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Snakebites

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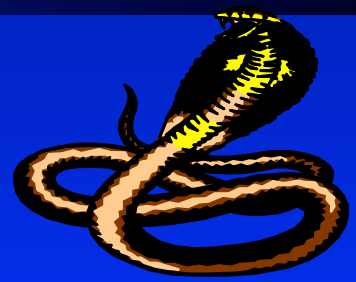


Snakebites
Epidemiology

- 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 milllion venomous bites
  - Possibly 30,000 to 60,000 deaths
- In U.S.A. annually :
  - 45,000 snakebites
  - 8000 venomous snakebites
  - 1 to 10 deaths

Snakebite Epidemiology (cont.)

- 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

Snakebites
Envenomation Risk

- 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)

Thomas Fatora, Wikimedia Commons

Copperhead

Fjguyote, Wikimedia Commons

Cottonmouth (water moccasin)

PD-GOV

Mark Bratton, Wikimedia Commons

Sidewinder rattlesnake

Ryan E. Poplin, 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

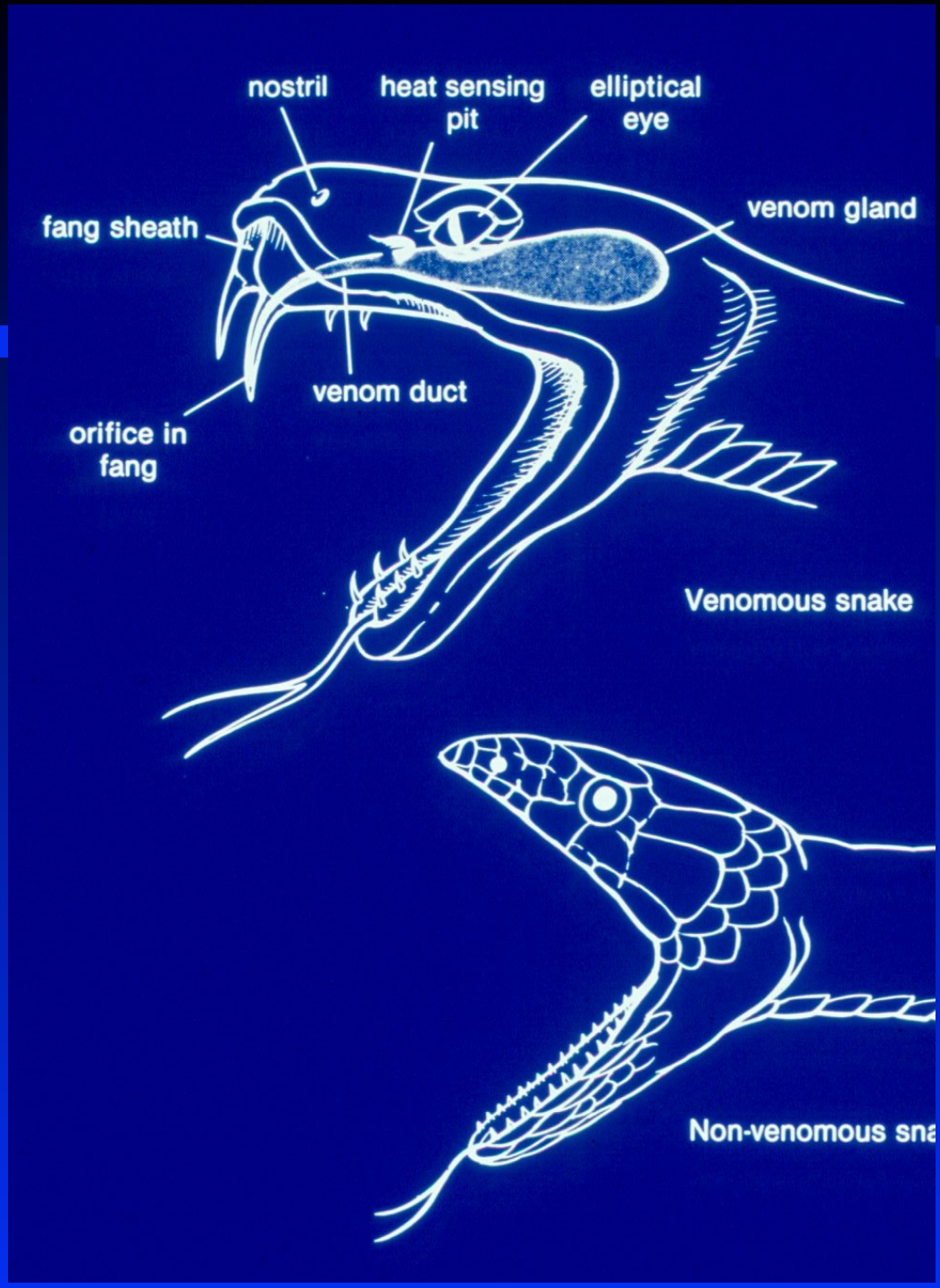
Most Dangerous U.S. Venomous Snakes

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

* Account for 95 % of deaths but only 10 % of total bites

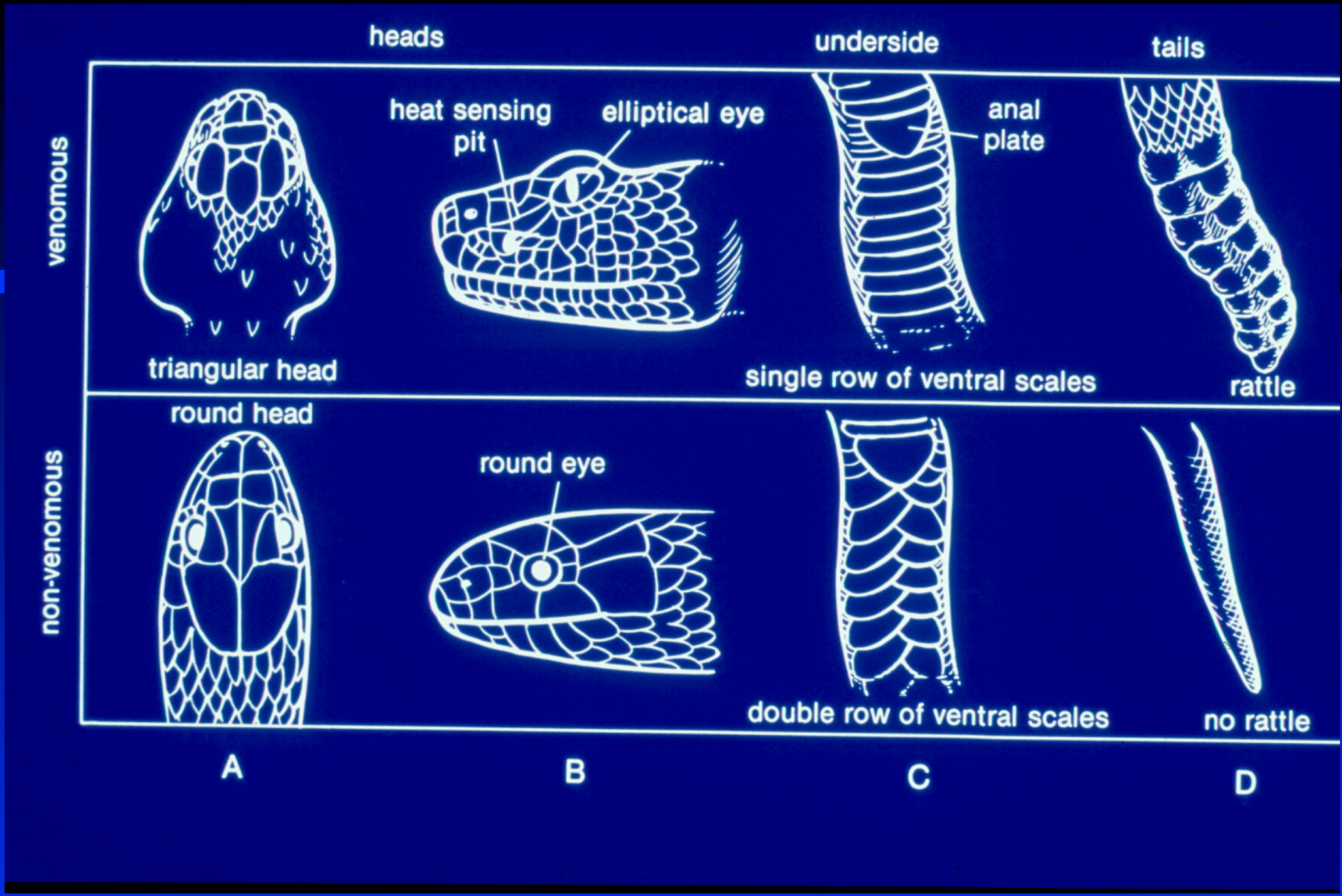
Identification Characteristics of U.S. Venomous Snakes

- 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
- 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

Source Undetermined



PD-INEL Source Undetermined

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

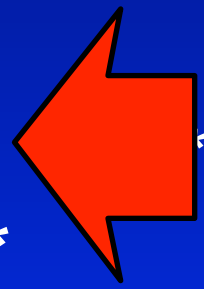
- Venom gland is modified salivary gland
- Venom duct runs into groove in fangs
- Fangs retract or fold down when snake closes mouth
- Anywhere from 20 % to 75 % of venom in gland can be discharged at one strike
- Snake has some control over amount of venom injected : tends to inject larger amounts if 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*



*these can cause acute renal failure

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 occurence)

- 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
- Coagulapathy
- 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

PD-INEL

Source Undetermined

Preserved snakehead from which accidental envenomation occurred

PD-INEL Source Undetermined

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

- History of confirmed strike : if only suspected, could be just injury from thorns or branch, etc.
- 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
- 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

Degree of Envenomation	Dose (Number of vials)
None	None
Minimal	Zero to 5
Moderate	6 to 15
Severe	15 to 30

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, protime, & 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 symtoms

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