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**Lightning Strike**



- Occurs year-round, mostly in afternoon or early evening
- Magnitude of energy > 30 million Volts
- Produces injury by:
  - Direct strike
  - Splashing / side-flashing off strike area
  - Traveling through ground (step voltage)

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**Evidence of Lightning Strike**

- Cows knocked down on field

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### Environmental Evidence of Lightning

- Trees showing lightning damage

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### Environmental Evidence of Lightning

- Damage to ground
- Damage to fruit

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### Environmental Evidence of Lightning: Fulgurites in Sand or Soil (bone or tube-like structures)

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## Lightning Strike

- Instantaneous duration of contact
- “Flash-over” effect may explain low overall mortality rate of 30%
- Of the survivors, >70% left with disabilities
  
- Water conducts electricity; current takes path of least resistance to ground
- Wetness on body increases “flash-over” effect
- Vaporization of moisture into steam produces explosive force--damages clothing & may blow off shoes

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## Lightning Strike

- Asystole or ventricular fibrillation:
  - Cardiac automaticity may restore rhythm, but thoracic muscle spasm & medullary respiratory center damage cause secondary hypoxic cardiac arrest
- Brain injury & multisystem trauma
- Ruptured tympanic membranes, blindness, cataracts & retinal detachment from heat / blast
- Immediate but transient paralysis lasting minutes to hours (keraunoparalysis)

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## Lightning Strike Burn Injury

- Superficial to full thickness, linear charring or contact burns from overlying metal objects



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## Lightning Strike: Skin Markings

- **Lichtenberg figures or keraunographic markings:** branching or ferning marks on skin (erythematous arborization)



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## Lightning Strike



- **Management**
  - Victims NOT electrically charged
  - CAB / CPR / AED / ACLS interventions
  - Spinal stabilization
  - Burn care if needed
  - **Beware of storm threat to rescuers!**
  - Fasciotomy for cold, pulseless extremities not indicated (keraunoparalysis resolves over course of hours)

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## Lightning Strike



- **Mass Casualty Management:**
  - **“Reverse triage”**: care for cardio-pulmonary arrest victims first! (those with “signs of life” have highest survival rate)
  - Immediate CPR:
    - CAB / AED
    - ACLS interventions

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## Lightning Strike Prevention

- Pay attention to weather forecasts (NOAA)
- Choose location & timing of hike, e.g., in Colorado during summer, plan hikes in AM
- **Seek shelter when thunder is heard!**

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## Lightning Strike Prevention

- **30 / 30 Rule:**
  - If “flash to bang” is **30 seconds or less**, danger exists
  - Remain sheltered until **30 minutes after** last thunder is heard

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## Consider Carrying a Lightning Detection Device

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## Lightning Strike Prevention

- Substantial buildings or fully enclosed metal-topped vehicles are the safest shelters (not an isolated shed, tent, or shallow cave entrance)
- Do not stand near open doors, windows, fireplaces or metal objects
- Turn off electrical appliances
- Do not talk on a corded telephone



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## Lightning Strike Prevention

- If caught outside: do not stand under the tallest tree or object--lightning is attracted to the highest point
- Instead, *choose a stand of trees*

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## Lightning Strike Prevention

- Get out of water (even indoor bathtub or shower)

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## Lightning Strike Prevention

- **Signs of imminent strike:** hair standing on end, seeing blue halos around objects (St. Elmo's fire), hearing high-pitched or crackling noises
- **St. Elmo's fire:** plasma energy from ionized air that glows blue due to an imbalance in electrical charges
- Do NOT sit or lie flat on the ground!

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## At Risk Here?



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## Answer: Yes!

- Entrances to shallow caves are **high risk** areas for lightning strike
- Surface / ground arcing can occur



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### At Risk Here?



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### Answer: Yes!

- Mountain peaks & high points are high risk areas for lightning strike



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### Do Rubber Soles Offer Protection?



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**Answer: No!**

- Rubber-soled boots offer no protection against lightning

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**Does Your Car Offer Protection?**



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**Answer: Yes!**

- Vehicles can be struck by lightning -- rubber tires offer no protection
- Electrical systems can short-out & catch on fire
- But...there have been no recorded fatalities of passengers in fully-enclosed, metal-topped vehicles

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Keep in Mind the Risk of Indirect  
Lightning Damage to Vehicle

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Motorcyclist “Zapped in Head”  
by Lightning -- Survives

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Lightning Strike Video

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### Poisonous Snake Bite Facts (US)

- Native to all states except Maine, Alaska & Hawaii
- Bite ~ 4,700 people / year
- Pit vipers are venomous at birth



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### Poisonous Snake Bite Facts (US)

- Snake bite-related **deaths**:
  - 2 to 5 deaths per year
  - More common in children & elderly
  - Associated with no use of antivenin, inadequate or late dose
  - Usually occur 18 - 32 hours after envenomation, but may occur earlier

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## Snake Bite Risk Factors

- Young, adult males
- Children < 10 years of age
- Under the influence of drugs or alcohol
- Use of snakes in religious rituals or sport




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## Crotalidae: Pit Vipers

- Rattlesnakes, Cottonmouths & Copperheads
- Have a **foramen or pit** between each eye & nostril - heat sensitive
  - enables snake to locate warm blooded prey
- **Triangular head** due to venom glands
- **Single row** of subcaudal scales

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## Crotalidae: Pit Vipers

- Two curved, canalized fangs--retract when mouth closed
- 3 pairs replacement fangs; fang replacement occurs throughout snake's life
- Snake regulates venom quantity based on size of prey
- Can inject from one or both fangs
- Amount of venom injected variable in defensive bites




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**Recognition: Venomous or Harmless?  
Applicable to North American Pit Vipers**



**Venomous**

- Triangle-shaped head
- Elliptical pupil
- Pit
- Fangs
- Rattle--rattlesnakes

**Non-venomous**

- Rounded head
- Round pupil
- No pit
- No fangs / small teeth



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**Jake: The Snake Who Lives in Our Wood Pile**



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Rattlesnake



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Cottonmouth, aka "Water Moccasin"

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Copperhead



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## Venom Composition

- Procoagulants
- Anticoagulants
- Neurotoxins
- Hemotoxins
- Cardiotoxins
- Effects include system toxicity, biologic tissue & blood cell destruction
- Interspecies variability in components of snake venom
- **Venom immobilizes, kills, & digests prey!**



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## Manifestations Related to:

- Size of the snake (large = more venom)
- Potency & amount of injected venom
- Depth of envenomation
- Location of bite (vascular puncture or a bite to face or neck can produce immediate crisis)
- Number of strikes (not all venom is injected with each bite; more bites = greater envenomation)
- Size & underlying health of victim



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## Recognition of Severity

### No Envenomation ("Dry" Bite)

- ◆ Fang marks without local or systemic reaction



### Minimal Envenomation

- ◆ Fang marks, local swelling, pain
- ◆ Rubbery, minty or metallic taste in mouth
- ◆ No significant systemic effects



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## Recognition of Envenomation Severity

### Moderate Envenomation

- ◆ Fang marks with local & systemic effects: pain, nausea, vomiting, paresthesias, fasciculations, swelling beyond bite site, mild coagulopathy

### Severe Envenomation

- ◆ Fang marks with severe swelling / local response, severe systemic manifestations, including hypotension & seizures
- ◆ Marked coagulopathy

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## Moderate to Severe Envenomation



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## Eastern Diamond Back Rattlesnake Envenomation



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## Field Interventions

- Move victim to safety away from snake
- Place victim at rest (exertion speeds venom effect)
- Remove jewelry & tight clothing
- Splint & immobilize bitten extremity at heart level
- Evacuate to hospital ASAP

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## Field Interventions

- **DO NOT:**
  - ◆ Apply ice
  - ◆ Apply a tourniquet
  - ◆ Incise or suck wound
  - ◆ Capture / handle snake
  - ◆ Use “extractor” devices



\*\***Note:** Even DEAD or decapitated snakes can inflict a bite -- take a **digital photo** instead!

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## Advanced Interventions



- Vascular access
- Supportive ALS care
- Contact Poison Control center
- Wound care
- Tetanus prophylaxis
- Antibiotic prophylaxis not routinely indicated

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## Advanced Interventions

- Obtain baseline diagnostic studies
  - EKG,
  - CBC,
  - Coagulation profile
- Consider radiographic imaging to identify the presence of foreign bodies in wound
  - Embedded teeth or fangs in bite wound possible, but very rare

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## Advanced Interventions



- Prophylactic fasciotomy not recommended; swelling from myonecrosis typically resolves with adequate antivenom administration
- Blood product transfusion not recommended
  - Adequate antivenom dosing will usually reverse coagulopathy
- Consider antivenom (**CroFab**) administration

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## CroFab--Crotalidae Polyvalent Immune Fab (Ovine)

- IV product used to treat North American crotalid envenomation
- Specific antibody fragments of immunoglobulin G (IgG) bind & neutralize toxins
- Enhanced safety profile: No skin testing
- Administer **within 6 hours** if possible
- Reverses coagulopathy & decreases edema

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### CroFab--Crotalidae Polyvalent Immune Fab (Ovine)

- **Dose:** Reconstitute with 10 ml sterile normal saline
- Add 4-6 vials to 250 ml NSS & infuse over 1-hour (slowly for first 10 minutes)
- Repeat 4-6 vials if needed, then 2 vials q6h X 18 hours (same dose for adult & peds)
- Contraindicated in known hypersensitivity to ovine (sheep) products & papain / other papaya extracts

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### CroFab--Crotalidae Polyvalent Immune Fab (Ovine): ADR's

- **Serum sickness:**
  - Type III hypersensitivity reaction
  - Develops within 3 to 21 days
  - Skin rash appears first; progresses to fever, joint pain, malaise & pruritus
  - Treated with oral steroids & diphenhydramine
- **Allergic reactions** (usually mild to moderate):
  - Pruritus & urticaria
- **Anaphylaxis** rare, but more likely after prior CroFab treatment – sensitization can occur

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### Coral Snake – Not a Pit Viper, but a venomous elapid

- “Red on yellow, kill a fellow.”
- “Red on black, venom lack.”

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## Coral Snake

- Generally non-aggressive
- Account for <1% of venomous snake bites in US
- Found in southeastern & southwestern US
- No fangs; small teeth
- Venom injected via chewing motion & spread by lymphatic system
- Venom contains neurotoxins & myotoxins
- Effects may be delayed up to 13 hours; prolonged observation indicated

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## Coral Snake

- **Manifestations:** Nausea, vomiting, weakness, cranial nerve deficits (ptosis, diplopia, dysphagia), paresthesias, altered mental status, fasciculations & respiratory paralysis
- **Treatment:**
  - Pressure immobilization / compression technique (distal to proximal extremity wrap)
  - Contact Poison Control Center
  - Supportive care / mechanical ventilation
  - Antivenom no longer being manufactured in US
  - Venom effects may persist for days

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## Snake Bite Prevention

- Don't molest snakes – use common sense!
- Don't keep venomous snakes as pets
- Stay out of striking distance
- Use caution in snake-infested areas: rocks, tall grass, caves & heavy underbrush
- Don't put hands & feet where eyes can't see
- Wear boots & protective clothing



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## Lyme Disease

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Quiz: Pick the images that best represent Lyme Disease?



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## Lyme Disease



- Most common vector-borne illness in the US; 20,000 confirmed cases annually
- Exposure typically April – October
- 96% of confirmed cases come from 13 states: Connecticut, **Delaware**, Maine, Maryland, Massachusetts, Minnesota, New Jersey, New Hampshire, New York, Pennsylvania, Vermont, Virginia, and Wisconsin

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## Lyme Disease



- Named after town of Lyme, CT, when clusters of juvenile rheumatoid arthritis cases were identified
- Discovered the children all played in woods, had a history of tick bite & a circular rash at bite site
- 1981 – researchers confirmed Lyme caused by bacteria (*Borrelia burgdorferi*) transmitted by bite of black-legged tick (deer tick)
- Both adult ticks & nymphs (immature ticks) transmit Lyme; most cases caused by nymphs

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## Black-Legged Tick (Deer Tick)



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## Lyme Disease



- **Signs & Symptoms:**
  - **Early, localized:** (within 1 month): circular rash with clear center (erythema migrans, aka “bullseye rash”—must be at least 2” in diameter to be diagnostic per CDC; occurs in <50% of patients), fever, headache, fatigue, stiff neck, muscle/joint pain
  - **Early, disseminated:** (within weeks to months): flu-like symptoms, nervous system effects - meningitis, encephalitis, facial palsy, poor balance & coordination; cardiac effects – heart block, carditis
  - **Late:** (months to years): joint swelling, arthritis

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## Erythema Migrans (Bullseye Rash)



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## Lyme Disease Diagnosis



- Lab studies not recommended for people without symptoms
- CDC: Two-test approach for active disease & previous infection using an enzyme-linked immunosorbent assay (ELISA) followed by a Western blot if positive or equivocal
- Positive test = both tests positive
- ELISA – only a 65% sensitivity; 20-30% of those with Lyme may have a negative Western Blot
- Clinical judgment necessary for diagnosis & decision to treat

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## Lyme Disease Treatment

- Early stage disease: oral antibiotic treatment with doxycycline, amoxicillin, or cefuroxime (Ceftin)
- Ceftriaxone IV when neurologic symptoms are present
- Criteria regarding when to initiate treatment as well as the schedule / duration of therapy remain controversial



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## Lyme Disease Prevention



- Use protective clothing & insect repellents / insecticides when spending time outdoors
- Carefully examine yourself (and significant others) for ticks using a mirror or magnifying glass as needed to inspect the body

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## Lyme Disease Prevention



- Tick Removal: A tick must feed for 36 to 48 hours to transmit disease
  - #1 - Grasp tick with fine-tipped tweezers close to skin; pull steadily & firmly until tick lets go
  - #2 - Save tick in container with 70% alcohol
  - #3 - Wash area with soap & water
  - #4 - Monitor for signs / symptoms of Lyme disease



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## Lyme Disease Prevention



- 2002: Lyme vaccine discontinued due to low demand; those vaccinated no longer protected
- Lyme cannot be transmitted person to person; pets (dogs & cats) can get Lyme disease, but can't infect people
- Pets can harbor ticks & bring ticks into home
  - Use tick control measures
  - Inspect pets for ticks
- A high heat setting in the dryer will kill ticks that may still be attached to clothing

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## Mosquito-Borne Illness



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## Mosquito-Borne Diseases

- West Nile Virus
- Zika
- Malaria
- Dengue Fever
- Eastern Equine Encephalitis
- Japanese Encephalitis
- St. Louis Encephalitis
- Western Equine Encephalitis
- Rift Valley Fever
- Yellow Fever
- La Crosse Encephalitis



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## Tick & Mosquito Prevention

- The prevention rule: **DON'T GET BITTEN**
- Mosquitoes are most active dusk & dawn
- Eliminate standing water where mosquitoes lay eggs
- Don't handle dead birds (may have West Nile virus)
- Wear protective clothing:
  - Long sleeves, loose, pants tucked in socks
  - Tightly woven fabrics (ex. Nylon)
- Window & door screens in good repair
- Mosquito nets
- Use chemical repellants / insecticides

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## Permethrin

- Pyrethrum is a powerful, rapidly acting *insecticide* marketed as Permethrin
- Not a repellent
- Low toxicity in mammals
- Apply directly to clothing, tent walls, or mosquito nets
- **Do not apply to skin**

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## DEET

- Considered Gold Standard of insect repellents
- Applied directly on skin, not clothing
- 25% DEET provides 4 to 8 hours protection
- Use high concentration (30-35%) in a malaria-endemic area

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## Insect Bite Protection

- **DEET**: 25% DEET: 4 to 8 hours protection
- **Picaridin**: Similar efficacy to DEET for up to 8 hours
- **Eucalyptus**: Average protection 4 to 7.5 hours; similar efficacy to DEET
- Permethrin-treated clothing + DEET or Picaridin-based repellents best



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## Bee & Wasp Stings

- Local pain to life-threatening envenomation & anaphylaxis
- Except for honey bees, bees & wasps have tendencies to sting repeatedly; venom doses are cumulative
- Honey bees die after stinging



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## Africanized or Killer Bees



- Hybrid of European & African honey bees; “feral” bee colonies take over territory
- *Smaller* in size than European bees
- Often have ground colonies
- Found in TX, CA, NV, AZ, AK, NM, GA, LA, FL
- More irritable, swarm more quickly, defend territory more aggressively & sting collectively
- Hundreds of stings possible in single attack
- Venom similar to European bees; cumulative toxic effects from mass stinging

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## Africanized or Killer Bees

- Median lethal dose of honeybee venom estimated at 19 stings per kg, or 500 to 1,400 stings for humans
- **Stinging induced by:**
  - Sudden movements
  - Dark colors
  - Odors, including human perspiration
  - Pheromones released from bees during stinging episodes
  - Disturbing the hive



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## Bee & Wasp Stings



### Local effects:

- Instant pain & wheal-and-flare reaction
- Swelling
- Pruritus

### Systemic effects:

- Generalized edema
- Nausea, vomiting, diarrhea
- Cardiac dysrhythmias
- Uterine cramping



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## Bee & Wasp Stings



### Toxic reaction:

- MI, renal failure, severe multisystem organ dysfunction, death
- Toxic effects may be delayed 8 to 24 hours to several days after multiple stings.

### Allergic reaction:

- Urticaria, pruritus, LOC, angioedema, respiratory distress, laryngeal edema, bronchospasm, hypotension, cardiovascular collapse

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## Bee & Wasp Stings



- **Emergency Care:** stinger removal by *fastest* method—
  - Credit card, needle, tweezers (envenomation increases the longer stinger is left in victim)
- Ice pack
- Assess ABC's: observe for toxic / allergic reactions

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## Bee & Wasp Stings



- **Anaphylaxis**: incidence is 0.3 to 8% in population
- Assist victim to use own Rx epinephrine
- Arrange for advanced life support care
- IV access, monitoring, epinephrine (IM or IV), albuterol, parenteral antihistamines (H1 blockers), H2 blockers, corticosteroids

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## Bee & Wasp Stings: Prevention Strategies



- Do not disrupt hives or nests; use care when mowing lawn
- When in a high-risk area, wear long sleeve shirts, pants & shoes to protect skin from stings
- Use screens in open windows
- Secure trash in closed containers
- Avoid perfumes when spending time outdoors
- If allergic, carry an epinephrine pen & consider immunotherapy to desensitize

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## Jellyfish Stings



- Tentacles have barbed, venom-charged **nematocysts** that fire stinging cells
- Toxins injected into skin & enter victim's circulation
- Reaction to toxin may cause collapse in water & drowning

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## Jellyfish Stings

- **Mild Reaction:**
  - Rash with stinging, itching, tingling, burning & intense throbbing pain
  - Red-brown-purple tentacle prints or welts
  - Skin infection can occur
- **Moderate to Severe Reaction:**
  - Multiple, body-wide effects including muscle spasms, nausea, vomiting diarrhea, stomach pain, severe pain at sting site
  - Anaphylaxis
  - Organ failure, coma & death

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## Jellyfish Stings: Treatment

- **Prevent firing of nematocysts:**
  - Wash area with sea water (not freshwater)
  - Hot water or topical lidocaine best for pain
  - Do **not** rub or compress
  - **Vinegar**, though widely advocated, increases pain from nematocyst discharge; effective only in stings from Physalia species
  - Remove tentacles with tweezers or gloved hand
  - Shave area with shaving cream or baking soda paste to remove nematocysts
- **Pain control** (ibuprofen, acetaminophen), diphenhydramine, tetanus immunization

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## Jellyfish Stings

- **Allergic / Anaphylactic Reaction:**
  - Immediate care essential
  - Rx epinephrine pen if available
  - Advanced life support
  - IV access, monitoring, epinephrine (IM or IV), albuterol, parenteral antihistamines, H2 blockers, corticosteroids
  - Supportive care

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## The End



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## References

- Auerbach, P.S. (2012). *Wilderness Medicine* (6<sup>th</sup> ed.). Philadelphia: Elsevier.
- Auerbach P.S. (2009). *Medicine for the Outdoors: The Essential Guide to First Aid and Medical Emergencies*. (5th ed.). Philadelphia, PA: Mosby-Elsevier.
- Della-Giustina D., & Ingebretsen R. (2013). *Advanced Wilderness Life Support* (8<sup>th</sup> ed.). Utah: AdventureMed.
- Johnson C., Anderson S.R., Dallimore J., et al (Eds.). (2016). *Oxford Handbook of Expedition and Wilderness Medicine*. 2<sup>nd</sup> ed. New York: Oxford University Press.
- Laskowski-Jones, L. (2016). Care of patients with common environmental emergencies. In D. Ignatavicius & L. Workman (Eds.), *Medical-Surgical Nursing: Patient-Centered Collaborative Care* (8<sup>th</sup> ed., pp. 120-137). St. Louis: Elsevier.
- <http://www.lightningsafety.noaa.gov>

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