch Point

- **IF PATIENT RECEIVES ANALGESICS,** then he begins to settle down as the pain lessens. HR and RR decrease to 88/minute and 16/minute, respectively.
- **IF LOCAL WOUND CARE IS NOT PERFORMED – OR – IF WOUND IS NOT INITIALLY EVALUATED,** then the edema and ecchymosis of the upper extremity worsen and appear to spread proximally (“ascending”).
- **IF THE EDEMA AND ECCHYMOSIS OF THE UPPER EXTREMITY WORSEN,** then the patient will begin to demonstrate worsening anxiety and fear over systemic spread of the venom.

Required Actions within the Next Several Minutes

- Labs return, notable for elevated INR, thrombocytopenia, and decreased fibrinogen levels
- Poison Center/Toxicologist consultation should have been obtained by this time
- Antivenom administration should be considered and started by this time

Branch Points

- **IF ANTIVENOM IS NOT ADMINISTERED AT THIS TIME,** then the edema and ecchymosis of the upper extremity continue to worsen and spread proximally. **HEMORRHAGIC BLISTERS AND BULLAE WILL BEGIN TO APPEAR AS THE CASE PROGRESSES UNTIL ANTIVENOM IS GIVEN.**
- **IF PATIENT DOES NOT RECEIVE ANTIVENOM AT THIS TIME,** then the patient's anxiety and hysteria regarding the systemic spread of the venom continues to worsen (**AGITATION WORSENS)**.
- **IF ANTIVENOM IS ADMINISTERED AT THIS TIME,** then the patient will begin to experience dysphoria that progresses to a "feeling of impending doom", shortness of breath, diffuse wheezing, and pruritis (patient will begin to demonstrate a diffuse, patchy, macular, blanching, erythematous urticarial rash over the arms, legs, torso, abdomen, and back). **NOTE: THERE WILL BE NO EVIDENCE OF ANGIOEDEMA OR TONGUE/LIP SWELLING AT THIS TIME.**

CASE CONTINUATION

Vital Signs: BP: 80/40 mmHg P: 118/minute R: 28/minute T: 37C (98.6F) POx: 95% (FiO_2=0.21)

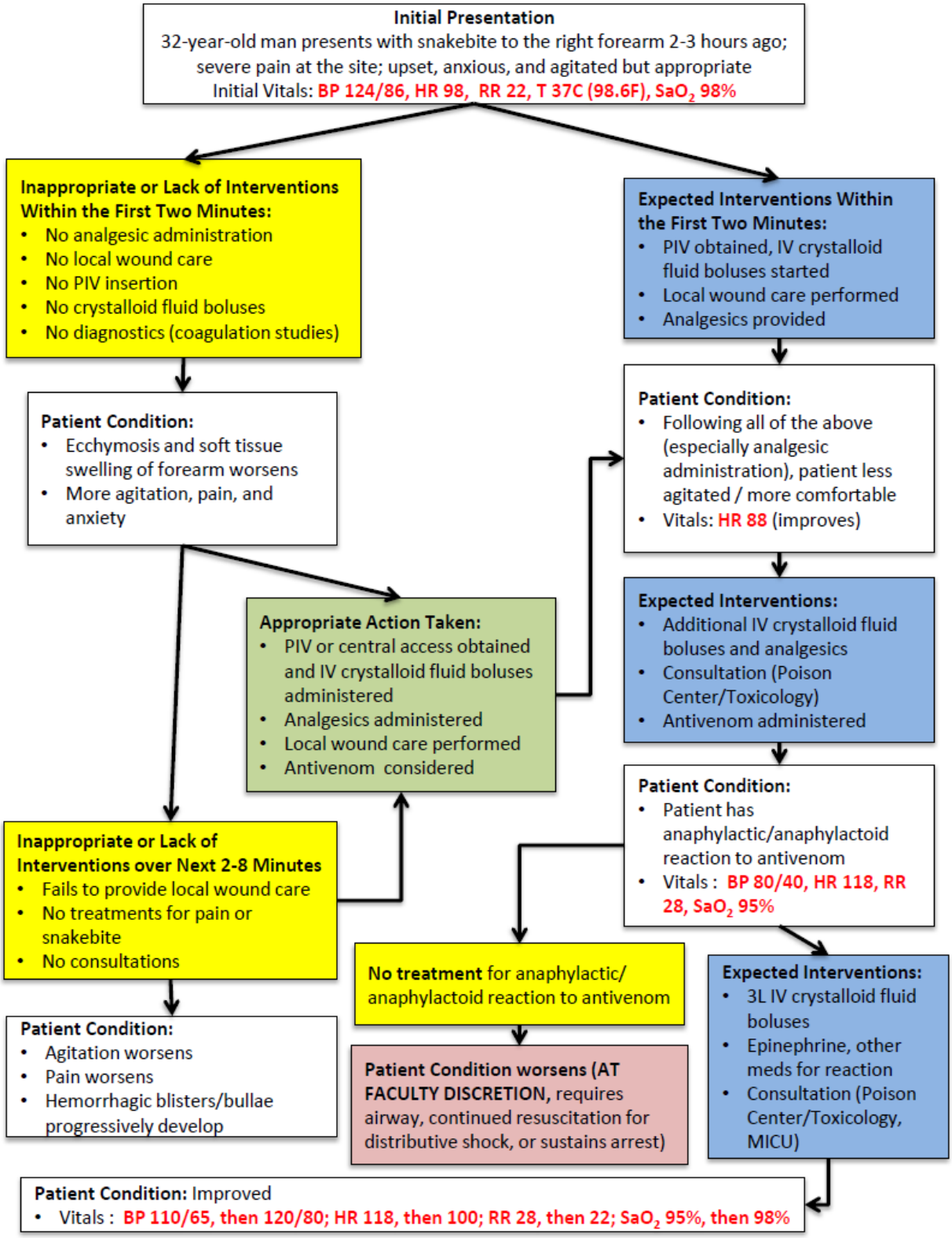
Required Actions within the Next Several Minutes

- Patient should receive therapies for anaphylactic/anaphylactoid reaction at this time.
- Patient should receive additional IV crystalloid fluid boluses at this time
- MICU should be consulted by this time for definitive disposition

Branch Points

- **IF PATIENT RECEIVES AT LEAST THREE LITERS OF CRYSTALLOID FLUID THERAPY, THEN HYPOTENSION RESOLVES.**
- **IF THERAPIES FOR THE ANAPHYLACTIC/ANAPHYLACTOID REACTION ARE GIVEN, THEN THE PATIENT'S CLINICAL STATUS WILL IMPROVE.**
  - **Vital Signs (First Reassessment): BP: 100/65 mmHg P: 118/minute R: 28/minute T: 37C (98.6F) POx: 95% (FiO_2=0.21)**
  - **Vital Signs (Second Reassessment): BP: 120/80 mmHg P: 100/minute R: 22/minute T: 37C (98.6F) POx: 98% (FiO_2=0.21)**

Timeline and Branch Points for This Case



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CRITICAL ACTIONS

1. **Obtain peripheral IV access (in contralateral arm)**

   Obtain peripheral IV access (in contralateral arm).
   Cueing Guideline: Nurse can ask if the doctor wants an IV inserted and blood for testing.

2. **Order coagulation studies (CBC, platelets, INR, fibrinogen).**

   Order coagulation studies. To meet this critical action, the participant should send for the following tests (at a minimum): CBC, platelets, INR, and fibrinogen.
   Cueing Guideline: Nurse can ask if the doctor what specific tests are indicated in the context of snakebite.

3. **Administer antivenom**

   Administer antivenom (4-6 vials intravenously).
   Cueing Guideline: The nurse asks if the doctor can provide an antidote for the patient's snakebite.

4. **Stop antivenom infusion when anaphylactic/anaphylactoid reaction to antivenom develops**

   Stop antivenom infusion when anaphylactic/anaphylactoid[1] reaction to antivenom develops.
   Cueing Guideline: The nurse asks if the doctor about the patient's sudden deterioration following antivenom administration, and what can be done.

5. **Provide volume resuscitation for anaphylactic/anaphylactoid reaction**
   Give at least 3 liters of fluid for volume resuscitation in the context of distributive shock from anaphylactic/anaphylactoid reaction to antivenom.
   Cueing Guideline: The nurse may say, "We have a line in place. Would you like any fluids?" or point out the patient's hypotension following antivenom administration.

6. **Provide medications for anaphylactic/anaphylactoid reaction**
   Provide medications for anaphylactic/anaphylactoid reaction. Administration of one or more therapies should be considered at this time (e.g., epinephrine, methylprednisolone, famotidine, cimetidine, diphenhydramine, etc.) in the context of distributive shock from anaphylactic/anaphylactoid reaction to antivenom.
   Cueing Guideline: The nurse may say, "We have a line in place. Would you like any medications for the patient's hypotension" or merely point out the hypotension following antivenom administration.

[1] The reaction to the antivenom may be anaphylactic if the patient had previously been exposed to antivenom. In a zoo worker, this is conceivable if he/she were bitten previously and received antivenom in the past.

7. Consult Poison Center/Toxicologist

The Poison Center or Toxicology Service should be consulted for further management recommendations regarding snakebite treatment.
Cueing Guideline: The nurse can ask if the doctor has called the Poison Center yet.

8. Admit to the MICU

Admit to the MICU for continued critical care monitoring and reassessment. A discussion with intensivist regarding admission is required prior to the completion of the case.
Cueing Guideline: The nurse can ask if there is a definitive disposition for the patient yet.

Critical Actions Checklist[2]

Resident Name	
Case Description	

Skills measured **Core competencies: PC** Patient care, **MK** Medical knowledge, **IC** Interpersonal and communication skills **P** Professionalism, **PB** Practice-based learning and improvement **SB** Systems-based practice	Very Unacceptable		Unacceptable		Acceptable		Very Acceptable	
Data Acquisition (D) PC MK I	1	2	3	4	5	6	7	8
Problem Solving (S) PC MK PB	1	2	3	4	5	6	7	8
Patient Management (M) PC MK IC P PB SB	1	2	3	4	5	6	7	8
Resource Utilization (R) PC PB SB	1	2	3	4	5	6	7	8
Health Care Provided (H) PC SB	1	2	3	4	5	6	7	8
Interpersonal Relations (I) IC P	1	2	3	4	5	6	7	8
Comprehension of Pathophysiology (P) MK PB	1	2	3	4	5	6	7	8
Clinical Competence (C) PC MK IC P PB SB	1	2	3	4	5	6	7	8

Critical Actions

Yes	No		Comments:
		Obtain peripheral IV access (in contralateral arm)	
		Order coagulation studies (CBC, platelets, INR, fibrinogen)	
		Administer antivenom	
		Stop antivenom infusion when anaphylactic/anaphylactoid reaction to antivenom develops	
		Provide volume resuscitation for anaphylactic/anaphylactoid reaction	
		Provide medications for anaphylactic/anaphylactoid reaction	
		Consult Poison Center/Toxicologist	
		Admit to the MICU	

Yes	No	Dangerous actions

[2] Modified ABEM Oral Certification Examination checklist and scoresheet

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STIMULUS INVENTORY

#1 Complete blood count

#2 Basic metabolic panel

#3 Urinalysis

#4 Liver function tests

#5 Venous blood gas

#6 Toxicology

#7 Coagulation studies

#8 ECG

#9 CXR

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LAB DATA & IMAGING RESULTS

Stimulus #1	
Complete Blood Count (CBC)	
WBC	10,000/mm^3
Hemoglobin	14.7 g/dL
Hematocrit	43%
Platelets	73,000/mm^3
Differential	
PMNLs	75%
Lymphocytes	22%
Monocytes	2%
Eosinophils	1%

Stimulus #2A	
Basic Metabolic Panel (BMP)	
Sodium	138 mEq/L
Potassium	4.6 mEq/L
Chloride	102 mEq/L
Bicarbonate	23 mEq/L
Glucose	142 mg/dL
BUN	29 mg/dL
Creatinine	0.8 mg/dL

Stimulus #3	
Urinalysis	
Color	Yellow
Specific gravity	1.030
Glucose	Negative
Protein	Negative
Ketones	Negative
LE/Nitrites	Negative
Blood	Negative
WBC/RBC	0/hpf / 0/hpf
Crystals/bacteria	Negative

Stimulus #4	
Liver Function Tests	
AST	49 IU/L
ALT	32 IU/L
ALP	110 IU/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

Stimulus #5	
Venous Blood Gas	
pH	7.42
pCO_2	35 mmHg
pO_2	55 mmHg
HCO_3	22 mEq/L
Lactate	2.4 mmol/L

Stimulus #6	
Toxicology	
APAP / ASA	Undetectable
Ethanol	Undetectable

Stimulus #7	
Coagulation Studies	
PTT	67 seconds
INR	2.8
Fibrinogen	40 mg/dL (200-400 mg/dL)

Stimulus #8
ECG Sinus tachycardia without ST Segment or T wave changes

Stimulus #9	
Radiology	
CXR	Normal

Stimulus #1

Complete Blood Count (CBC)

WBC	10,000/mm^3
Hemoglobin	14.7 g/dL
Hematocrit	43%
Platelets	73,000/mm^3
Differential	
PMNLs	75%
Lymphocytes	22%
Monocytes	2%
Eosinophils	1%

Stimulus #2

Basic Metabolic Panel (BMP)

Sodium	138 mEq/L
Potassium	4.6 mEq/L
Chloride	102 mEq/L
Bicarbonate	23 mEq/L
Glucose	142 mg/dL
BUN	29 mg/dL
Creatinine	0.8 mg/dL

Stimulus #3

Urinalysis

Color / pH	Yellow
Specific gravity	1.030
Glucose	Negative
Protein	Negative
Ketones	Negative
LE/Nitrites	Negative
Blood	Negative
WBC/RBC	0/hpf / 0/hpf
Crystals/bacteria	Negative

Stimulus #4

Liver Function Tests

AST	49 IU/L
ALT	32 IU/L
ALP	110 IU/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

Stimulus #5

Venous Blood Gas

pH	7.42
pCO_2	35 mmHg
pO_2	55 mmHg
HCO_3	22 mEq/L
Lactate	2.4 mmol/L

Stimulus #6

Toxicology

APAP / ASA	Undetectable
Ethanol	Undetectable

Stimulus #7

Coagulation Studies

PTT	67 seconds
INR	2.8
Fibrinogen	40 mg/dL (200-400 mg/dL)

Stimulus #8

ECG: Sinus tachycardia without ST Segment or T wave changes

Stimulus #9

Radiology

CXR	Normal

<u>Debriefing Materials</u> - Snakebites

Remember Educational Goal: To recognize and manage a patient presenting with a snakebite.

Sample Debriefing Questions

1) How did you know this patient had a venomous snakebite (vs. a dry bite)?
2) What are the indications for giving antivenom? When did this patient meet them?
3) What are the possible complications of snake envenomation? Of antivenom?
4) Did you feel comfortable/prepared to treat this patient? What could have helped you?
5) When did you first decide to contact the poison center?

Background

- 2 main classes of venomous snakes in North America
  - elapidae
    - coral snakes, cobras
  - crotalidae
    - pit vipers
    - includes rattlesnakes, copperheads, water moccasins

Clinical Features

- bites may be “dry” in as much as 25-30%
- envenomation can cause anaphylaxis
- elapidae
  - cause neurotoxicity at the level of the acetylcholine receptor
  - often starts with ptosis, then vertigo, paresthesias, fasciculations, slurred speech, paralysis
  - mortality generally due to respiratory failure
- crotalidae
  - cause 1)local tissue damage, 2)systemic effects, and 3)coagulopathy
  - local effects: burning pain, edema, ecchymosis, hemorrhagic blisters, rarely compartment syndrome
  - systemic effects: weakness, nausea, vomiting, sweating, coagulopathy, ARDS, hypotension (from extravasation), myokymia (muscle twitching)
  - coagulopathy: thrombocytopenia, hypofibrinogenemia, elevated INR & PT

Laboratory Studies

- must include CBC, INR, fibrinogen should be sent to assess for coagulopathy

Management

- supportive care
  - manage active bleeding, respiratory failure, hypotension, etc., as required
  - avoid blood products (platelets) → treat coagulopathy with antivenom

    - if envenomation to the head or neck, early airway control may be required
    - local wound care, including tetanus as required
    - immobilize the limb with a splint
- tourniquet use is not recommended
- prophylactic antibiotic use not recommended
- **antivenin (elapids)**
    - should be given as neurotoxicity can progress rapidly
        - but not manufactured in US any longer
        - outdated supply limited
        - observe patients; administer if worsening respiratory function
- **antivenom (crotalids)**
    - derived from sheep serum
    - derived from several species of North American pit vipers:
        - Crotalus atrox (Western Diamondback rattlesnake), Crotalus adamanteus (Eastern Diamondback rattlesnake), Crotalus scutulatus (Mojave rattlesnake), and Agkistrodon piscivorus (Cottonmouth or Water Moccasin)
    - thought to have reasonable cross-coverage with other species bite classification (crotalids)
        - grade 0
            - no evidence of envenomation, puncture wound and <1 inch of skin changes, no systemic involvement
        - grade 1
            - minimal envenomation, moderate pain, 1-5 inches of edema/erythema, no systemic involvement
        - grade 2
            - moderate envenomation, severe and more widely distributed pain, edema spreading proximally, petechiae and ecchymoses locally, nausea and vomiting
        - grade 3
            - severe envenomation, rapidly progressive with edema spreading proximally, generalized ecchymosis and petechiae, systemic signs such as tachycardia and hypotension, coagulopathy, renal or hepatic abnormalities
        - grade 4
            - very severe envenomation, as per grade 3, but with skin necrosis, rapid onset of systemic manifestations shock, potential convulsions and coma
            - intravenous envenomation may rapidly produces cardiac arrest
    - indications for antivenom:
        - grade 2 or higher envenomation
    - antivenom response may be incomplete or venom effect may outlast antivenom → be prepared to redose as often as every 1-2 hrs if symptoms are progressing
    - complications
        - anaphylaxis

- must be prepared to manage with good IV access, epinephrine available, and ability to manage airway
- if severe envenomation, may still require antivenom → can be given dilute form with simultaneous epinephrine

Disposition

- crotalids
  - if asymptomatic x8h, can discharge home with follow-up at 24-48h
  - if local pain and minimal edema with normal labs, can discharge at 12h
  - if moderate to severe envenomation, admit to ICU for antivenom and further management
- elapids
  - admit all to ICU for monitoring

References:

Rehab AM, Pizon AF. Chapter 122, Native (US) Venomous Snakes and Lizards. In: Hoffman RS, Howland MA, Lewin NA, et al editors. Goldfrank's Toxicologic Emergencies. 10th ed. China: McGraw-Hill Education; 2015. p.1537-46.