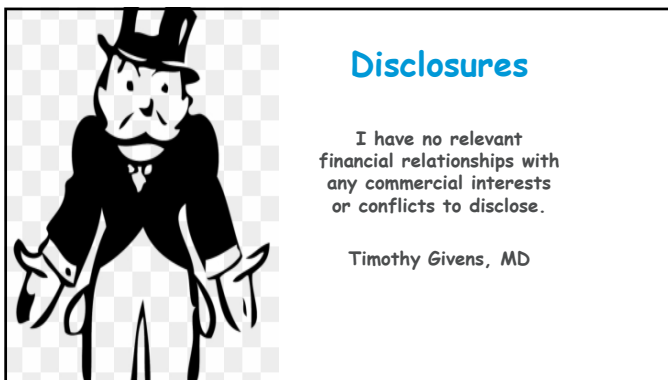
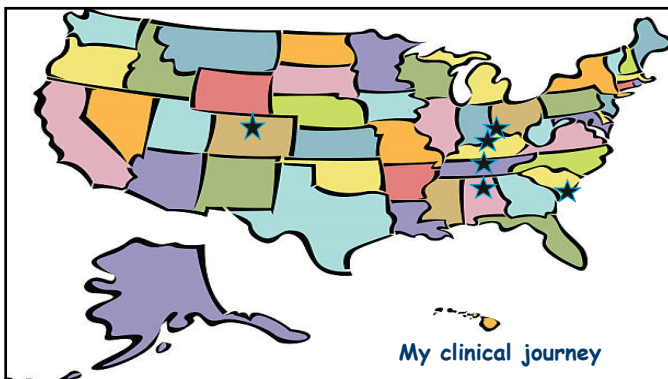


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What's in your environment?



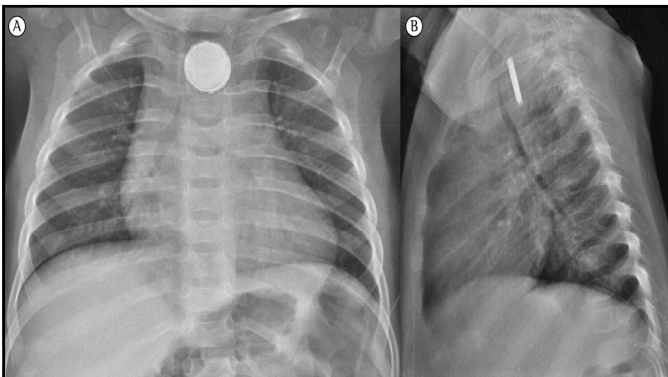
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Case: 2 year old ingestion

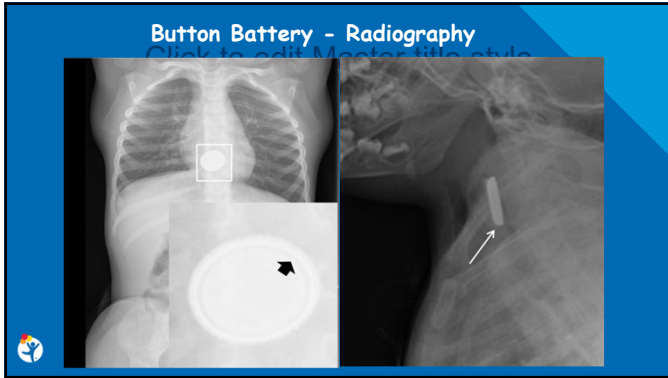
- 2 yo M choked on something 20–30 minutes ago
- Now drooling, won't eat or drink
- Mom saw him playing on the floor but didn't see what he put into his mouth
- Vital signs normal, looks uncomfortable
- Lungs clear
- Patient drooling
- Nothing visible on inspection of mouth
- What to do???



5



6





7



8

Advantages of lithium

- Lightest metal on the periodic table
- Higher voltage: 3 volts vs. 1.5 volts in alkali batteries
- Wide range of operating temperature
- Long shelf life
- Non-corrosive

	
Alkaline - 11mm	Lithium - 20mm

9



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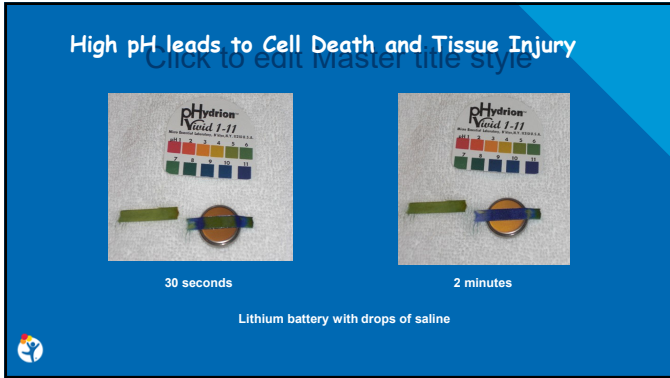
11

Button batteries—real danger!

- Esophageal button batteries are a **TRUE EMERGENCY!!!**
- Cause injury in as little as 2 hours, perforation in as little as 6 hours
- Mechanisms of injury include:
 - Caustic leakage → liquefaction necrosis
 - Pressure necrosis
 - Completion of an electrical circuit → current injury
- Brumbaugh D, et al, *JPGN* 2011; 52(5):585-589.



12



13




14



15

Triage and treatment


1. Suspect the diagnosis!!!
 1. Symptoms: acute airway obstruction, drooling, wheezing, vomiting, chest pain, refusal to eat, coughing/choking/gagging
 2. Presumed "coin" or other FB ingestion
2. Do not induce vomiting; NPO *except...*
3. Administer HONEY immediately and en route to ED if:
 1. 12 months or older
 2. Incident occurred within past 12 hours
 3. Child able to swallow
 4. Dose: 10 mL every 10 minutes for up to 6 doses
 5. Use commercial honey if available (not specialized/artisana)
4. Transport immediately—honey slows but does not stop battery injury and is no substitute for removal



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CHCO (updated) transport protocol

- Transport via CCT helicopter
- If CCT helicopter unavailable, nearest CCT ground or ALS ambulance
- Teams will bring trauma blood & dose Carafate q10min (10 mL/dose)



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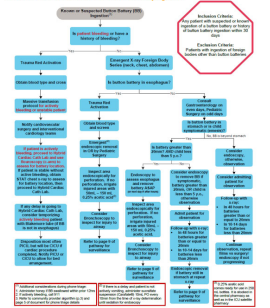
CHCO hospital ED management




CLINICAL PATHWAY

INGESTED BUTTON BATTERY

ANSCHITZ ALGORITHM Treatment of Button Battery Ingestion





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What's in your environment?



19



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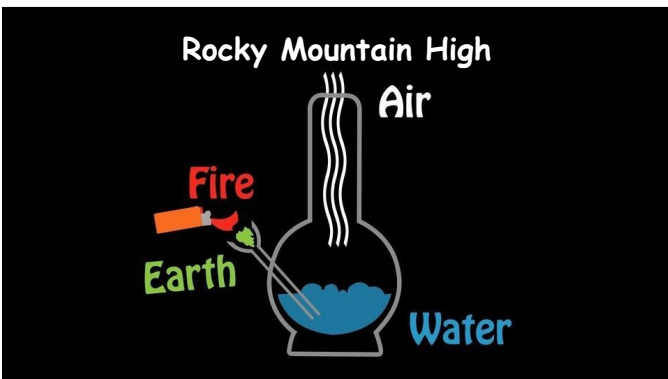
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24

Case: child struck by lightning

- 10 yo M helping dad on the farm when thunderstorm began
- Was holding metal rake when struck by lightning bolt and thrown 4-5 feet
- Initially brief LOC; now awake but dizzy and confused
- EMS summoned
- Patient tachycardic but VS otherwise normal
- ECG: sinus tachycardia



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28



29

Lightning facts


- Lightning strikes earth > 100 times/second
- Estimated 150-300 deaths/year in USA
 - Used to affect outdoor workers; now, larger % are hikers, campers, golfers, etc.
 - Most occur in daytime, in summer
 - Prevalent in high mountainous areas, around large bodies of water
 - Greatest proportionate fatality: CO, WY, MT



30

Lightning myths

- Lightning strikes are invariably fatal
 - 30% mortality
 - Generally only those with immediate CP arrest expire
- Lightning victim is "electrified"
 - Belief delays resuscitation efforts
- Lightning never strikes in the same place twice



31



32

Mechanisms of lightning injury

1. High voltage
2. Secondary heat production
3. Explosive force



33

Primary injury mechanisms

- **Direct hit**
 - Usually in the open (no shelter)
 - Carrying a conductor (metal)
- **Splash**
 - Tree/building hit, splashes onto nearby victim
 - Path of least resistance
- **Contact**—holding object which is struck
- **Step voltage**
 - Hits ground near victim, spreads in wave through victim's feet
- **Blunt trauma**—thrown by explosive forces



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Lightning injuries


- **Minor**
 - Confusion, amnesia, temporary LOC, blindness/deafness
 - Paresthesias, muscle pain
 - Transient hypertension
- **Moderate**
 - CNS changes (disoriented, comatose), seizures, motor paralysis
 - Loss of pulses due to arterial spasm
 - Burns
 - Tympanic membrane rupture
- **Severe**
 - Cardiac arrest (Vfib or asystole)
 - Direct brain damage



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High-voltage electricity vs. lightning injuries

- Lightning contact with body is instantaneous, leads to flashover (over the body rather than through it)
 - Seldom burns of any magnitude
- High-voltage electricity exposure more prolonged, victim freezes to the circuit
 - Energy through tissues with little resistance to flow: massive internal thermal injury, myoglobin release, renal failure, compartment syndrome (fasciotomy?)



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Care of lightning victims


- ABC's
 - "Prolonged" CPR unnecessary
- Spinal precautions
- IVF/O2
- Splint fractures
- Transport



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Case: young child found in lake

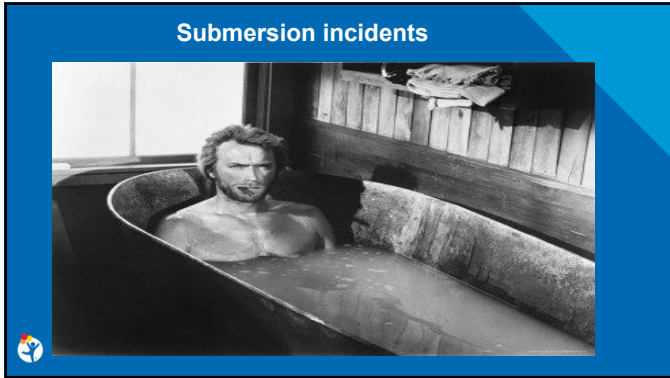
- 5 yo F wandered away from family campsite while they were cooking dinner
- 5 minutes later, found face down in water at edge of lake
- Father pulled her out of water, gave rescue breaths
- Child vomited some water, sputtered, had some labored breathing
- Family drove to nearest hospital 40 minutes away
- On arrival, patient awake, tachypneic with oxygen sats 88%



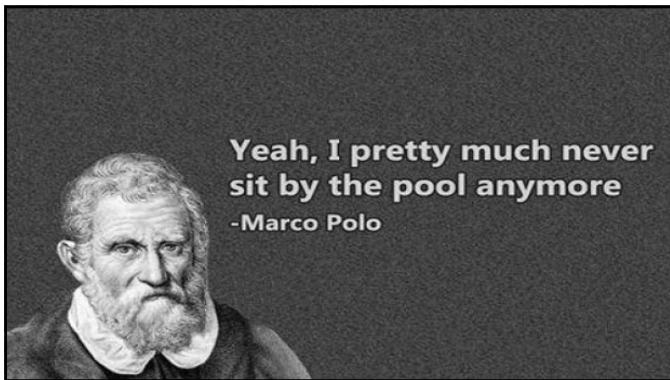
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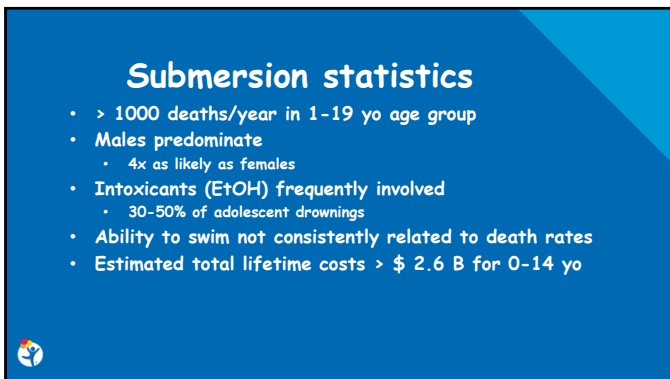
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42


Submersion survival

- Medical care for severe submersion episodes → little effect on improving survival
- "Survival" does not equal intact neurologic function
- ??Better decision-making in prehospital arena
- Children swimming less in natural bodies of water, more at pools & beaches with lifeguards → better access to early CPR
- Submersion duration best predictor of outcome
 - No protective effect of cold H₂O



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- Recent decline in pediatric mortality , hospitalization rates with submersion incidents
 - Particularly in South and West USA
 - Likely due to targeted prevention efforts



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Bath time supervision

45



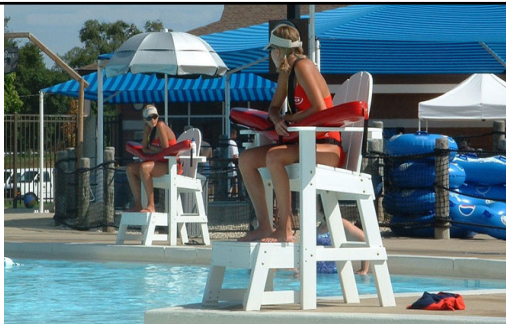
Four-sided pool fencing

46



Use of personal flotation devices

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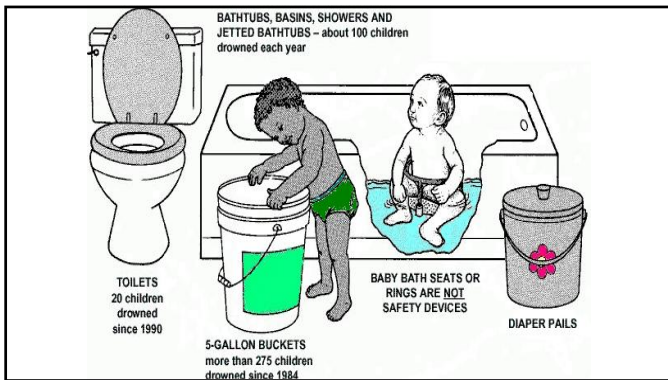
Swimming in supervised areas

48



Swimming lessons


49



50

Submersion injury pathophysiology


- Panic & struggling
- Breath-holding
- Voluntary suppression of respiration is overcome
 - 15% laryngospasm ("dry drowning")
 - 85% aspirate liquid ("wet drowning")
- Common denominator is hypoxia
- LOC → airway reflexes lost → CP arrest



51

Associated hypothermia


- Cold water submersion – better prognosis???
- (especially pediatric patients)
- Obtain core temperature, resuscitate until temp WNL



52

Other considerations


- Possible medical emergency could have preceded submersion incident
 - Trauma (head/neck)
 - Seizure
 - Dysrhythmia
 - Toxic ingestion
 - NAT



53

Submersion treatment--prehospital

- Assume spinal injury
 - Immobilization
 - Maintain precautions during transport
- Rescue breathing & supplemental oxygen
- ?CPR—start on almost all patients
- Begin rewarming



54

Q. Should all victims of submersion incidents be evaluated in an emergency department?

- A. Any patient with residual symptoms should be transported to an ED for observation for progressive respiratory insufficiency for 4-6 hours
- Coughing
 - Wheezing
 - Tachypnea
 - Low oxygen saturation
- **EVEN IF AWAKE & COGNIZANT!**



55

Submersion treatment--ED

- Unless obviously dead, assume survivability
 - Especially children
- Intubate if unable to oxygenate/ventilate
 - PEEP improves ventilation and volume
 - Shifts fluid into capillaries
- ACLS algorithms if indicated
- Rewarm patient per hypothermia protocols



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57

Who gets admitted?

- CNS compromise
- Respiratory compromise
- Any symptoms after observation
- Abnormal vital signs

- If normal RA oxygen saturation, normal lung exam, GCS > 13 may be safely discharged home




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Case: Texas teenager on spring break

- 19 yo collegiate M flew from Houston to Denver 3 days ago
- He & friends drove immediately to mountains for ski trip
- Has been skiing hard and partying harder for 3 days
- This morning, awakened with difficulty getting breath
- Speaks only in short sentences, is tachypneic to 30's
- Mountain clinic documented oxygen sats of 85%



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AMS

Acute Mountain Sickness

How does the height affect?

No medical exam can determine a person's aptitude to height. There is no difference in sex or age. The height and the cold are the two variables that are more dangerous in climbing to the summit of America.

The Altitude:

- As we ascend, the air pressure and partial of oxygen decrease progressively and this may be the cause of many height inconveniences.
- About 50% of the Aconcagua climbers had suffered one or more AMS's symptoms.

Symptoms of AMS:

- Headache
- Nausea
- Loss of appetite
- Shortness of breath
- Blurred vision
- Loss of energy
- Difficulty sleeping
- Loss of balance
- Other

Prevention:

- Ascend gradually. Start the rise before 3000 m.
- Height of acclimatization every 1000 meters.
- Adequate hydration (3 liters per day).
- You can achieve higher blood oxygen levels with a slow walk to the top of the mountain.

AMS Levels:

- Mild AMS:** Headache, nausea, loss of appetite, shortness of breath, blurred vision, loss of energy, difficulty sleeping, loss of balance.
- Moderate AMS:** Headache, nausea, loss of appetite, shortness of breath, blurred vision, loss of energy, difficulty sleeping, loss of balance.
- Severe AMS:** Headache, nausea, loss of appetite, shortness of breath, blurred vision, loss of energy, difficulty sleeping, loss of balance.

First Aid:

- Rest and oxygen.
- Headache: Paracetamol.
- Nausea: Antiemetic.
- Shortness of breath: Oxygen.
- Blurred vision: Rest.
- Loss of energy: Rest.
- Difficulty sleeping: Rest.
- Loss of balance: Rest.

Severe AMS:

- It is a medical emergency. The person should be evacuated to a lower altitude as soon as possible.
- It is a medical emergency. The person should be evacuated to a lower altitude as soon as possible.

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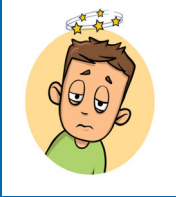

Altitude definitions:

- Moderate: 8-10,000 feet
- High: 10-18,000 feet
- Extreme high: > 18,000 feet

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High altitude sickness

- Can occur at altitude > 5,000 feet
- Influenced by:
 - Rate of ascent
 - Final altitude
 - Duration at altitude
 - Sleeping altitude

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WHAT IT'S LIKE BEING HIGH IN PUBLIC



65

Who is at risk?


- Hard to predict
- Those at greater risk include:
 - Younger > older
 - Male > female
 - History of previous altitude sickness
 - Can occur in previously unaffected
 - Overexertion
 - Alcohol, sedatives, smoking
 - State of physical fitness NOT protective



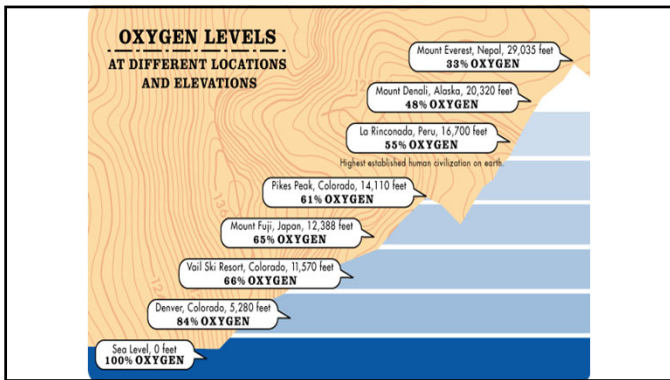
66

Physiology

- Hypoxia due to ↓ barometric pressure
- Hypoxemia due to ↓ pO₂ of inspired air
- Impact on the cell variable
 - Ability to acclimatize/compensate
 - Pre-existing medical conditions




67



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Acclimatization

- Ventilation—increases almost immediately
- Cardiovascular
 - Increased cardiac output (CO)
 - Increased pulmonary perfusion
 - Increases V/Q mismatch
- Increase in cerebral blood flow
- Hematologic
 - Relative increase in hemoglobin (diuresis)
 - Erythropoietin—stimulates bone marrow → ↑ RBC production
 - Effect takes weeks



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Types of illness

- Altitude-exacerbated conditions
 - NOT the focus of this talk, but be aware!
 - Congenital heart disease
 - Pulmonary hypertension
 - Coronary artery disease
 - Congestive heart failure
 - Sickle cell disease/trait
 - Obstructive sleep apnea
 - Pregnancy

71

High altitude illnesses


- Acute mountain sickness
- High-altitude cerebral edema (HACE)
- High-altitude pulmonary edema (HAPE)



72

Acute Mountain Sickness


- Defined as headache, plus one or more of:
 - Anorexia
 - Nausea/vomiting
 - Dizziness
 - Fatigue/weakness
 - Difficulty sleeping
 - Lightheadedness
- Typically 6-10 hours after ascent
- Usually self-limiting



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Acute Mountain Sickness--Treatment


- Rarely need to descend—slow/halt ascent
- Analgesics/antiemetics prn
- Consider acetazolamide 125-250 mg BID
 - Speeds acclimatization
- Descend if symptoms do not improve
 - Dexamethasone 4 mg po/IM if unable to descend
- Graded ascent is best preventive measure (600 m/day)



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High Altitude Cerebral Edema (HACE)


- AMS symptoms progress → global cerebellar dysfunction
 - Ataxia or altered mental status
 - Vertigo, diplopia, (rarely) seizures
- Usually > 12,000 feet (has occurred at > 9,000 feet)
- Begins > 12 hours after onset of AMS
- Symptoms typically global
 - Isolated focal seizures → think CVA/TIA



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HACE--Treatment


- Immediate descent = definitive treatment
- Supplemental oxygen @ highest flow → sats > 90%
- Dexamethasone 8 mg po/IM, then 4 mg q6hrs
- If cannot descend, hyperbaric therapy



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High Altitude Pulmonary Edema (HAPE)


- Non-cardiogenic pulmonary edema
- Accounts for most high-altitude deaths
- Occurs 1-3 days after arrival at altitude
 - Rarely occurs after 4 days—consider alternative diagnosis
- 1-2% of high-altitude climbers
 - 15% of those with rapid ascent



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HAPE Pathophysiology


- Hypoxia leads to pulmonary artery hypertension
 - Increased pulmonary vascular resistance
 - However, occurs in everyone, not just HAPE
- Pulmonary capillary pressure increases
 - Leads to over-perfusion, capillary leakage
 - Fluid as well as proteins leak out → exudative fluid
- With descent, pressure decreases
- Inflammatory mediators likely not primary process, but secondary to leaked proteins



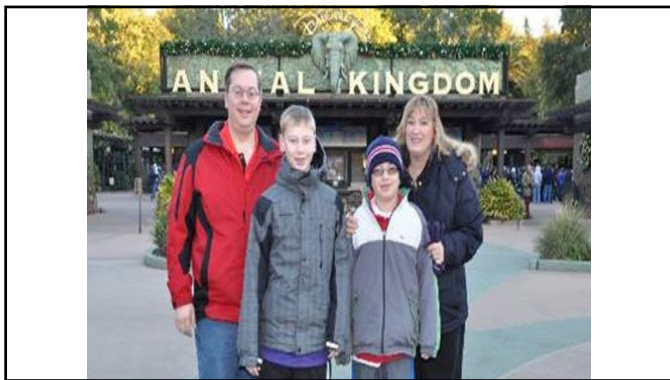
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HAPE Treatment

- Immediate descent
- Supplemental oxygen
 - Decreases pulmonary artery pressure up to 50%
- Beta-agonists
 - Increase fluid clearance from alveolar spaces
- No role for dexamthasone




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Case: snakebit

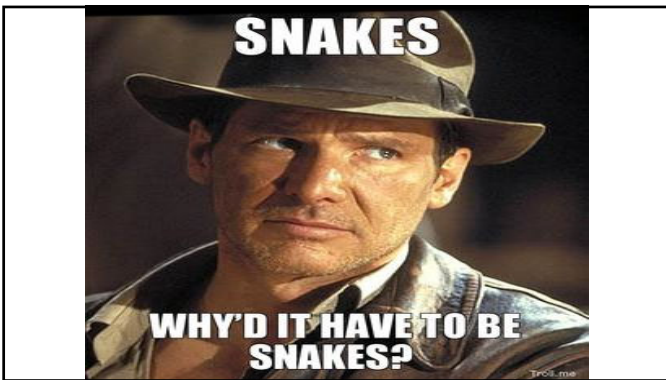
- 16 yo M hiking with buddies
- Came across rattlesnake on trail
- Tried to fend it off with a stick
- Snake bit patient on forearm approx. 2 hours ago
- Now, with pain, swelling, discoloration of forearm spreading from bite site
- Tachycardic, tachypneic, dizzy and sweaty



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83

Snakebite stats

- **Global**
 - > 2 million annually
 - 20,000- 94,000 deaths
- **USA**
 - 6-8,000 snakebite envenomations/year
 - 5-6 deaths/year (kids, elderly, delayed care)
 - 99% Crotalidae (pit vipers)
 - 5 subspecies of copperheads
 - 3 subspecies of cottonmouths
 - > 60 subspecies of rattlesnakes



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85

The typical bite victim



- Definitely male
- Under 30 years old
- Mostly warm months
- Bitten on extremity
- Alcohol involved
- Stupidity: attempt to handle, harm, or kill a snake
- Senseless risks

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Snake venom

- Pit vipers' (Crotalidae) venom contains zinc-dependent metalloproteinases
 - Direct capillary damage → hemorrhage & fluid extravasation
 - Tissue necrosis
 - Hemotoxicity: consumptive coagulopathy → DIC
- Coral snakes' (Elapidae) venom contains alpha neurotoxins
 - Direct neurotoxicity

87

Autonomic "terror" reactions must be differentiated from envenomation effects.



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Envenomation effects

- Majority: painful swelling at injury site; conservative management
- Smaller % significant morbidity: consumptive coagulopathy, renal failure, hypovolemic shock, anaphylaxis
- Children at higher risk: smaller size, higher concentration of venom



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Manifestations of pit viper envenomation

- Fang marks
- 30-60 minutes: pain, edema, erythema, ecchymosis at or around bite site
- Early systemic: nausea/vomiting, perioral paresthesia, fingers/toes tingling, lethargy, weakness, myokymia
- Rubbery, minty, or metallic taste
- Systemic: hypotension, tachypnea, tachycardia, altered sensorium



90



91

Snakebite treatment: in the field

- Move victim beyond striking distance
- Place victim at rest
- Keep victim warm
- Transport immediately to nearest emergency medical facility
- Remove constrictive clothing, jewelry
- No stimulants




92

What NOT to do

- Tourniquets
- Incision and suction
- Cryotherapy (ice)
- Electric shock therapy

- IF a tourniquet has been placed as first aid, leave in place until hospital evaluation/initiation of antivenom Rx



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Snakebite treatment in ED

- Supportive care with IV fluids
- Screening labs for coagulopathy (draw from unaffected limb)
- Observe affected limb with leading edge of edema demarcated and time q30"
- Prophylactic antibiotics discouraged



94

Use of antivenom

- Not well-defined
 - Moderate or increased swelling (progression)
 - Lab evidence of coagulopathy
 - Systemic signs
 - All coral snake bites (due to risk of respiratory muscle paralysis)



95

Cro-Fab

- First approved in 2000
- Ovine (sheep) Fab₂ fragment
- Made from venom of 4 snakes
 - Eastern diamondback rattlesnake
 - Western diamondback rattlesnake
 - Mojave rattlesnake
 - Cottonmouth (Water moccasin)
- Preferred therapy for envenomation



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Cro-Fab

- Dose: 4-6 vials IV load (diluted in NS) initially; can reload if progression
 - Not "per kg" dosing—clinical effects due to venom dose, not patient weight
- 2 vials q6-8hours maintenance dose
- Stops progression; does not resolve symptoms (takes days to weeks)
- Adjunctive analgesia required
- 14.3% reaction rate (urticaria mostly; serum sickness possible for 1-3 weeks)



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AnaVip

- First approved in 2018
- Equine (horse) F(ab')₂ fragment
- Longer elimination half-life than Crofab
- Theoretically, requires less vials of antivenom dosing
- Dose: 10 vials loading dose IV
- Cost: Crofab \$3400/vial; Anavip \$1200/vial wholesale

- Early trials indicate more vials Anavip used vs. Crofab
- Late coagulopathy complications due to longer half-life



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Disposition

- Observe all patients with pit viper bites in ED for minimum 8-12 hours
 - If no clinical or lab manifestations during this time, may discharge
- If treated with antivenom, should be admitted and monitored in an ICU



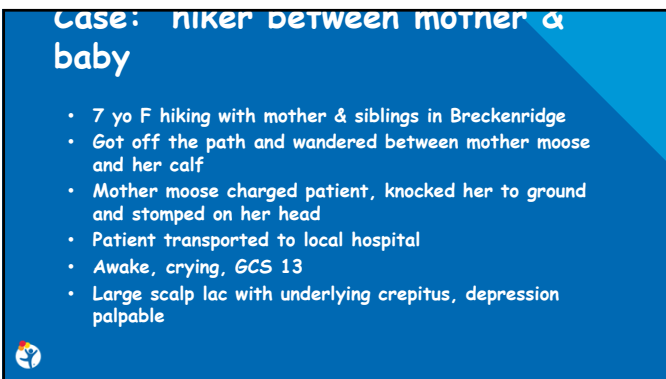
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102



103

Wild animal attacks: general

- Tearing, cutting, crushing, penetrating injuries
- Accompanying blunt trauma (falls, large animal forces)
- Local infection, variety of pathogens
- Transmission of systemic disease
- Remote wilderness areas → delay in notification, rescue, definitive care



104

HOW TO SURVIVE ANIMAL ATTACKS



105

Best defense is avoidance

- Keep a clean camp
- Treat garbage like you would food
- Never take food into a tent
- Don't sleep in the same clothes you cooked dinner in
- Don't feed wild animals—even deer, squirrels (it attracts the bigger animals)



106

Be prepared

- Pepper spray
- Club
- Substantial knife
- ?Firearm



107

How to survive an animal attack



- Know thy enemy's physical weak points
 - Nose/snout
 - Eyes
 - Neck
 - Testicles
 - Inside leg



108

How to survive an animal attack



- Know thy enemy's psychological weak points
 - Loud noises
 - Scream & yell
 - Aggressive behavior
 - Wave your hands/clothing around
 - Appearance of size



109

How to survive an animal attack

- If you can't scare the animal off, you have 2 choices:
 - RUN
 - FIGHT
 - Use sharp objects/weapons, if you have them
 - Improvise: grab a big stick or a log
 - Strike at weak points, yell, make erratic movements



110

- **Caveat: animals can usually run and fight better than you can**



111

What to do for the attack victim



112

Field management of attack victim

- First, assure scene safety
 - Rescuer safety
 - Victim safety
 - Will the animal return?
- Things to consider
 - What equipment is available?
 - Is help reasonably close?
 - Can the victim walk?
 - Consider mechanism of injury



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Field management of attack victim

- Airway
- Breathing
- Circulation
- Disability
- Exposure
- Wound care: irrigate, debride, dress, splint



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Trauma management & wound care

- ATLS principles
- Wound care
 - Explore
 - Cleanse
 - Irrigate
 - Debride
 - To close or not to close?
 - Antibiotic coverage
 - Tetanus prophylaxis



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