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Snakebites

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Snakebites

Epidemiology

- About 3000 species of snakes worldwide
- 375 medically important venomous snakes worldwide
- Snakes belong to Class Reptilia, Order Squamata, Suborder Serpientes
  - Comprised of 11 families
  - Venomous snakes are in 5 families
Venomous Snakebite
Epidemiology

5 families of venomous snakes & representative species:
- Colubridae
  - Boomslang, Bird snake
- Elapidae
  - Coral snakes, cobras, kraits, mambas, most Australian snakes
- Hydrophiidae
  - Sea snakes, sea krait
- Viperidae
  - Vipers, adders, asps (Old World)
- Crotalidae (pit vipers)
  - Rattlesnakes, Fer-de-lance, Bushmaster, copperhead
General Anatomic Comparisons of Venomous Snakes

- **Colubridae**: rear-fanged
- **Elapids**: front fangs, fixed maxilla
- **Vipers**: (both true & pit vipers) front-fanged, mobile maxilla
Snakebite Epidemiology

- No required reporting of cases, so quoted incidence numbers may be inaccurate

- Worldwide annually:
  - Possibly one million venomous bites
  - Possibly 30,000 to 60,000 deaths

- In U.S.A. annually:
  - 45,000 snakebites
  - 8000 venomous snakebites
  - 1 to 10 deaths
1951 worldwide mortality survey: numbers of deaths:
- Asia: 35,000
- South America: 4000
- Africa: 1000
- North America: 300 to 500
- Europe: 50
- Oceana: 10

However a 1980 estimate of deaths from spitting cobra and carpet viper was 23,000 in West Africa alone.
Factors determining relative risks of human envenomation by different snakes:

- Venom toxicity / potency
- In some species: size of the snake
- "Effectiveness" of the bite (at injecting venom)
- Innate aggressiveness of the snake
- Likelihood of human contact
Risk of Snakebite in Field Situations

- Southern Arizona Rescue Association: 115,000 man hours in "snake country" with no bites
- LeSelva Biological Station in Costa Rica: 1968 to 1987: 350,000 man hours without incident
- Organization for Tropical Studies in Costa Rica: one Fer-de-lance bite in 660,000 man hours
Risk of Snakebite in the U.S.A.

Most (60 to 80%) of reported bites in the U.S. are "illegitimate" (defined as bites occurring when the person by their own decision chose to handle a snake or expose themself to risk)

Most "legitimate" (i.e., accidental or unintentional) bites are on the lower extremity
Typical Profile of the U.S. Venomous Snakebite Victim

- Male
- Age 16 to 40 years
- Intoxicated
- Tatooed
- "Illegitimate" cause of the bite
- Usually bitten on upper extremity
- Most "legitimate" bites (2/3) are from April thru July
"Exotic" Snakebites in the U.S.A.

- Estimated 1 million snakes imported into the U.S. per year
- Largest import firm is in Florida
- Is legal in most states to import venomous snakes as pets
- Can see cobra bites & other "exotic" non-native snakebites anywhere in U.S.
- Zoos usually stock exotic snake antivenin for the species they have
Risk of Snakebite in Great Britain

- Vipera berus (European adder) is only poisonous snake in Britain
- Only 14 fatalities reported from 1876 to 1976
- 50% of cases have significant local or systemic toxicity
- Possibly several hundred bites per year total
Basic Purposes of Snake Venom

- Immobilize prey
- Assist in or start the digestive process
- Deter other predators
Functional Classification of Composition of Snake Venoms

- **Neurotoxins**
  - Mainly paralytic agents
  - These are main toxins from cobras, sea snakes

- **Myotoxins**
  - Cause tissue necrosis

- **Hemotoxins**
  - Cause coagulopathies
  - These are main toxins from pit vipers

- **Locally active toxins**
  - Cause tissue necrosis, blistering
Components of Snake Venom

Almost all are complex, multi-component mixtures:

- Proteolytic enzymes
- Collagenases
- Hyaluronidase
- Phospholipase
- Lactate dehydrogenase
- Acetylcholinesterase
- Nucleotidases
- Steroids
- Inorganic elements: zinc, magnesium
- Histamine, bradykinins, serotonin
- Aminopolysaccharides
Venomous U.S. Snakes

- Crotalidae (pit vipers) : 95 % of bites :
  - Rattlesnakes : about 20 species in 47 states
  - Mojave rattlesnake : only one with mainly neurotoxins ; only in Arizona
  - Cottonmouth (Water Moccasin) : Midwest and South states
  - Copperhead : in about 40 states ; least toxic (almost never requires use of antivenin)
Copperhead

Thomas Fatora, Wikimedia Commons.

Copperhead
Cottonmouth (water moccasin)
Sidewinder rattlesnake

Mark Bratton, Wikimedia Commons
Diamondback rattlesnake
Venomous U.S. Snakes (cont.)

- Elapidae: 3 to 5% of bites
  - Eastern coral snake: Southeastern U.S.
  - Western Coral Snake: Arizona, New Mexico
  - Both these species are unaggressive
  - Yellow-bellied sea snake: off California in Pacific Ocean

- Gila Monster: world's only poisonous lizard: in New Mexico, Arizona

- Exotic pet snakes or zoo snakes
Most Dangerous U.S. Venomous Snakes

- Eastern Diamondback Rattlesnake*
  - Largest U.S. native snake
- Western Diamondback Rattlesnake*
- Mojave Rattlesnake
- Least toxic type is Copperhead

* Account for 95 % of deaths but only 10 % of total bites
Identification Characteristics of U.S. Venomous Snakes

*f* Pit Vipers
- Indentation or "pit" between eye and nostril
- Flat triangular-shaped head
- Vertical pupils
- Curved fangs (usually 2; sometimes 1 to 4)
- Rattlesnakes have "rattle" at end of tail

*f* Coral Snakes
- Rounded head, black snout
- Red & black bands separated by yellow or white rings
- "Red on black: venom lack; red on yellow: kill a fellow" is how to tell apart from banded King and corn snakes
Head identification differences between U.S. poisonous and non-poisonous snakes
Other features differentiating U.S. poisonous versus non-poisonous snakes
Identification Characteristics of U.S. Non-venomous Snakes

- rounded head
- round pupil
- 2 rows of small teeth
- double row of subcaudal plates (less reliable)

Note: many non-North American venomous snakes have above characteristics
Characteristics of U.S. Pit Vipers

- Deaf, poor vision, color blind
- Excellent sense of smell and vibration
- Feed at night; less active during day
- Are venomous from birth
- Are strict carnivores
- Top speed only 3 m.p.h.
- Can strike at > 8 feet/second speed
- Strike up to half body length
- Live up to 30 years
Venom Apparatus of U.S. Pit Vipers

- Venom gland is modified salivary gland
- Venom duct runs into groove in fangs
- Fangs retract or fold down when snake closes mouth
- Anywhere from 20% to 75% of venom in gland can be discharged at one strike
- Snake has some control over amount of venom injected: tends to inject larger amounts if suspected larger prey
- Small snakes have lesser amounts of venom than larger snakes
- If fang breaks, it can be replaced by a new one growing in from behind
Major Actions of Pit Viper Venom

- Local tissue damage / necrosis
- Coagulopathy
  - Thrombocytopenia
  - Fibrinolysis
- Hemolysis
- Vascular wall / capillary damage
- Neurotoxins: from Mojave rattlesnake cause respiratory paralysis
Complications of Pit Viper Envenomation

- Hypotension: can progress to frank shock
- Pulmonary edema or respiratory distress syndrome
- Disseminated intravascular coagulation / fibrinolysis
  - Bleeding from bite site, mucus membranes, other sites
  - Thrombosis of smaller vessels
- Rhabdomyolysis*
- Fasciculations*
- Hemolytic anemia*
Manifestations of Coagulopathy in the Envenomated Patient

- Bleeding from bite site
- Hematuria
- Epistaxis
- Melena
- Petechiae / Purpura
Sequence of Local and Regional Signs and Symptoms from Pit Viper Envenomation

(in rough order of occurrence)

- Pain
- Swelling / edema
- Ecchymosis
- Fasciculations
- Vesiculation
- Tissue necrosis
Systemic Envenomation Symptoms from Pit Viper Bites

- Perioral tingling or numbness
- Numbness of extremities or scalp
- Metallic taste in mouth
- Nausea and vomiting
- Weakness
- Diaphoresis
- Faintness / Chills
- Coagulopathy
- Neurologic (rare): paralysis, seizures
Symptoms & Signs of Envenomation by Copperheads

- Pain disproportionate to appearance
- Proximal pain
- Extremity paresthesias
- Bitter or altered taste
- Nausea
- Lightheadedness
- Edema & ecchymosis at site with proximal progression
- Normal platelets, protime
- Mild rhabdomyolysis
Symptoms & Signs of Envenomation by Rattlesnakes

Similar to copperhead, except:
- Vomiting & other systemic sx & signs
- Rapid onset severe thrombocytopenia
- Site bleeding
- Delayed hemorrhagic bullae
- Generalized fatigue
- Tissue necrosis
- Metallic taste
- D.I.C.
- Severe rhabdomyolysis
Preserved snakehead from which accidental envenomation occurred
Arm swelling in the patient envenomated by the preserved snakehead (skin puncture site was on the index finger)
Systemic Envenomation Symptoms from Elapidae (Coral Snake) Bites

- Mild pain +/- paresthesias at bite site
- Peripheral nerve block (numbness +/- motor weakness)
- Ptosis / blurred vision
- Muscle weakness
- Hypersalivation / nausea / dyspnea
- May progress to diaphragm paralysis & respiratory failure
- Cobras cause above effects & also cardiotoxic effects
Diagnostic Confirmation of Venomous Snakebite

1. History of confirmed strike: if only suspected, could be just injury from thorns or branch, etc.
2. Fang puncture marks
   - may be one to four in number per strike (if snake strikes more than once, can be multiple)
   - If skin marks are in multiple rows, this implies non-venomous snake
3. Local +/- systemic envenomation signs
Sequence of Standard Therapy for Pit Viper Snakebite

- Oxygen
- Place IV line and draw blood for:
  - blood type / crossmatch, CBC, platelet count, protime, PTT, fibrinogen, electrolytes, BUN, creatinine, glucose, CPK, liver function tests
  - Lymphatic tourniquet / splint
  - Urinalysis / EKG
  - Tetanus toxoid immunization
  - Wound cleansing / irrigation; consider antibiotics
  - Consider compartment pressure monitoring
  - Consider use of antivenin; base use and dose on classification of degree of envenomation
Classification of Degree of Envenomation by Pit Vipers

- None (struck but no venom injected)
  - Puncture marks only

- Minimal
  - Mild bite site pain & local swelling only
  - No progression by 60 minutes

- Moderate
  - Swelling progresses beyond the bite site
  - Ecchymosis, skin blebs, paresthesias

- Severe
  - Swelling or pain involves entire extremity
  - Any systemic sign (metallic taste, coagulopathy, etc.)
  - Any major lab value changes
Wyeth Antivenin Dosage for Pit Viper Bites

<table>
<thead>
<tr>
<th>Degree of Envenomation</th>
<th>Dose (Number of vials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Minimal</td>
<td>Zero to 5</td>
</tr>
<tr>
<td>Moderate</td>
<td>6 to 15</td>
</tr>
<tr>
<td>Severe</td>
<td>15 to 30</td>
</tr>
</tbody>
</table>
Antivenin for Pit Viper Bites

- Marketed as Crotalidae Polyvalent Antivenin by Wyeth
- Covers venom from U.S. rattlesnakes, cottonmouth, & copperhead
- Made from refined horse serum from horses immunized with venom from Western & Eastern Diamondback rattlesnakes, South American rattlesnake, & Fer-de-lance
- Separate antivenin required for Mojave Rattlesnake bites
- Separate antivenin also required for coral snake or sea snake bites
- Polyvalent Crotalidae antivenin also manufactured in Brazil
New Commercially Available Type of Antivenin

Crotalidae polyvalent immune Fab (CroFab, FabAV) became commercially available in the U.S. in December 2000

Derived from sheep hyperimmunized against Crotalus atrox, C. adamanteus, C. scutulatus, & Agkistrodon piscivoris

The sheep antibodies are treated with papain to cleave off the Fc fragments, leaving the Fab antibodies
Initial Clinical Experience with the New Fab Antivenin FabAV

- More expensive than the Wyeth antivenin
- Lesser incidence & severity of allergic reactions
- Venom induced coagulopathy may be relatively more resistant to Fab than to Wyeth antivenin
- Recurrence or delayed coagulopathy may occur
- If coagulopathy is only a single factor deficiency and asymptomatic, then extra Fab doses may not be needed
Antivenin for Coral Snake Bites

- Usually need 3 to 5 vials in 300 to 500 cc normal saline
- Should give before development of symptoms because it may not be effective once symptoms develop
Skin Test for Sensitivity to Antivenin for Snakebites

- Skin test for sensitivity to horse serum (0.02 ml. of horse serum diluted 1:10) unnecessary & potentially hazardous
  - Not 100% predictive of anaphylaxis (both false negative & false positive)
  - May sensitize patient to subsequent dose of antivenin
  - Delays administration of antivenin
Administration of Antivenin for Snakebites

- Pretreatment
  - IV steroids (100 mg hydrocortisone or methylprednisolone)
  - IV diphenhydramine 50 mg
  - IV fluid loading: at least 300 to 500 cc LR or NS

- Reconstitute each antivenin vial with 10 cc sterile water
- Then dilute each vial dose in 100 to 250 cc D5W or NS
- Give each diluted antivenin vial dose over 1/2 to 2 hours IV (DO NOT IV push the vials); for first 10 min., give at TKO rate
- Stop or slow infusion (& consider epinephrine 0.1 mg boluses or drip IV) if patient manifests any signs of anaphylaxis (hypotension, wheezing, edema, hives)
- Incidence of major allergic reactions low with pretreatment
Repeat or Additional Doses of Antivenin

- Reevaluate extremity circumference, pain, prot ime, & platelet count every 2 to 4 hours until stable
- Infuse an additional 1 to 5 vials prn for any progression of above signs
Adjunctive Therapy for Snake Envenomation

- **Opiate analgesics**
- **Constant elevation of limb above heart** once antivenin is started, or for > 4 to 6 hours post-bite (use stockinette or hanging traction apparatus)
- **Splint affected joints**
- **Hydration to lessen effect of rhabdomyolysis**
- **Initiate physical therapy once pain & edema decrease**
Disposition of Patients with Snakebites

- Confirmed pit viper bite
  - Discharge if no evident envenomation after 4 hours
  - Admit to hospital if local signs or antivenin required

- Suspected coral snake, Mojave rattlesnake, or exotic snakebite:
  - All should be admitted (usually to ICU)
  - May have delayed symptoms & signs

- Monitor for progression of local or systemic signs and symptoms
Serum Sickness After Antivenin Administration

- 75% of patients receiving > 5 vials of antivenin develop serum sickness.
- Manifested by fever, malaise, rash, arthralgias, lymphadenopathy.
- Usually symptoms develop at 7 to 21 day delay.
- Treat with systemic steroids (prednisone 1 to 2 mg/kg/day) for 7 to 10 days +/- antihistamines.
Contraindicated Potentially Harmful Treatments for Snakebites

- Tourniquets beyond only lymphatic compression
  - Australians however utilize entire limb compression (via air splint or elastic wrap) to retard venom absorption
- Cryotherapy (ice packs): increases tissue damage
- Electric shock
- Excision of the bite site
- Routine fasciotomy
  - Only rarely indicated if venom injected below muscle fascia (most injections are only subcutaneous)
- Incision & suction of bite site
  - Only small amount of venom removable
  - Increases risk of infection and tendon damage
Snakebite Infections

- Old references quote high infection rates from snakebites & recommend routine prophylactic antibiotics
- Snake venom itself is sterile but snake mouth & exterior of fangs harbor fecal bacteria from the snake's prey
- Two recent studies (one for venomous & one for non-venomous snakes) show low rates of infection & no need for prophylactic antibiotics
First Aid and Field Therapy for Snakebites

- Avoid panic & retreat out of snake's striking range
- Immobilize the affected part & limit activity
- Place lymphatic constriction band
- Don't try to capture & carry the snake
- Rapid transport to medical facility
  - Try to make sure the medical facility has sufficient antivenin (20 to 30 vials may be required)
  - Cleanse & irrigate the bite site if this will not delay transport
Precautions to Avoid Snakebite

- Wear knee-high heavy boots & heavy gloves
- Watch where you are walking, sitting, or grasping
- Don't put your hands into ground holes, or under rocks or bushes
- Don't approach snakes when they are seen
- Wear eye protection if in "spitting cobra country"
- Familiarize yourself with the types of snakes in the area
- Don't keep pet snakes
Signs and Symptoms of Envenomation by the Indian or Common Cobra

- Drowsiness: > 90%
- Ptosis, respiratory paralysis, dyspnea: 80%
- Ophthalmoplegia: 40%
- Palatal or glossopharyngeal paralysis: 40%
- Limb paralysis: 30%
- Seizures: 10 to 20%
- Also can have (at lesser frequency):
  - Nausea, vomiting, hypotension, bite site pain, abdominal pain, ataxia, headache
Snakebites
Summary

- Determine the type of snake involved if possible
- Assess for envenomation
- Draw bloodwork early (especially type & crossmatch)
- Monitor for complications
- Decide if antivenin needed
  - If used, dilute & administer slowly
  - Usually should pretreat to avoid allergic reaction
- If further information needed, call:
  - Exotic Snake Antivenin Index (Oklahoma City): 405-271-5454
  - Arizona Poison Center: 602-626-6016
  - San Diego Poison Center: 619-543-6000