The Annual General Pediatric Review & Self Assessment

Nicklaus Children's Hospital

EMERGENCY MEDICINE

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Disclosure of Relevant Relationship

Dr. Peña has not had (in the past 24 months) any relevant conflicts of interest or relevant financial relationship with the manufacturers of products or services that will be discussed in this CME activity or in his presentation.

Dr. Peña will support this presentation and clinical recommendations with the “best available evidence” from medical literature.

Dr. Peña does not intend to discuss an unapproved/investigative use of a commercial product/device in this presentation.

OBJECTIVE

- To review the clinical presentation and management of acute toxic exposures in children
- Discuss trauma, drowning, burns, child abuse
- Review bites and stings

CASE

- 18 mo male found playing with open bottle of Tylenol capsules approximately 2 hours ago.
- Mother removed a tablet from his mouth.
- He is asymptomatic and acting well.
- VS and PE normal

ACETAMINOPHEN (APAP)

- Most common drug overdose
- Case fatality – low (quantity ingested – low)
- Assess risk:
  -Dose of concern: >150 mg/kg in child;
  7.5 g in anyone > 50 kg
- Early abdominal pain or vomiting are indicators of potential toxicity
- Most are asymptomatic

ACETAMINOPHEN (APAP)

- GI decontamination:
  - < 2 hours: activated charcoal (1g/kg)
  - > 2 hours: nothing
- Obtain APAP level:
  - no earlier than 4 hours after ingestion (earlier if history is uncertain)

ACETAMINOPHEN (APAP)

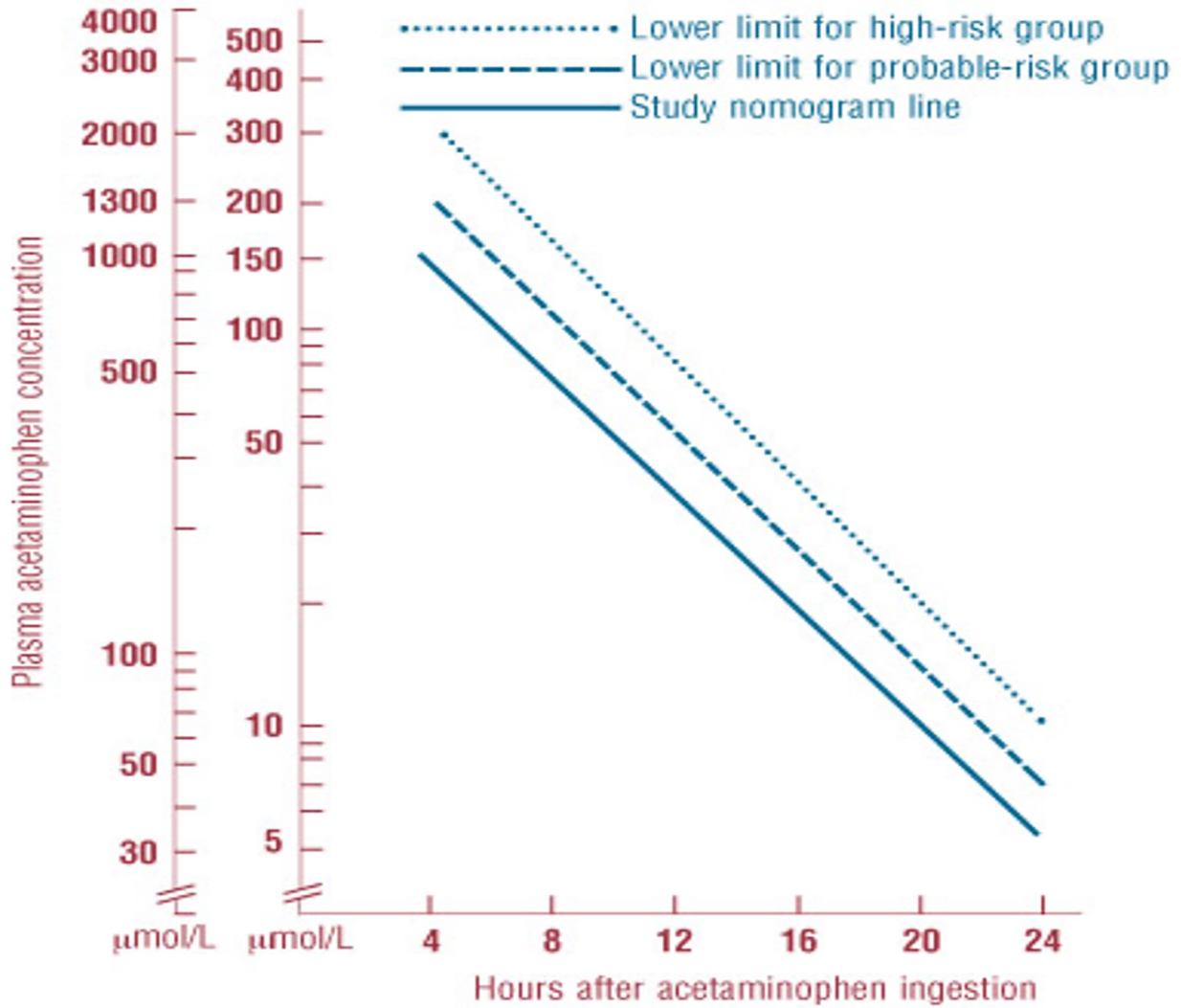
- Antidote=NAC=Glutathione substitute
- Indications for N-acetylcysteine (NAC):

  -Serum concentration in toxic portion of nomogram (150μg/ml at 4 hours)

  -Serum concentration will not be known within 8 hours of ingestion (optimal response of NAC)

FIGURE 2

Rumack-Matthew nomogram for predicting prognosis of hepatotoxicity in acetaminophen overdoses.



Source: Fauci A. *Harrison's Principles of Internal Medicine*, 14:2530. New York: The McGraw-Hill Companies, 1998. Reproduced with permission of The McGraw-Hill Companies.

CASE

- 14 mo found to have ingested 4 cc of “oil of wintergreen”.
- She is tachypneic, febrile and diaphoretic.

ASPIRIN (ASA)

- Common cause of poisoning
- Hallmark: Tachypnea and Respiratory Alkalosis
- Toxic dose:
  - **150-300 mg/kg: mild toxicity**
  - **300-500 mg/kg: moderate toxicity**
  - **>500 mg/kg: severe toxicity**

ASPIRIN (ASA)

- Toxicity:

  -**Mild**: (30-50 mg/dl) :GI upset, tinnitus, mild tachypnea

  -**Moderate**: (50-100 mg/dl): fever, diaphoresis, agitation

  -**Severe**: (>100mg/dl): dysarthria, coma, seizures, death

ASPIRIN (ASA)

Management:

- Labs: ASA, lytes, ABG (respiratory alkalosis and metabolic acidosis), LFTs, CBC, PT/PTT, UA and ECG
- GI decontamination for those who present 4-6 hrs after ingestion
- Activated charcoal should be administered even if >6 hrs after ingestion
- Urine alkalinization
- Hemodialysis (preferred) or hemoperfusion

CASE

- 3 yo male ingested approximately 25 of mother's pre-natal vitamins 2 hours ago.
- He is vomiting and has bloody diarrhea.
- VS: HR 140 RR 28 BP 86/40
- He is deeply somnolent and extremities are cool and moist

IRON

- Most common cause of poisoning death in children < 6 years
- Most difficult to treat
- Clinical stages:
  - -Early (1-6 hrs): vomiting, diarrhea and GI blood loss
  - -Latent (6-24 hrs): no symptoms; child seems well
  - -Late (>24 hrs): cyanosis, metabolic acidosis, shock, coma, seizures

IRON

- Can see metabolic acidosis, leukocytosis, hyperglycemia, hyperbilirubinemia, elevated LFTs and elevated PT
- Abdominal films may show radiopaque material in the stomach

IRON

- Dose of concern: child >40 mg/kg; adolescent>1.5 g
- Lack of GI symptoms within 6 hrs: likely non-toxic ingestion
- Deferoxamine challenge test

IRON

Management:

- Abdominal x-ray central to management
- Gut decontamination (WBI)
- Obtain serum iron concentration
- Monitor for shock and acidosis
- Indicators for chelation:
  - -Serum iron >400 µg/dl or clinical symptoms

CASE

- 16 yo female with depression admits to taking some of her antidepressants in a suicide attempt.
- She is agitated, flushed, tachycardic and hypotensive.
- EKG shows wide-complex tachycardia with a prolonged QT interval

TRICYCLIC ANTIDEPRESSANTS

- May produce symptoms refractory to any treatment methods
- Onset of toxicity is early (within 4 hrs)
- Life threatening events: cardiac and CNS
- Other symptoms due to anticholinergic action (tachycardia, dry skin, ileus, fever, delirium)

TRICYCLIC ANTIDEPRESSANTS

Well-appearing patient:

- Normal VS and LOC: unlikely to deteriorate
- Traditional dose of concern: >10mg/kg
- Rule of thumb: concern if > 5 therapeutic doses ingested

TRICYCLIC ANTIDEPRESSANTS

Management (well-appearing child):

- Cardiac monitor and ECG for QRS duration and rhythm
- IV
- Gut decontamination: single dose of charcoal
- Observe 6 hours post-ingestion

TRICYCLIC ANTIDEPRESSANTS

- **Management** (ill-appearing child):
  - Assess VS and stabilize
  - IV access, ABG, cardiac monitor
  - Correct acidosis and QRS > 100 ms with $NaHCO_3$
  - Gut decontamination
  - Ventricular dysrhythmias: 1st line therapy: $NaHCO_3$: if ineffective, anti-dysrhythmics, pacing
  - Hypotension: 1st line therapy: crystalloid; if ineffective, pressors
  - Seizures: 1st line therapy: benzos; if ineffective, GA

CASE

- 15 yo male presents to the ED obtunded with shallow breathing
- Exam is remarkable for miosis, hypotension

DRUGS OF ABUSE (OPIATES)

- Pain relief (codeine, morphine)
- Abuse (heroin)
- Antidiarrheals (diphenoxylate, loperamide)

DRUGS OF ABUSE (OPIATES)

- Toxidrome:
  - Miosis
  - Respiratory depression
  - CNS depression

DRUGS OF ABUSE (OPIATES)

- Management:
  - -GI decontamination (AC +/- lavage)
  - -Supportive care (ABCs)
  - -Naloxone (0.1mg/kg)
    - short half-life (may have to repeat)

CASE

- 17 yo female presents to the ED with sudden-onset hallucinations
- She is agitated and confused
- Exam is remarkable for tachycardia, hypertension and mydriasis

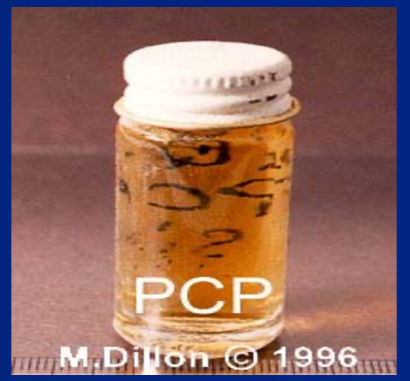
DRUGS OF ABUSE (LSD)

- Present with acute panic attacks or psychotic reactions
- Sympathomimetic effects (mydriasis, hypertension, tachycardia, hyperpyrexia)
- Treatment: supportive care; may use benzos or haldol

CASE

- 14 yo male presents to the ED with combativeness, agitation and violent outbursts
- He is tachycardic and hypertensive with miotic pupils and mild nystagmus

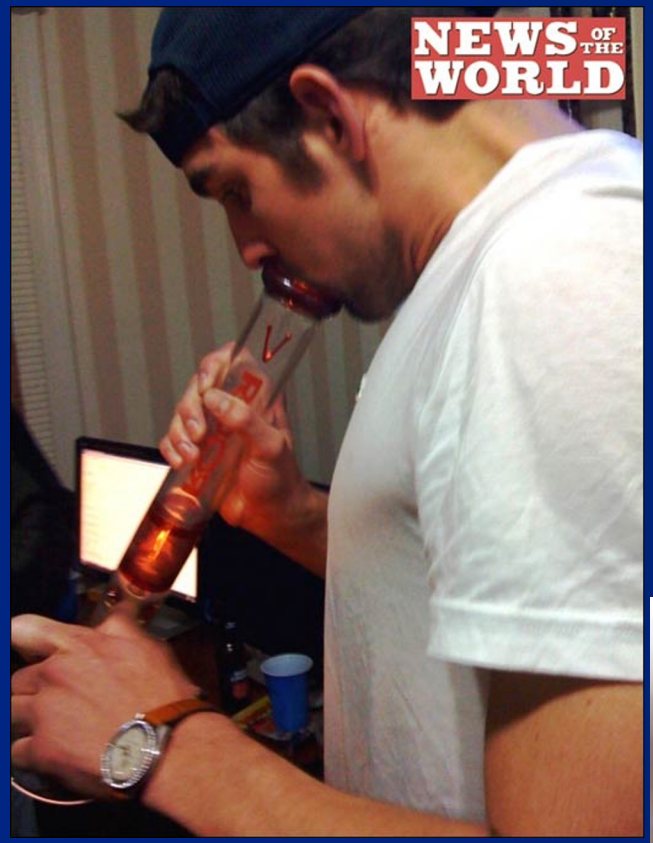
DRUGS OF ABUSE (Phencyclidine-PCP)



- Present with violent outbursts
- Sympathomimetic effects (muscle rigidity, hypertension, tachycardia, hyperpyrexia)
- However, see miosis!
- Treatment: supportive care; may use benzos or haldol

CASE

- 10 yo male presents with distorted perception, vivid sights and vivid sounds after eating brownies a friend gave him
- Exam remarkable for injected pupils and hypotonia


NEWS OF THE WORLD

DRUGS OF ABUSE (CANNABIS)

- Most commonly used drug in USA
- Childhood ingestions:
  - Rapid onset of drowsiness
  - Hypotonia
  - Pupillary dilation

- Treatment: decontamination and supportive care

DRUGS OF ABUSE (SYNTHETIC MARIJUANA SPICE/ K2)

- Designer drug made to mimic effect of natural cannabinoids
- Herbs sprayed with synthetic chemicals manufactured in a lab
- Effects are usually stronger due to the synthesized chemicals
- HBP, tachycardia, vomiting, extreme anxiety, paranoia, hallucinations, seizures, MI
- Often not detectable on standardized drug tests

DRUGS OF ABUSE (CANNABIS)

- Hyperemesis syndrome- cyclical nausea, vomiting, and abdominal pain
- Several years of preceding cannabis use
- Cyclical pattern of hyperemesis every few weeks to months
- Symptoms relieved by hot bath or shower
- Resistant to ondansetron
- Treatment is benzos, TCAs and haldol

CASE

- 17 yo female presents with agitation, tachycardia, hypertension and mydriasis
- Exam reveals a perforated nasal septum

DRUGS OF ABUSE (COCAINE)

- CNS stimulant
- Arrhythmias most common cause of death
- See hypertension, tachycardia, mydriasis, hyperthermia, agitation, seizures, renal failure
- Treatment: benzos for seizures, nitroprusside and benzos for hypertension

CASE

- 12 yo male presents with mood swings, increased irritability and anger
- Parents report he has episodes of risk-taking and violent outbursts

DRUGS OF ABUSE (INHALANTS)

- CNS symptoms: excitation to depression, ataxia, hallucinations
- CVS: “sudden sniffing death syndrome” (ventricular arrhythmias)
- Can lead to methemoglobinemia

DRUGS OF ABUSE (GHB)

- Euphoriants and aphrodisiacs at dance parties or “raves”
- “Date-rape” agent
- CNS depressant- rapid onset of deep sleep that can progress to coma and respiratory depression
- Treatment: supportive care

DRUGS OF ABUSE (AMPHETAMINES)

- Powerful CNS stimulants
- Methamphetamine and MDMA- most commonly abused

- Symptoms include: alertness, mood elevation, restlessness, dizziness, tremor, insomnia, fever, seizures, coma, psychotic reactions
- Treatment: GI decontamination; benzos, haldol for agitation

TOXINS and ANTIDOTES

- APAP → N-acetylcysteine
- Anticholinergics → Physostigmine
- Benzos → Flumazenil
- B-Blockers → Glucagon
- Carbamates → Atropine
- CO → Oxygen

TOXINS and ANTIDOTES

• Cyanide→	Cyanide antidote kit
• Digoxin→	Digibind
• Ethylene glycol→	Fomepizole, EtOH
• Isoniazid →	Pyridoxine
• Iron →	Deferoxamine
• Methanol→	Fomepizole, EtOH

TOXINS and ANTIDOTES

- Methemoglobinemia→ Methylene blue
- Opiates→ Naloxone
- Organophosphates→ Atropine (+oxime)
- Sulfonylureas → Diazoxide
- Tricyclics→ $NaHCO_3$
- Warfarin→ Vitamin K

IMPORTANT FACTS

- Anion gap= Na- ($Cl+HCO_3$)
- Normal= 12 $\pm$ 4
- Anion gap metabolic acidosis:
  - M Methanol
  - U Uremia
  - D Diabetic ketoacidosis
  - P Paraldehyde, Phenformin
  - I Iron, Isoniazid
  - L Lactic Acidosis
  - E Ethylene Glycol
  - S Salicylates

IMPORTANT FACTS

- Osmolar gap= measured-calculated osmoles
- Calculated osmoles= 2Na+Glu/18 + BUN/2.8
- Normal= 5 $\pm$ 10
- Osmolar gap present consider:

-ethanol
-isopropanol
-methanol
-ethylene glycol
-alcoholic ketoacidosis
-lactic acidosis
-renal failure
-shock

IMPORTANT FACTS

- Abdominal x-rays:
  - C Chloral Hydrate
  - H Heavy Metals
  - I Iron
  - P Phenytoin
  - S Slow-Release Medications

ANIMAL BITES

- Dog bites = 80-90% of these injuries
- Feline bites = high infection rates- 50% due to deep puncture wound difficult to irrigate and cleanse
- Human bites= high infection rates
- Treat with antibiotics and check tetanus status
- Rabies prophylaxis

SPIDERS

- 37,000 species
- 50 U.S. species can bite humans
- 15 U.S. species will produce symptoms
- Only two are dangerous
  - Black widow (*Latrodectus mactans*)
  - Brown recluse (*Loxosceles reclusa*)

BLACK WIDOW

- Throughout U.S.
  - As far north as Oregon, New York
  - Common in South, Southwest
- Irregular webs in wood piles, under rocks, in trash dumps, in outdoor structures
- Occasionally in houses
- Females rarely leave web
- Only females can bite humans

BLACK WIDOW

- Neurotoxic venom - one of the most potent venoms
- More potent than pit viper venom
- Generally does not cause death due to small amount of venom injected
- Minimal local effects
- Binds to nerve-ending calcium channels at NMJ (neurotoxin)
  - Triggers neurotransmitter release
  - Blocks neurotransmitter re-uptake
  - Inhibits normal nerve impulse transmission
  - Produces low serum calcium

BLACK WIDOW

- **CLINICAL MANIFESTATIONS:**

- Bite is painless or feels like a pinprick

- Tender regional lymph nodes 30 min-2 hours after

- Target lesion with surrounding erythema 1-2 hours after

BLACK WIDOW

- ***Muscle cramping*** is the hallmark of envenomation
- Begins 30-90 minutes after the bite
- Peaks in 3-12 hours
  - Upper extremity: pleuritic chest pain
  - Lower extremity/genitalia: abdominal pain, rigidity
- Anxiety, agitation, respiratory distress and grunting are common presentations in children
- Weakness, headache and periorbital edema may remain for days to weeks

BLACK WIDOW

- ***TREATMENT- FIRST AID***
  - ABCs
  - Clean wound with soap and water
  - Tetanus if needed
  - Elevate bitten extremity
  - Apply cold compress

BLACK WIDOW

- ***TREATMENT:***
  - Analgesia:
    - Mild cases: oral codeine or hydrocodone
    - Severe cases: IV Morphine q 2-4 hours
    - Benzodiazepines aid in muscle relaxation and anxiety relief

BLACK WIDOW

- ***TREATMENT:***
  - In the past, calcium gluconate has been recommended, but studies have shown no benefit
    - No longer recommended
    - Antivenin available:
      - Indicated for severe cases unresponsive to treatment (hypertension, tachycardia, respiratory distress)
      - High-risk groups- young children, pregnant women, elderly
    - One vial diluted in 50-100 cc NS given over 30-60 min
      - Sx generally resolve rapidly and completely
      - Risk of hypersensitivity reactions and serum sickness

BLACK WIDOW

DISPOSITION

- If sxs mild and well-controlled with analgesics→ dc home
- Close follow-up is needed-- pain may recur or worsen
- Most children should be admitted
- Patients requiring IV pain meds and those with hypertension or autonomic sx should be admitted

BROWN RECLUSE

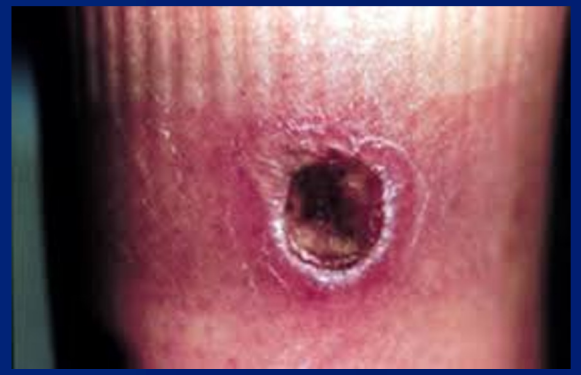
- Found in most of the US
- Most common in Midwest and South
- Woodpiles, sheds, garages, closets, bedding and piles of clothing
- Generally, not aggressive
  - Except if threatened or trapped against skin of victim

BROWN RECLUSE

- Usually 1 cm in length
- Light brown to tan
- Dark, violin-shaped mark on cephalothorax
- Has six eyes rather than eight

BROWN RECLUSE

- Venom contains Sphingomyellinase D (cytotoxic to endothelial cells and RBCs)
- ***LOCAL*** effects
  - Tissue necrosis
  - Leukocyte infiltration of bitten area
  - Edema
  - Hemorrhage
  - Thrombosis



BROWN RECLUSE

- Local signs and symptoms
  - No pain or only mild stinging- bite often unnoticed
  - Within 2 hours: Local pain, blue-gray constrictive halo
  - 12 to 18 hours: Bleb formation, growing ischemic zone, purple discoloration
  - 5 to 7 days: Aseptic necrosis, eschar formation, necrotic ulcer
  - Severe lesions up to 30 cm in diameter

BROWN RECLUSE

- Mild systemic signs and symptoms (40% of patients)
  - Fever, chills
  - Malaise
  - Nausea, vomiting
  - Joint pain
  - Hemolysis, thrombocytopenia, hemorrhage and renal failure more common in children
  - Rarely fatal

BROWN RECLUSE

- Hospital management
  - Supportive and symptomatic care
  - No randomized, controlled studies
  - Debride full thickness lesions with subsequent grafts if large areas of necrosis (delay until area clearly demarcated)
  - Dapsone no longer recommended- leads to methemoglobinemia and hemolysis
  - Antivenin under development (shows reduction in inflammation in animals)
  - Outcomes NOT improved by
    - Early excision
    - Steroids

SNAKES

- 45,000 bites per year in U.S.
- 8,000 bites from venomous snakes
- Most bites occur in warm weather and daylight between April and October
- 25% are dry strikes (no venom)
- Bites most often on extremities:
  - upper extremities in adults (85%)
  - lower extremities in children (70%)
- 5-15 deaths/year

VENOMOUS SNAKES

- Types of U.S.venomous snakes
  - Pit vipers (Crotalidae)
    - 90-95% of poisonous snake bites each year
      - Rattlesnakes
      - Copperheads
      - Water moccasins (cotton mouth)
  - Coral snakes (Elapidae)
    - 2-3% of poisonous snake bites/year

VENOMOUS SNAKES

- Pit viper characteristics
  - Heavy bodies
  - Triangle-shaped heads
  - Vertical, elliptical pupil
  - Heat sensing pit located on upper lip between eye and nostril
  - Erectile fangs that move forward when snake strikes
  - Venom primarily hemotoxic, necrotoxic (exception: Mojave rattler)

VENOMOUS SNAKES

- Rattlesnakes
  - 13 Species
  - 7,000 bites/year
  - 9 to 10 fatalities
  - Most deaths are from Western diamondback or Eastern diamondback
  - Rattle is in the tail

VENOMOUS SNAKES

- Copperhead
  - Deaths VERY rare due to mild toxicity of the toxin
  - Local minimal edema and pain

VENOMOUS SNAKES

- Water moccasin
  - Only venomous water snake in the US
  - Causes an average of one death a year
  - Produces mild systemic symptoms, potential for severe local tissue injury and necrosis

PIT VIPER ENVENOMATION

- Usually one or more puncture marks seen
- Local findings within 30-60 min
- Feel pain in 90% of bites (except the Mojave rattlesnake)
- Erythema and edema (30 min)
- Ecchymosis in 3-6 hours
- Fluid-filled or hemorrhagic bullae 4-8 hours
- Swelling may lead to vascular compromise (compartment syndrome)

PIT VIPER ENVENOMATION

EARLY SYSTEMIC MANIFESTATIONS:

- Weakness, sweating, nausea, vomiting
- Perioral paresthesia, tingling of scalp, fingers and toes
- “Rubbery”, “minty” or “metallic” taste in the mouth
- Tachycardia

SEVERE SYSTEMIC EFFECTS:

- Hypotension, respiratory distress, altered mental status
- Consumptive coagulopathy
- Hemolysis
- Renal failure

VENOMOUS SNAKES

- Coral snake
  - Thin-bodied
  - Small, rounded head
  - Brightly colored
  - Small, non-erectile fangs
  - Injects venom by chewing
  - Venom primarily neurotoxic
  - “Red on yellow, kill a fellow; red on black, friend to Jack”

Venomous

Non-venomous

CORAL SNAKE ENVENOMATION

- Little, no pain
- Little, no swelling
- Salivation
- Mental status changes- drowsiness, euphoria
- Neurologic manifestations:
  - Paresthesias around bitten area
  - CN palsies: ptosis, visual disturbances, dysarthria, dysphagia, respiratory paralysis
  - Muscular incoordination, weakness
  - Once these symptoms appear, difficult to reverse or prevent worsening
  - Most deaths occur from respiratory arrest within 36 hours

SNAKEBITE FIRST AID MANAGEMENT

- Calm victim
- ABCs
- Keep victim at rest, warm and transfer to nearest medical facility
- Immobilize bitten area, keep dependent below the level of the heart
- Remove jewelry and restrictive clothing
- Clean, bandage wound
- NPO
- Supplemental O2, analgesia and IV access

SNAKEBITE MANAGEMENT

- Do NOT
  - Apply ice
  - Place tourniquet or constriction band (may increase local necrosis or cause “bolus” effect when released)
  - Apply arterial tourniquet
  - Incision and suction- can increase risk of infection
  - Use electrical shock
  - Actively attempt to locate a venomous snake
  - Bring a live venomous snake to the hospital!!!

SNAKEBITE MANAGEMENT

ED MANAGEMENT:

- ABCs
- Rapid history (time of bite, description of snake, first aid)
- Physical- close attention to CV, respiratory, neuro
- Baseline circumferential measurements
- Re-check q 15-20 min until no progression

SNAKEBITE MANAGEMENT

ED MANAGEMENT:

- LABS: (Pit Vipers)
  - CBC with plts, PT/PTT, INR, fibrinogen level, electrolytes
  - Consider CK and EKG based on sx severity
- Tetanus if needed
- Prophylactic antibiotics not recommended
- Fasciotomy if compartment syndrome
- Antivenin

SNAKEBITE MANAGEMENT

- ***ANTIVENIN- PIT VIPER***

- *Antivenin (Crotalidae) Polyvalent (ACP)*
  - Developed in 1954; derived from horse serum
  - Significant risk of serum sickness and hypersensitivity reactions (23-56%)
- *Crotalidae Polyvalent Immune Fab (FabAV)*
  - Released Oct 2000; derived from sheep serum
  - More potent
  - Less risk of adverse reactions (14%)

SNAKEBITE MANAGEMENT

- *Crotalidae Polyvalent Immune Fab (FabAV)*
  - Reverses sx in CV, CNS, GI and hematologic systems
  - No effect on local sx- pain, swelling
  - Effective against all North American pit vipers
  - Indications for use:
    - progressive injury
    - coagulation abnormalities
    - systemic effects
  - ICU admission for all pts treated with antivenin
  - Watch for signs of hypersensitivity rxn and serum sickness

SNAKEBITE MANAGEMENT

- ***ANTIVENIN- CORAL SNAKE***
- Confirmed coral snake bite- treat with coral snake antivenin immediately except for Arizona Coral Snake (supportive care)
    - North American Coral Snake Antivenin effective against all Texas and Eastern Coral Snake Envenomation
- ICU admission for all pts treated with antivenin
- If suspected only, observe for 12 hours for neurotoxic symptoms.

PEDIATRIC TRAUMA

Epidemiology

- Injury leading cause of death > 1 year old
  1. MVA
  2. Homicide or suicide
  3. Drowning
- 1.5 million injuries per year
  - 500,000 hospitalizations
  - 50,000 permanent disabilities
  - 20,000 deaths per year
- Males > females 2:1
- 87% blunt, 10% penetrating

Primary Survey

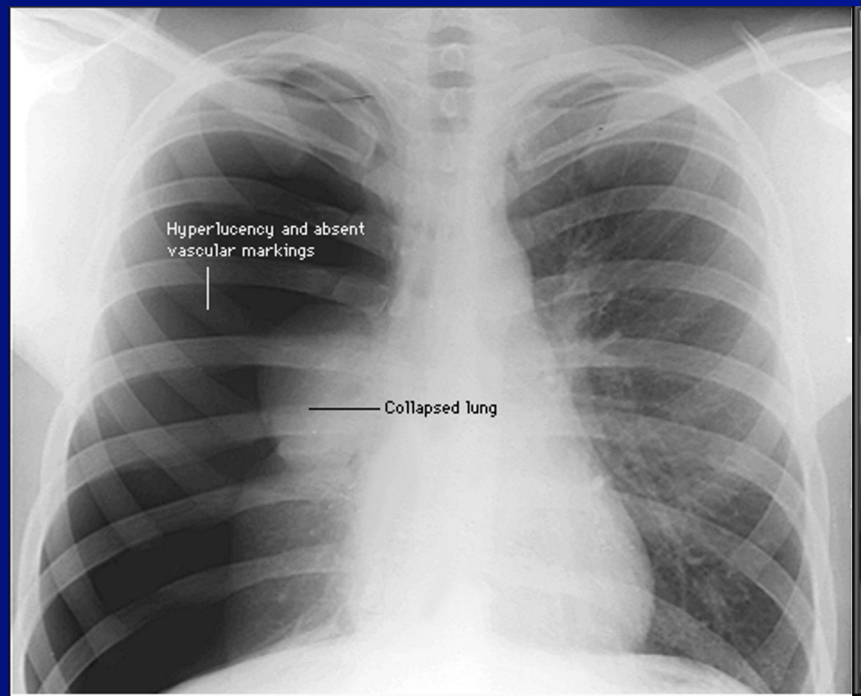
- **A**irway
- **B**reathing
- **C**irculation
- **D**isability
- **E**xposure

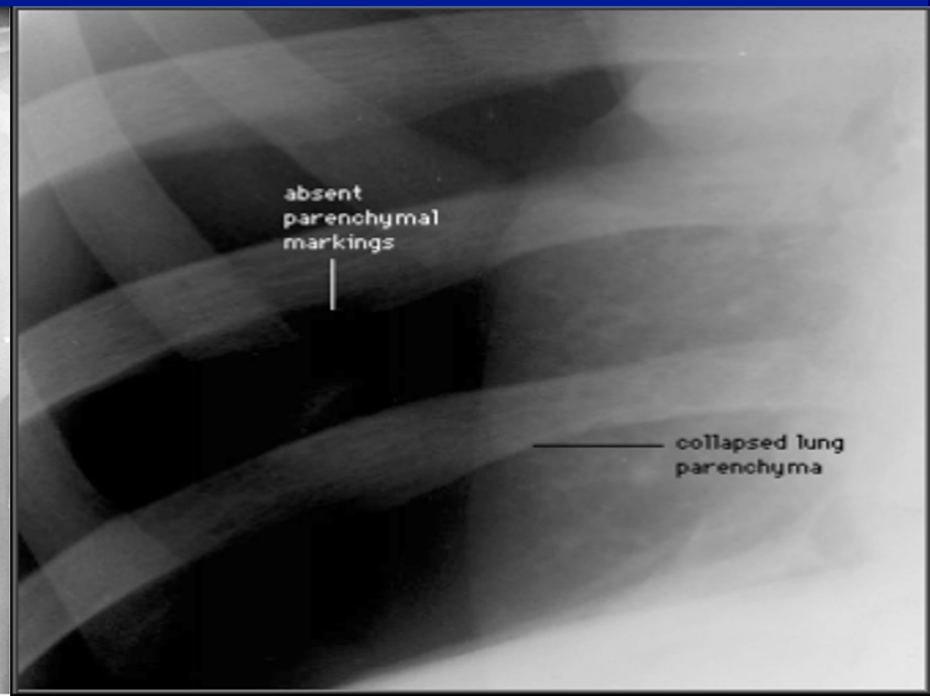
Airway

- Assess for airway patency
- Assess for facial fractures
- Maintain Cspine immobilization

Breathing

- Non-rebreather
- Auscultation and inspection of neck and chest
- Inspiratory effort





Circulation

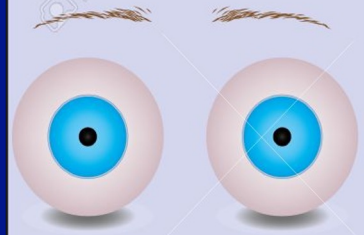
- Pulses
- Tachycardia first sign of hypovolemia
- Intravenous lines
- Volume resuscitation
  - 60cc/kg then blood
  - Massive transfusion
    - Anticipated need to replace total blood volume in 24 hours
    - 1:1:1 (RBC:FFP:platelets)

Circulation

- Hemorrhage control
  - Direct pressure
  - Staples for scalp laceration
  - Pelvic binder

Disability

- Neurologic assessment
  - Level of consciousness (GCS)
  - Pupils
- Evidence of cerebral herniation
  - IV mannitol 1gm/kg
  - IV hypertonic saline
    (2-6cc/kg 3% NaCl)

Behaviour	Response
 Eye Opening Response	4. Spontaneously 3. To speech 2. To pain 1. No response
 Verbal Response	5. Oriented to time, person and place 4. Confused 3. Inappropriate words 2. Incomprehensible sounds 1. No response
 Motor Response	6. Obeys command 5. Moves to localised pain 4. Flex to withdraw from pain 3. Abnormal flexion 2. Abnormal extension 1. No response

Exposure

- Removal of clothing
- Heated room to prevent hypothermia
- Discontinue backboard

Secondary Survey

Blunt Abdominal Trauma

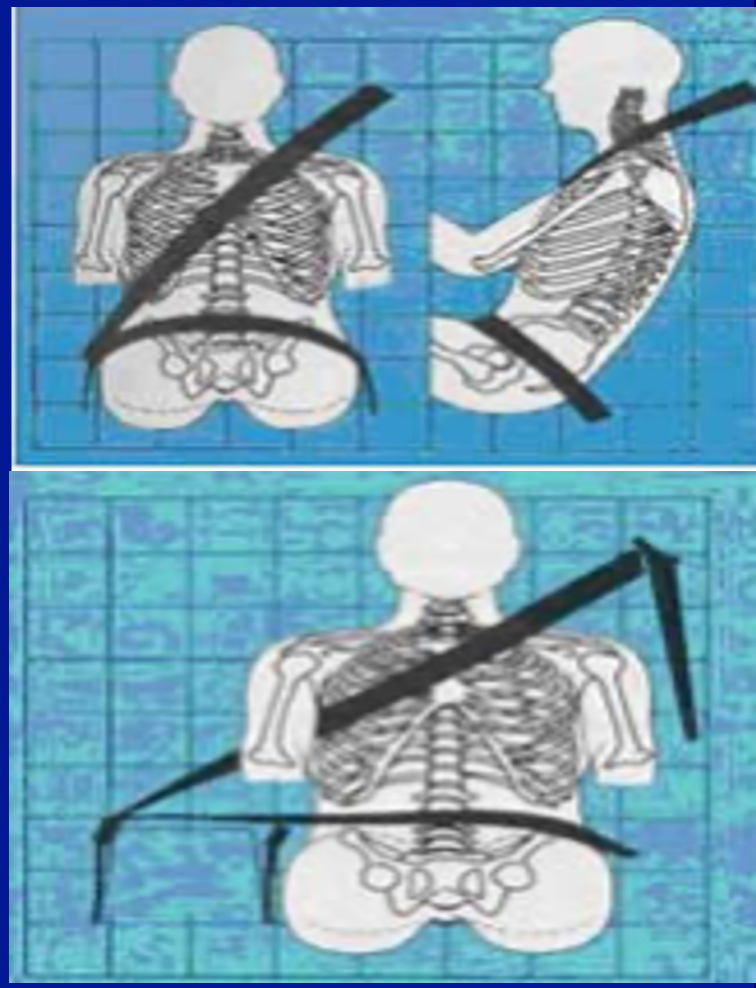
- Third leading cause of traumatic death
  - Mortality rate of 8.5%
- 85% blunt
  - MVA 50%
  - Falls
  - Bicycle crashes
  - Sports
- Mortality < 20% in isolated liver, kidney, spleen, or pancreas

Physical Exam

- ABC's
- Signs of abdominal injury
  - Distention, tenderness, rigidity
  - Ecchymoses
  - Tire-tracks
  - Seat-belt marks
  - Left shoulder pain
  - Prolonged ileus
  - Blood on rectal exam

Seat Belt Syndrome

- Described in children - 1980s
- Distinctive pattern of injuries
  - Abdominal wall contusions
  - GI tract perforation
  - Lumbar spine injury



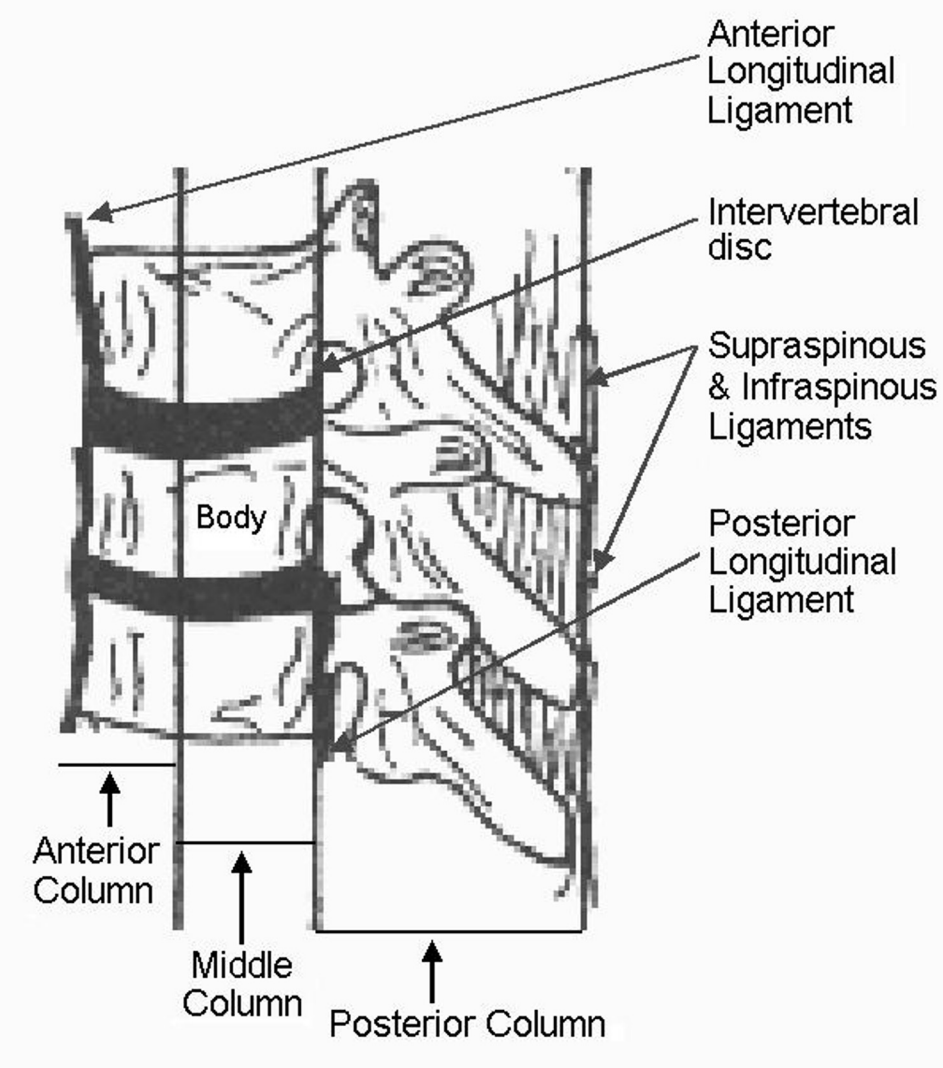
GI Tract Perforation

- Factors involved in belt-related bowel injury
  - Immaturity of pelvis to properly anchor lap portion of belt
  - Tendency of children to scoot forward in seat allowing lap belt to ride over anterior abdominal wall
- Direct compression
  - mesenteric tears and bowel wall contusions
- Increase in intraluminal pressure
  - Intestinal perforation

Lumbar Spine Injuries

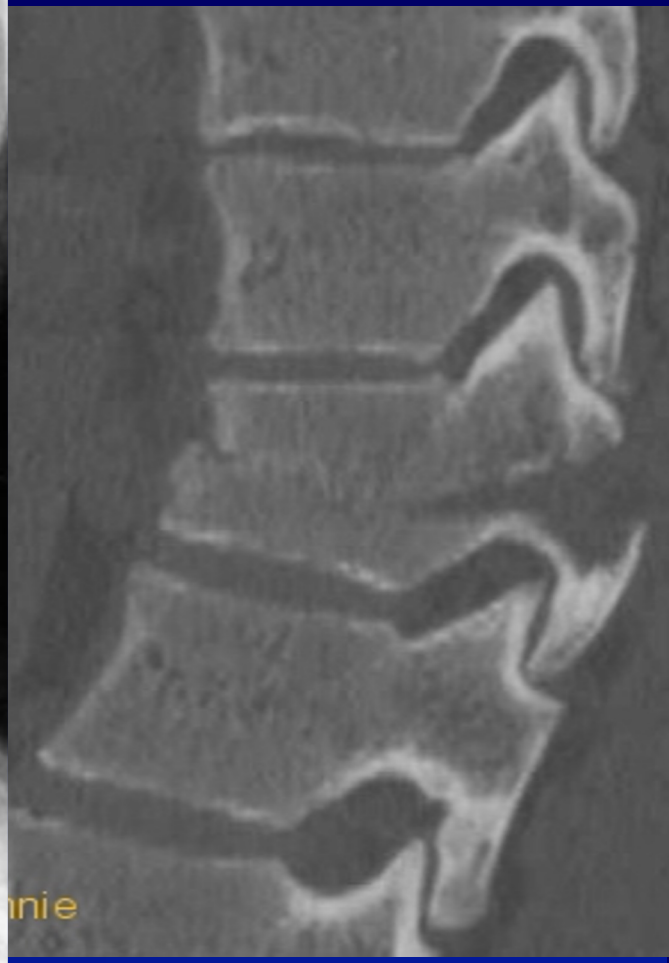
- Two types of injuries
  - Compression fractures
  - Chance fractures
- Position of lap belt over abdominal wall
  - Fulcrum of crash forces over abdominal wall
  - High tension forces over elements of spine

Compression



Chance Fracture

- Flexion-distraction injury
- Rupture of posterior ligaments and transverse fracture of spinous process, pedicles and vertebral body



Specific Injuries

Spleen

- Most common organ injured
- Most vascular organ
- Present with diffuse abd tenderness, LUQ pain, left shoulder pain (50%)
- Hypotension (25-30%)

Spleen

- Plain films
  - Left lower rib fracture 44%
  - Triad: left hemidiaphragm elevation, LLL atelectasis, pleural effusion
  - medially displaced gastric bubble and inferior displacement of splenic flexure gas pattern
- CT with contrast modality of choice

Management

- Nonoperative preferred
- Operative – hemodynamic instability or transfusion requirement of > 40cc/kg of PRBC

Liver

- Second most commonly injured organ
- Most fatal abdominal injury
  - 10-20% mortality rate
- Present with RUQ tenderness, rebound, peritonitis, hypotension

Transaminases

- Sensitive and specific indicator of hepatic injury
- AST > 450 IU/L and ALT > 250 IU/L (100% sensitivity, 92% specificity)
- No correlation between enzyme level and extent of hepatic injury

Hennes *et al*, **Elevated liver transaminase levels in children with blunt abdominal trauma: a predictor of liver injury**. Pediatrics 1990 (86), 87-90

Management

- Same as splenic injuries
- Nonoperative management in majority of cases (97%)

GI tract

- Occurs in 1-15% of patients with blunt abdominal trauma
  - Higher rates in assault victims, multiple solid organ injuries, pancreatic injury
- Two types of forces
  - Compression
  - Deceleration

GI tract

- Clinical signs of bowel injury present in 31% of pts
- Characteristic injury patterns according to anatomic regions
- Injuries occur at points of fixation
  - Ligament of Treitz, ileocecal valve, phrenocolic ligament

GI tract

- GI perforation
  - Most common intestinal injury
    - Jejunum > ileum > duodenum
  - Difficult diagnosis
    - Peritonitis present < 50% of pts
    - < 1/3 with free air on plain films
    - CT insensitive for detecting GI injuries
  - Management
    - Fluid resuscitation, antibiotics, surgical repair

GI tract

- Duodenal hematoma
  - Presents within 1-5 days from injury
  - Gastric distention, abd pain, bilious emesis, signs of proximal bowel obstruction, upper abd mass
  - Nonspecific findings on plain films
  - UGI, US or CT for diagnosis
  - Usually resolves with NG suction and bowel rest

CHILD ABUSE/NON-ACCIDENTAL TRAUMA

Epidemiology

- The incidence of child abuse in the United States is difficult to ascertain, but is believed to be much higher than reported
- Inconsistencies in reporting and variation in definitions make it difficult to precisely determine prevalence and track trends

Risk Factors

- Family stress factors
  - Single-parent homes
  - Economic difficulty
  - Poor housing
  - Unemployment
  - Illness
  - Crowding
- Child factors
  - Young (age < 3 yr)
  - First born children
  - Unplanned children
  - Premature infants
  - Disabled children
  - Stepchildren

Evaluation

- History
  - Is the history provided by the parent or caretaker consistent with the injuries of the child?
  - Is the history vague or lacking in detail?
  - Does the history change in repeated versions given by the same caretaker to different healthcare workers, or are conflicting histories given by different family members?
  - Is the injury attributed to actions of young siblings?
  - Is no history offered?
  - Is the history consistent with the developmental stage of the child?

Evaluation

- Parental Behavior
  - Arguing, roughness, or violence
  - Aloofness and lack of emotional interaction between parents or between parents and children
  - Inappropriate response to the severity of the injury
  - Inappropriate delay in seeking medical care
  - A partial confession by the parent (e.g., "I hit him, but not that hard") or a frank admission by parent that injury was inflicted

Evaluation

- Physical Exam – entire body must be completely exposed
  - Injuries with patterns that indicate a method of infliction
    - Slap, belt, loop of cord and other shaped bruises
    - Cigarette, iron, spatula and other shaped burns
    - Immersion burns up to a “high tide” level
  - Multiple injuries in various stages of healing, or different types of injuries coexisting

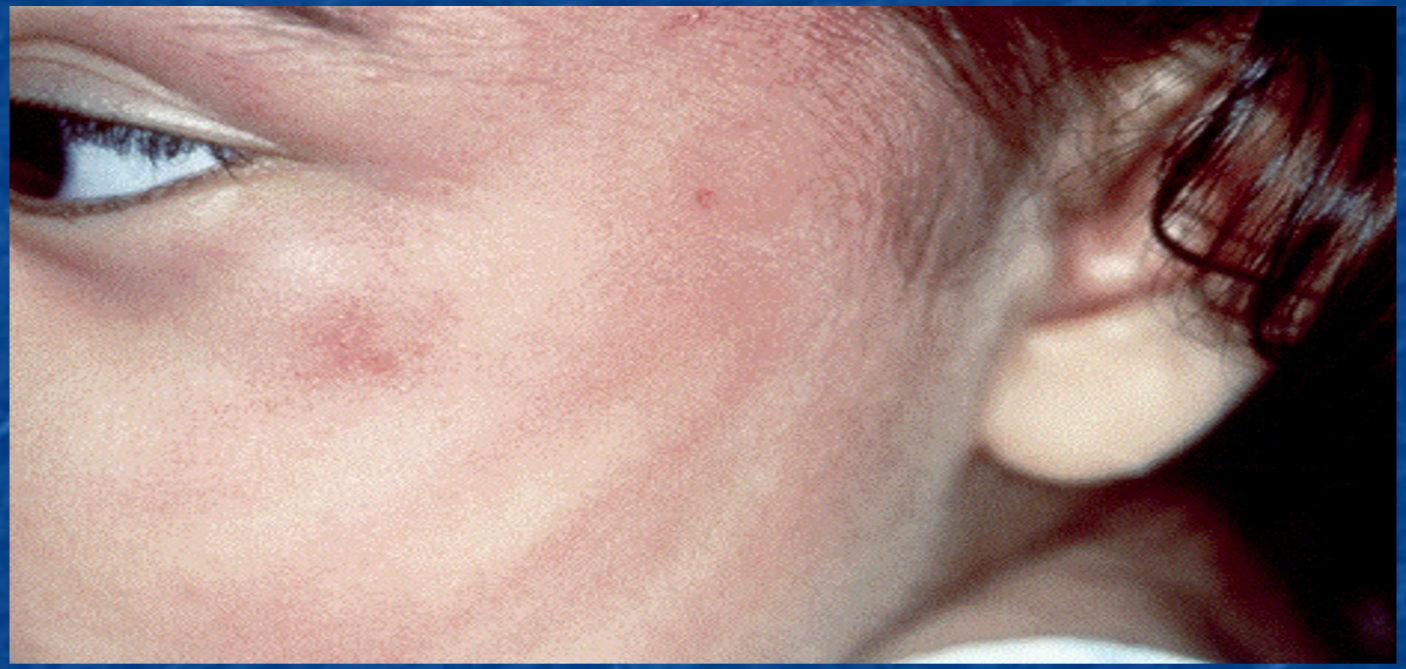
Evaluation

- Physical Exam (continued)
  - Injuries with a high epidemiological association to abuse
    - Bruises in children who cannot cruise
    - Bruises of the trunk, ear, and neck
    - Long bone fractures in children who do not walk
    - Rib fractures in infants younger than one year of age
    - Hollow viscus injury in children younger than four years old
    - Subdural hematoma in infants younger than one year old
  - Sudden onset of altered mental status not attributable to medical illness or other signs of poisoning
  - Injury to the genitalia

Skin Findings

- Bruising
  - Most common type of injury in abused children caused by direct blunt force to the skin
  - Unintentional bruising tends to occur on bony prominences, such as the forehead, extremities, and front of the body
  - Central bruising to the buttocks, back, trunk, genitalia, inner thighs, cheeks, earlobes, or neck is suggestive of abuse

Handprint Injuries

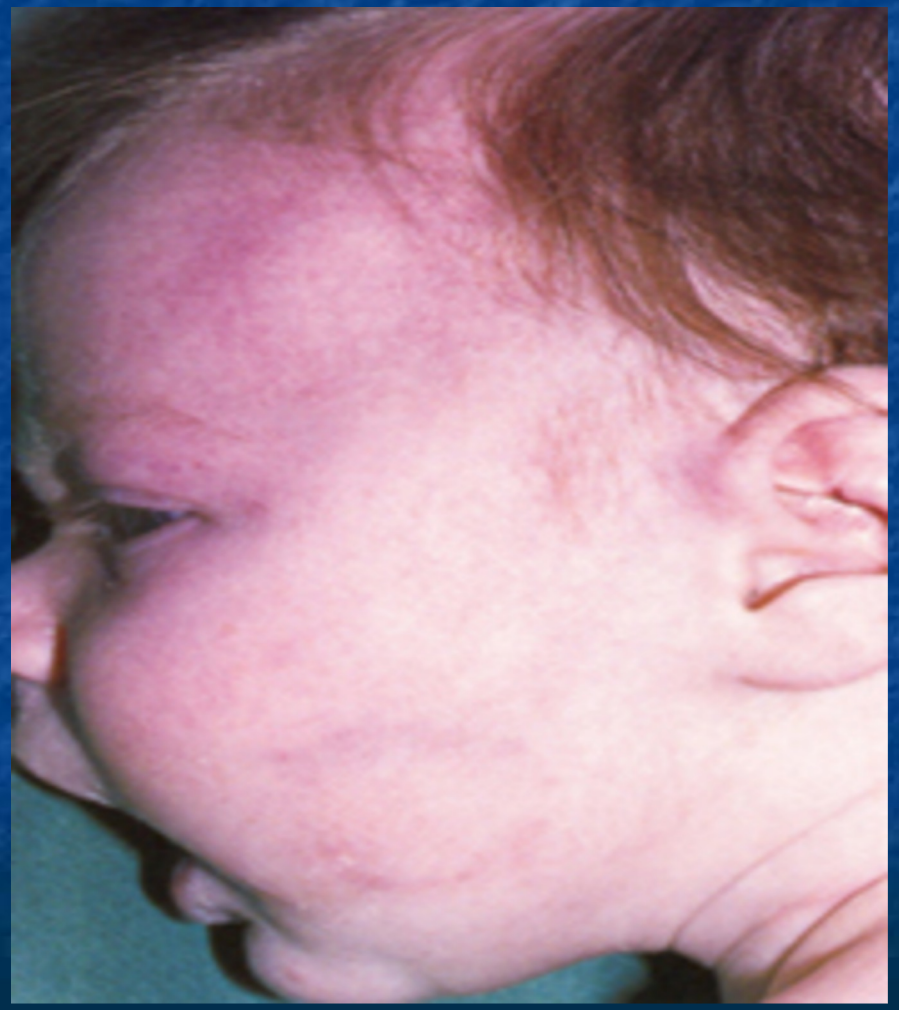


Looped Cord Injuries

Fingertip Bruises

Blow to Ear

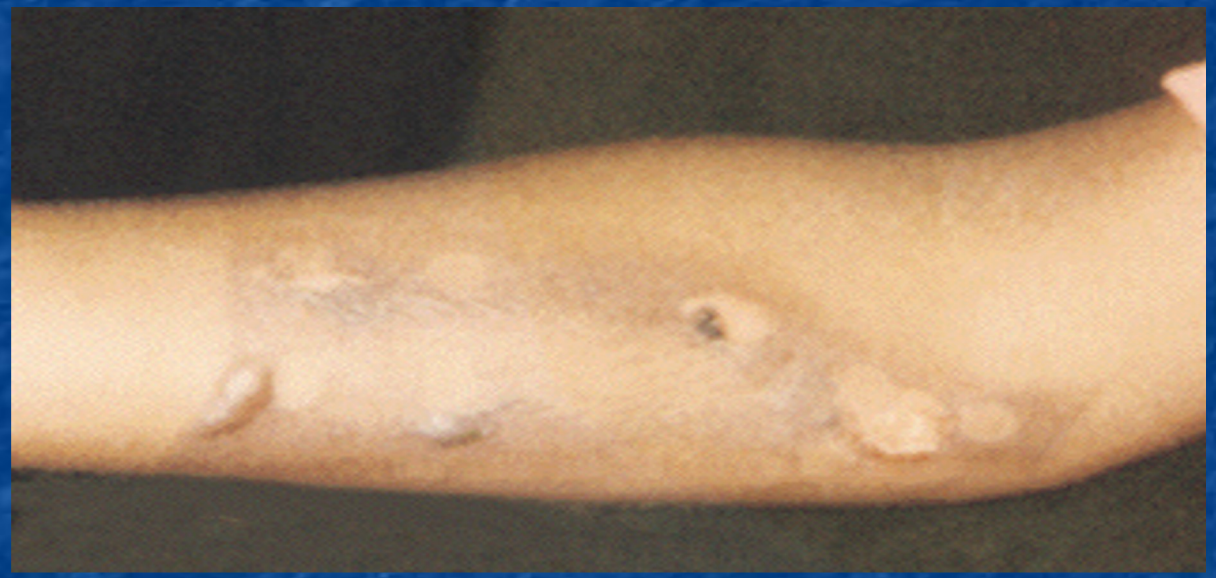
Bite Marks



Skin Findings

- Burns
  - Occur in up to 20% of physically abused children
  - More indicative of premeditated acts
  - Intentional burn are uniformly deep and leave clear outlines of the identifiable object on the skin
  - Unintentional burns are shallow and leave only part of an outline due to the withdrawal reflex

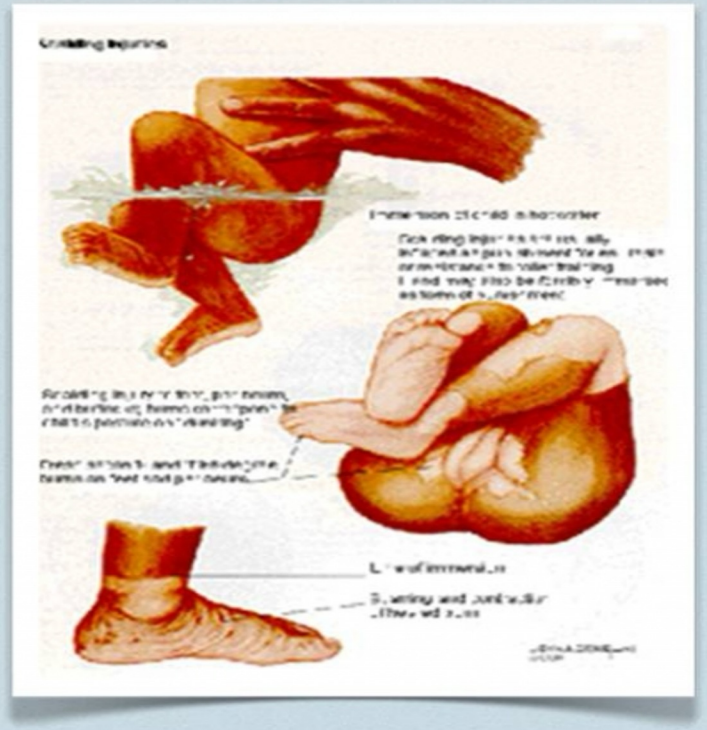
Brand or Contact Burn

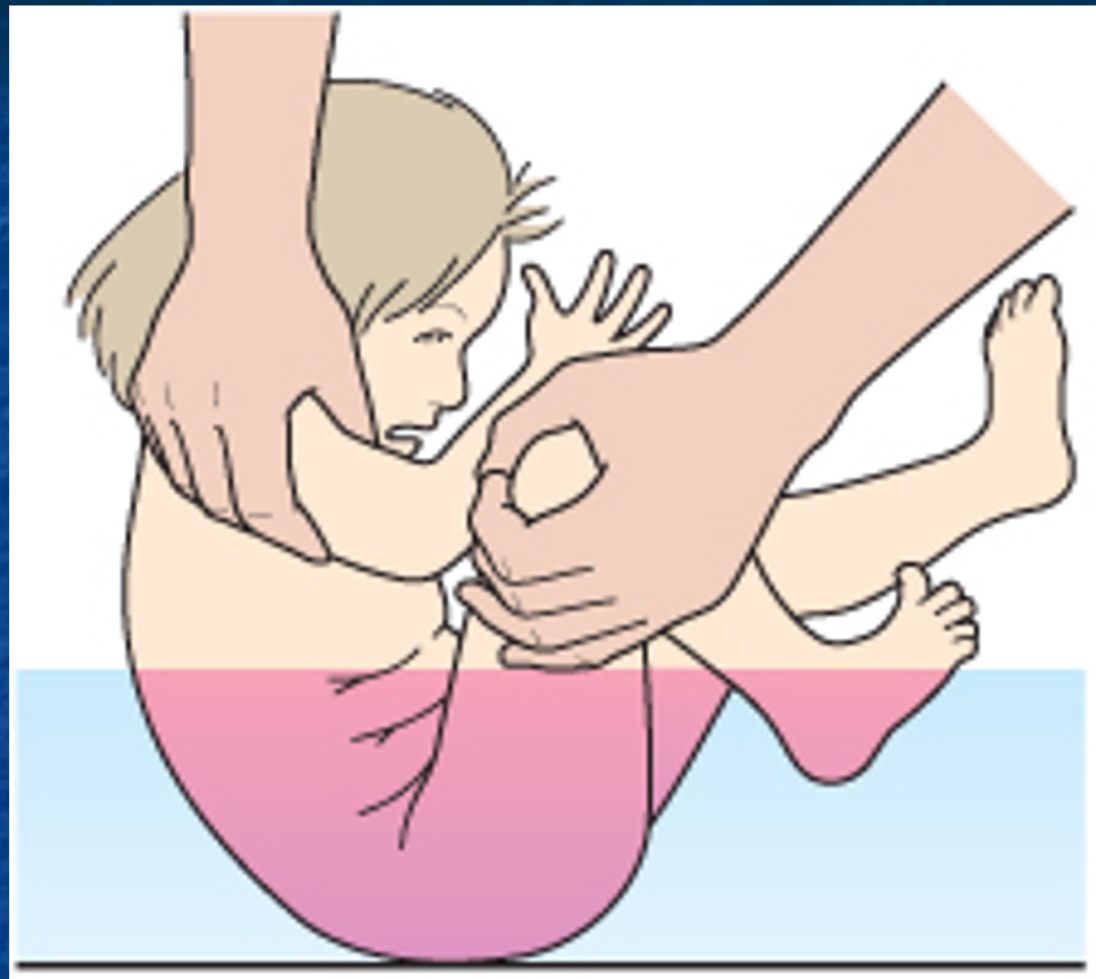


Cigarette Burns

Immersion

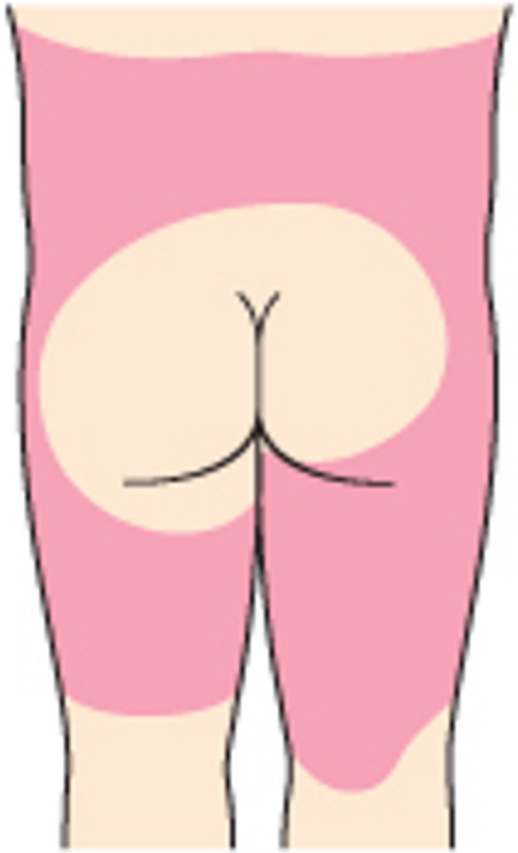
- Scald burns with sharp margins vs. splash pattern
- Uniform intensity of burn
- Stocking/glove pattern
- Folds spared
- “Doughnut” shape on buttocks--central sparing





Forced submersion in a flexed position

'Zebra' stripe



'Doughnut hole' sparing

Immersion Burns

Fractures

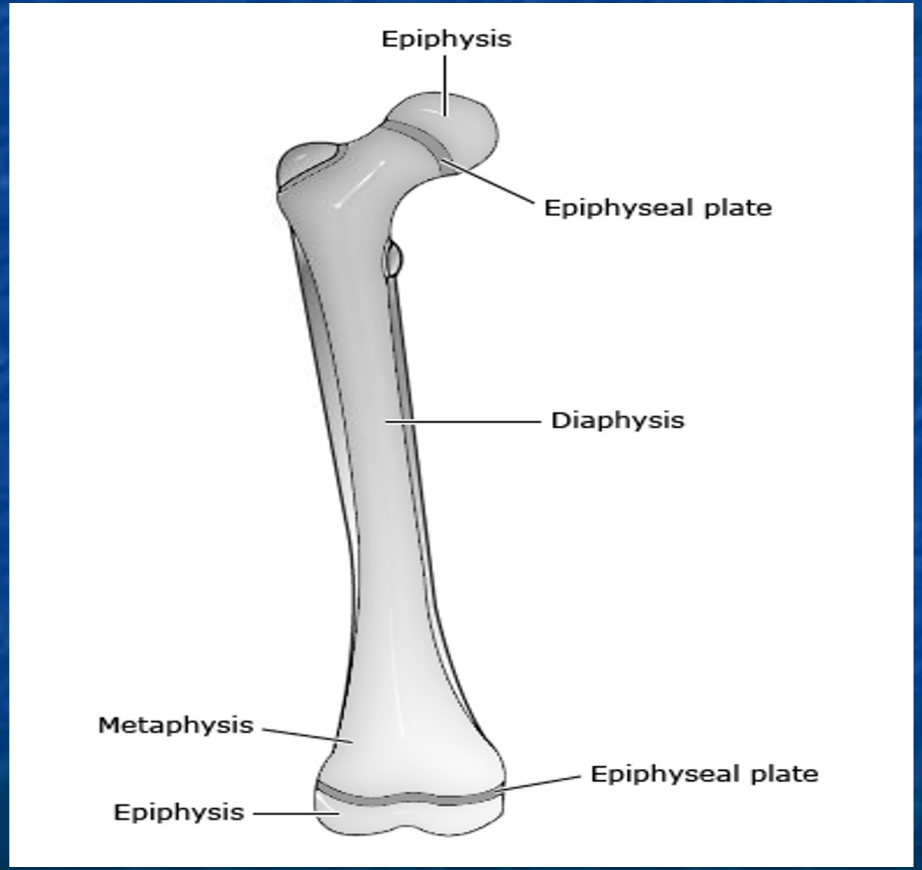
- Second most common injury in physical abuse, detected in up to 55% of abused children
- 69% in children younger than 1 year
- 85% in children younger than 3 years

Fractures

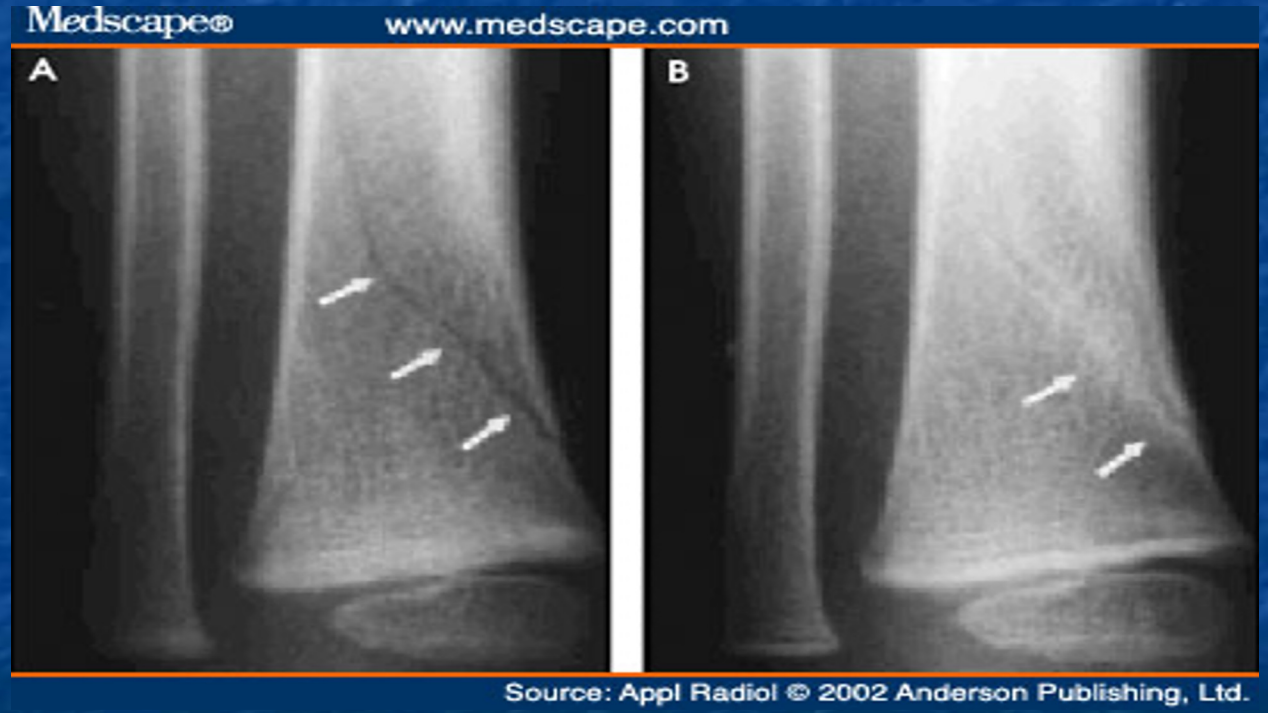
- Fractures that are highly suggestive of intentional injury include:
  - Bilateral acute long-bone fractures
  - Metaphyseal corner fractures
  - Epiphyseal separations
  - Rib fractures
  - Fractures of the sternum, scapula, or spinous processes
  - Multiple fractures in various stages of healing
  - Vertebral body fractures and subluxations in the absence of a history of high force trauma
  - Digital fractures in children younger than 36 months of age or without a corresponding history
  - Complex skull fractures in children younger than 18 months of age, particularly without a corresponding history

Long Bone Fractures

- Transverse and spiral diaphyseal fractures and metaphyseal corner fractures comprise the most common types of long bone fractures seen in abused children
- Most commonly injured bones in child abuse: femur, humerus, and tibia
- Isolated fractures of the tibia and femur are common in toddlers and may result from low-energy falls



Toddler's Fractures



Source: Appl Radiol © 2002 Anderson Publishing, Ltd.

Femur Fractures

- Whether or not a child is ambulatory is the single most important predictor of inflicted injury in isolated femur fractures
- Abuse accounts for 60 to 80 percent of femoral shaft fractures in children <1 year
- There are no clinical features that absolutely differentiate intentional from unintentional injury in children >1 year who have femoral shaft fractures

Diaphyseal Fractures

- Spiral fractures
  - Result from a torsional force on the limb
  - Suspicious in a child who is too young to walk or who lacks a consistent history
  - In the presence of such a twisting force these fractures often occur accidentally
    - "toddler's fracture - spiral fracture of the tibia that is usually nondisplaced

Humeral Fractures

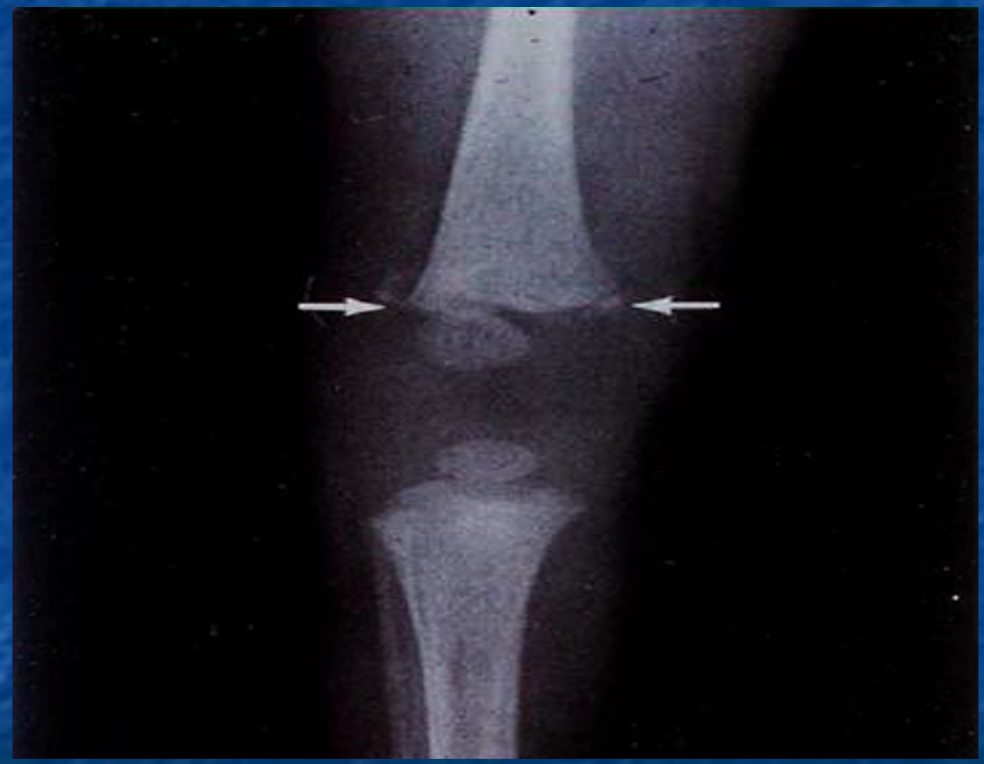
- Midshaft humeral fractures are more common in abuse
- Supracondylar fractures are more common in nonabuse
- Spiral/oblique fractures are the most common type of humeral fracture related to abuse

Metaphyseal Fractures

- Also called a “corner” or "bucket-handle" fracture
- Occur when the extremity is pulled or twisted forcibly, or the child is shaken
- Fractures that occur in infants who are not yet walking are highly associated with child abuse
- Plain radiographs reveal a disruption of the metaphysis with lucency

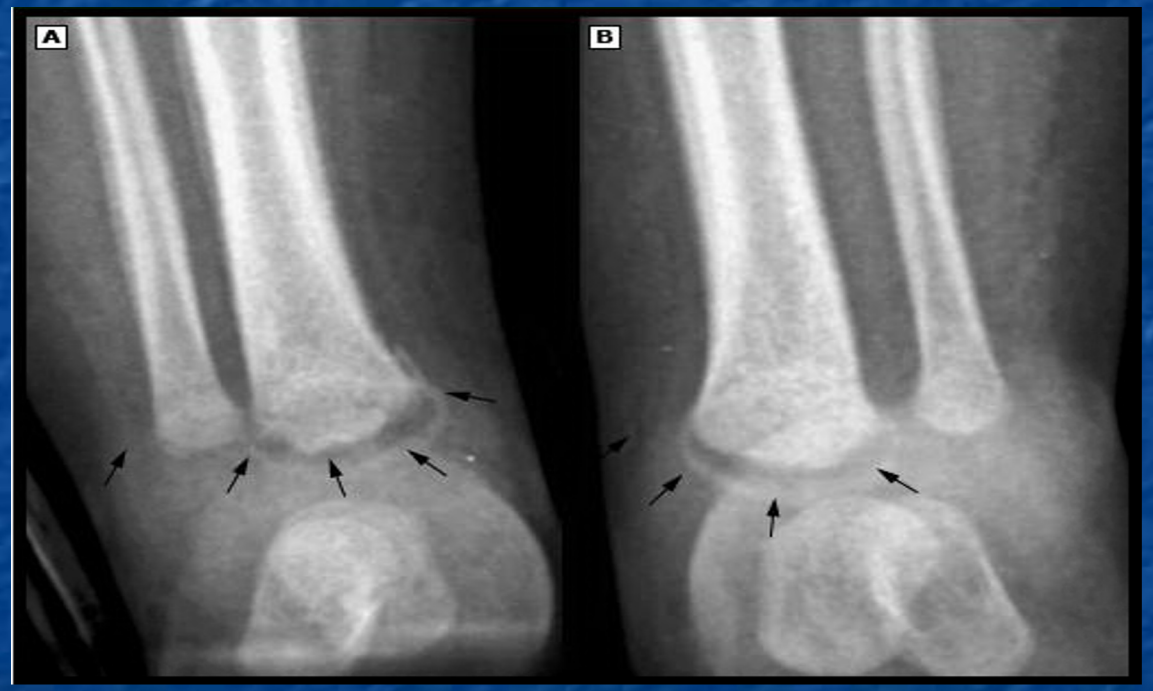
Metaphyseal Fractures

- When viewed tangentially, the lesion appears as a triangular fragment of the metaphysis
  - "corner" fracture



Metaphyseal Fractures

Metaphyseal Fractures



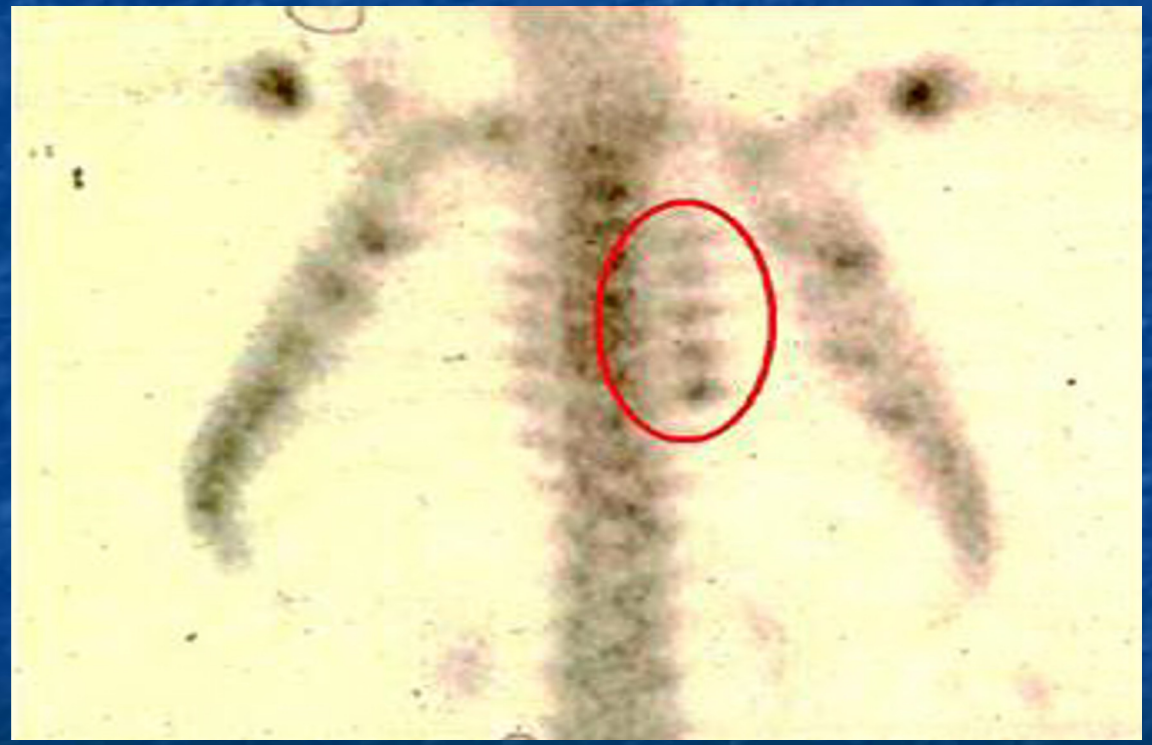
- If an angulated view is obtained, the fragment appears as a curvilinear density adjacent to the metaphysis
  - "bucket handle" fracture

Rib Fractures

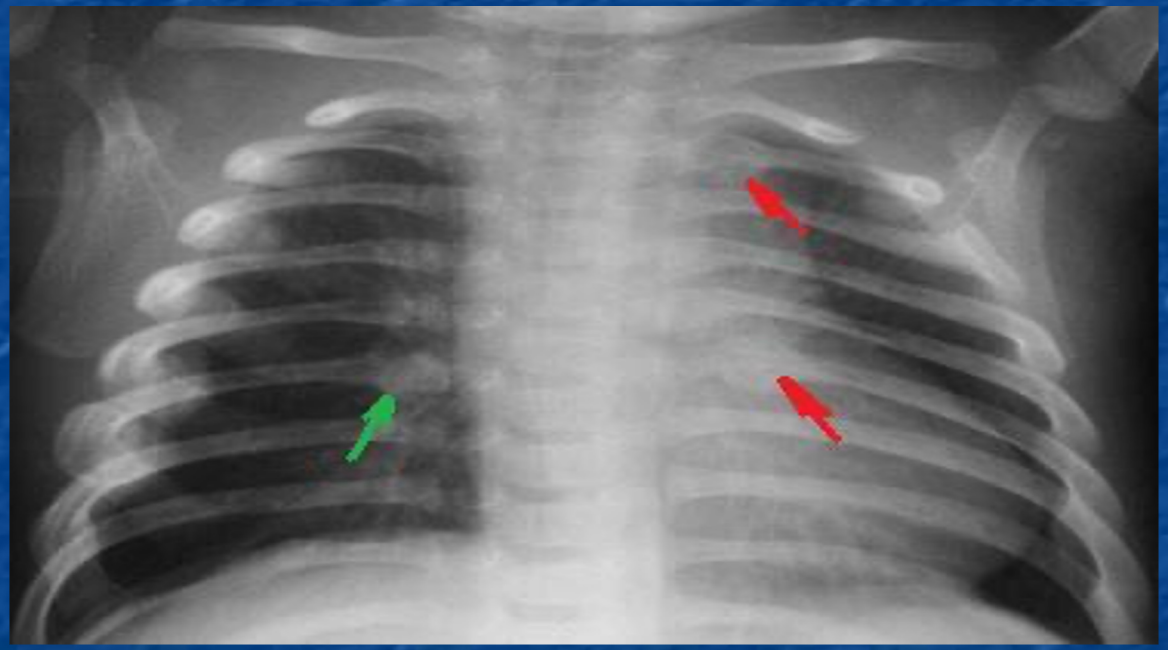
- Produced by direct blows to the chest or compression of the chest as the torso is grasped during squeezing or shaking
- Children's ribs are flexible and difficult to fracture, so a rib fracture in the absence of a history of severe trauma is strongly suggestive of child abuse

Rib Fractures

- Inflicted rib fractures are usually nondisplaced and involve multiple sequential ribs corresponding to the positioning of the abuser's fingers



Rib Fractures



- Rib fractures are most apparent during the stage of callus formation, 10 to 14 days after the injury
- The addition of oblique views and/or radionuclide imaging increases ability to detect rib fractures in children suspected to be victims of nonaccidental trauma

Fractures

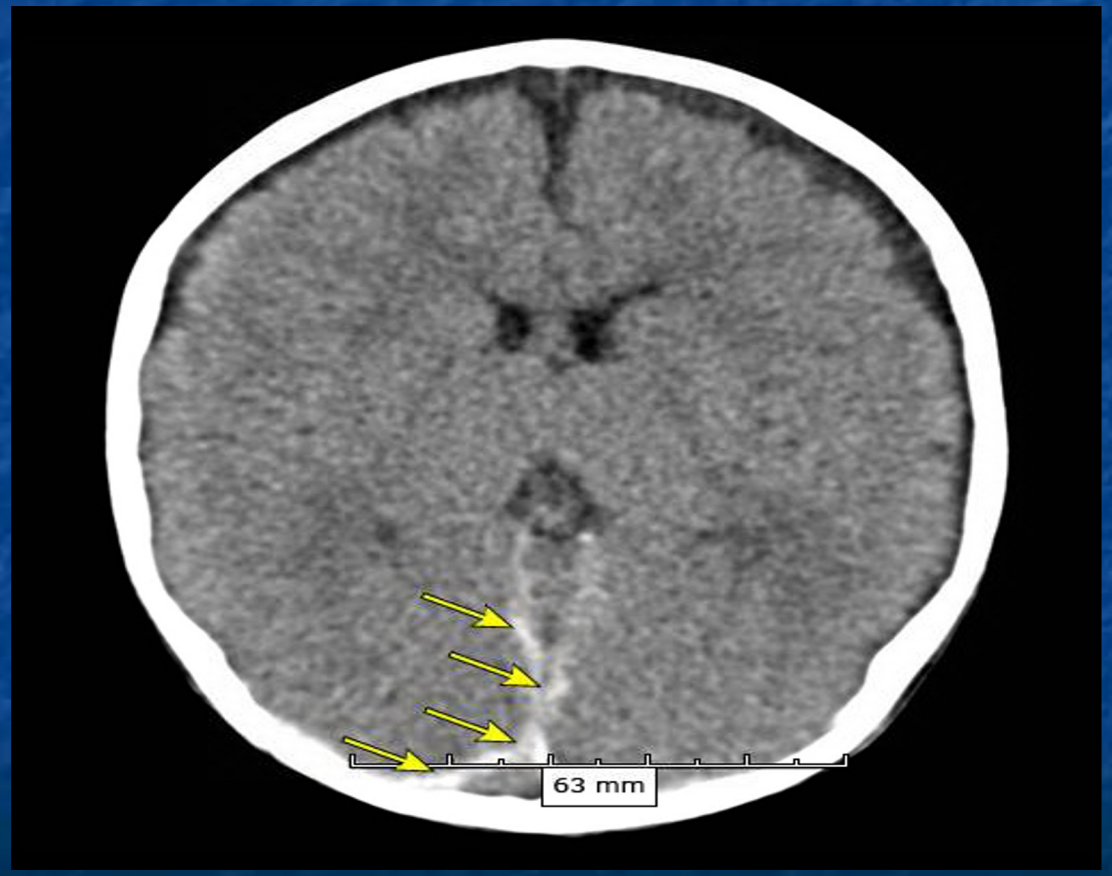
- According to the American Academy of Pediatrics (AAP) and the American College of Radiology, the skeletal survey is "the method of choice for global skeletal imaging in cases of suspected child abuse" and is mandatory for all children younger than two years of age in whom child abuse is suspected

Abusive Head Trauma

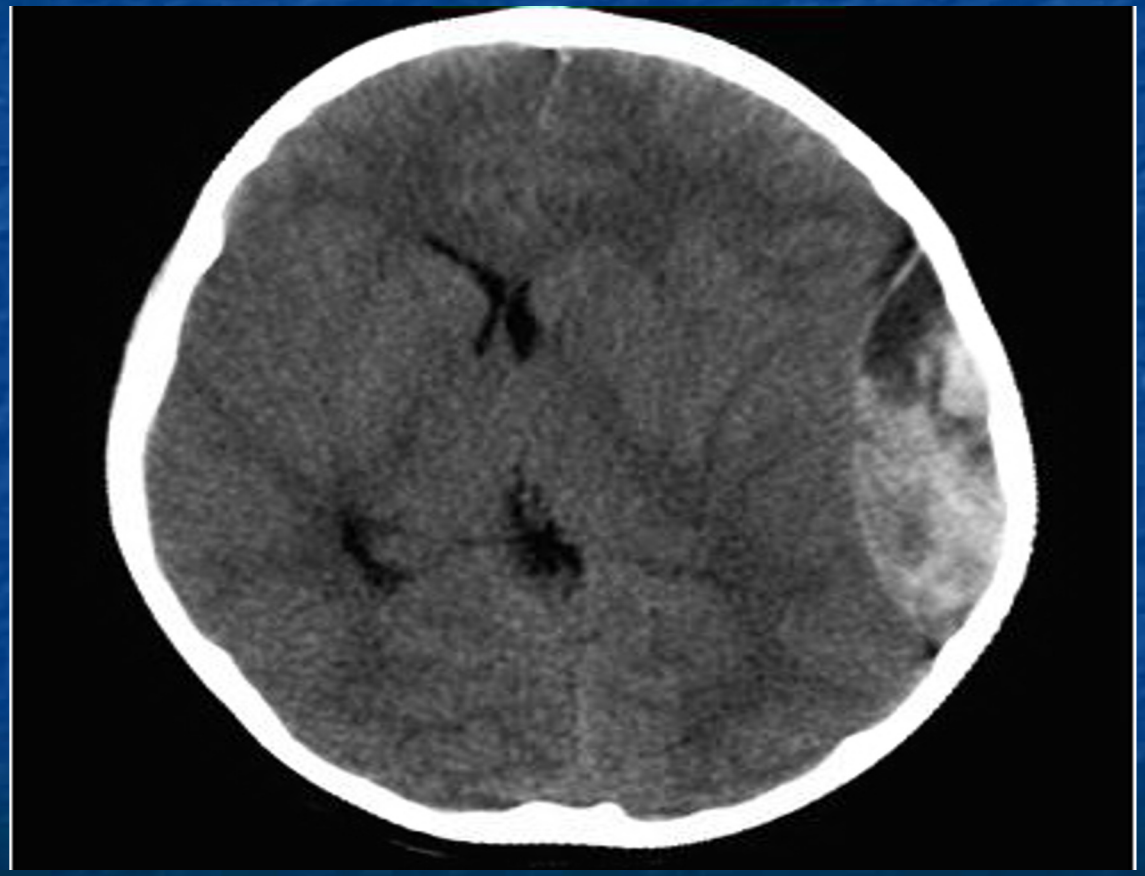
- Inflicted cranial, cerebral, and spinal injuries resulting from blunt force trauma, shaking, or a combination of forces
- Most common cause of lethal child abuse
- Most fatal head injuries in children less than two-years old are secondary to abuse
- Head-injured infants frequently present with nonspecific clinical features and no history of trauma
  - 30% of children with inflicted head injuries may be misdiagnosed at the initial evaluation

Subdural Hemorrhage

- Significantly associated with abusive head trauma
- Occurs almost three times more frequently in abused children than patients with serious unintentional head trauma



Epidural Hemorrhage



- Falls are the typical mechanism of injury
- Occurs significantly more frequently following unintentional head trauma than after abusive head trauma

Skull Fractures

- Linear, parietal skull fractures are the most common type of skull injury following both unintentional and inflicted trauma
- Complicated skull fractures (complex, stellate, branching, multiple, bilateral, crossing suture lines, depressed, or diastatic) are suggestive of abusive head trauma when the history of injury is absent or implausible

Abusive Head Trauma

- Intracranial hemorrhage (ICH)
  - Subdural hemorrhage
  - Epidural hemorrhage
  - Intraparenchymal bleeding
  - Subarachnoid hemorrhage
  - Concomitant skull fracture may or may not be present

Management

- Majority of abuse cases result in medical records becoming part of legal record
- Carefully document history, physical exam and radiographic findings
- Document evidence supporting physical abuse

DROWNING

Epidemiology

- Drowning
  - Leading cause of unintentional injury-related death worldwide
  - Fifth leading cause of unintentional injury-related death in the US
    - ~4,000 deaths in US annually
  - Second leading cause of unintentional injury-related death in children 1-14 years of age in the US
    - MVC are first
  - Leading cause of death in children 1-4 years of age except congenital anomalies

Epidemiology

- More common in males, African Americans, low socioeconomic status, and residents of southern states
- More common in summer months
- Bimodal age distribution
  - Children <5
    - unsupervised swimming pools, bathtubs
    - ~7% related to abuse/neglect
  - Age 15-25 years
    - Usually males
    - rivers, lakes, beaches

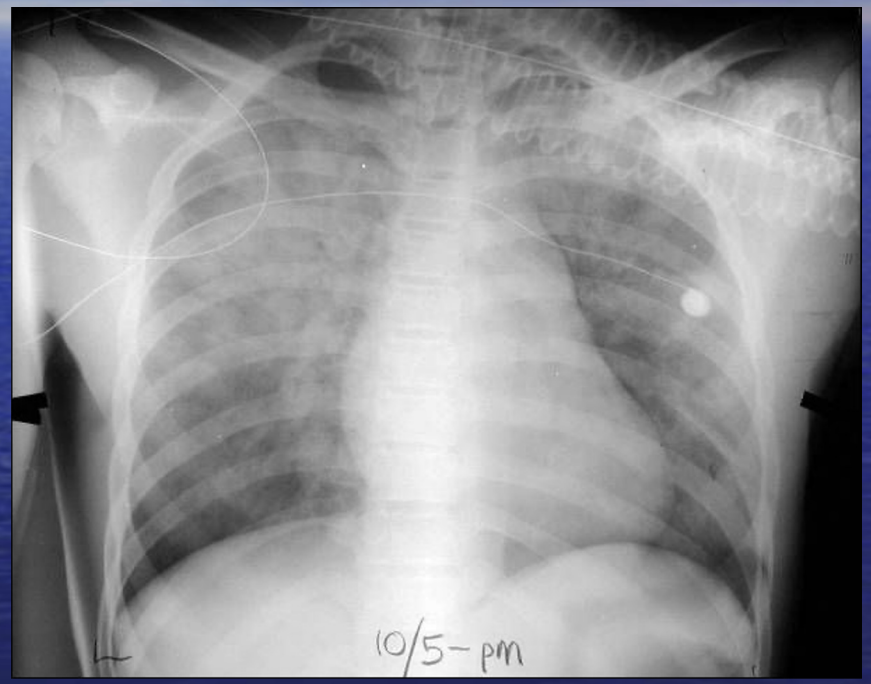
Pathophysiology

- Often begins with panic, abnormal breathing patterns, breath-holding, air hunger and struggle
- Reflex inspiratory efforts (aspiration or reflex laryngospasm)
- Primary injury☐ pulmonary ☐ Hypoxemia
- Secondary injury☐ tissue hypoxia to every organ system (cerebral hypoxia)

Pathophysiology

- Pulmonary
  - Hypoxemia
  - Washout of surfactant
  - Noncardiogenic pulmonary edema and acute respiratory distress syndrome (ARDS)
  - Rapid or insidious development of pulmonary insufficiency
    - Shortness of breath, crackles, wheezing
  - CXR at presentation may vary from normal to localized, perihilar, or diffuse pulmonary edema

Pulmonary Edema



Pathophysiology

- Neurologic
  - Hypoxia/ischemia leads to neuronal damage
  - Cerebral edema and elevated ICP
  - Approximately 20% of near-drowning victims sustain neurologic damage
- Cardiovascular
  - Arrhythmias occur secondary to hypoxia and hypothermia
    - Sinus tachycardia, sinus bradycardia, and atrial fibrillation are more common initial arrhythmias than ventricular fibrillation or asystole
    - Swimming may induce ventricular arrhythmias in patients with congenital long QT syndrome type 1

Pre-hospital Management

- Rapid extraction from water
- Early initiation of cardiopulmonary resuscitation
- Follow PALS/ACLS protocols
- Routine cervical spine immobilization can interfere with essential airway management and is not recommended
- Abdominal thrust maneuver or postural drainage techniques have no proven value
- O2 via mask or intubation
- Passive/active rewarming

Emergency Department Care

- ABCs
  - O2 via mask
  - CPAP or BiPAP
  - ETT
    - Intubation if signs of neurologic deterioration, inability to maintain PaO2>60mmHg or O2 Sat >90
    - Orogastric tube placement to relieve gastric distension
  - IV access
- Trauma evaluation
- Remove wet clothing

Emergency Department Care

- Rewarming
  - Warm blankets, heating pads, radiant heat, forced warm air, warm baths, insulators to reduce heat loss, pleural/peritoneal irrigation with warm saline, AV rewarming, or CP bypass
  - Hypothermia is neuroprotective
  - Complete recovery has been documented despite prolonged resuscitation
  - Continue resuscitative efforts until temperature 32-35°C (90-95°F)
- EKG, electrolytes, serum and urine toxicology/alcohol screens

Emergency Department Care

- CXR
  - May not be reflective of severity of pulmonary involvement
- Bronchospasm
  - Treated similarly to asthma
  - Responds to inhaled beta-adrenergic agonists
- Routine use of glucocorticoids not indicated
- Empiric antibiotic treatment not indicated
  - Use if clinical evidence of infection or immersion in grossly contaminated water
  - If pneumonia develops, consider aeromonal, pseudomonas and proteus
- Exogenous surfactant
  - Not supported by clinical and animal studies

Disposition

- All symptomatic patients require admission until symptoms resolve
- Asymptomatic patients with normal blood gas and normal CXR may be discharged home after 6-8 hours of observation
  - Studies have shown that those who develop symptoms do so within 7 hours of immersion

Prognosis

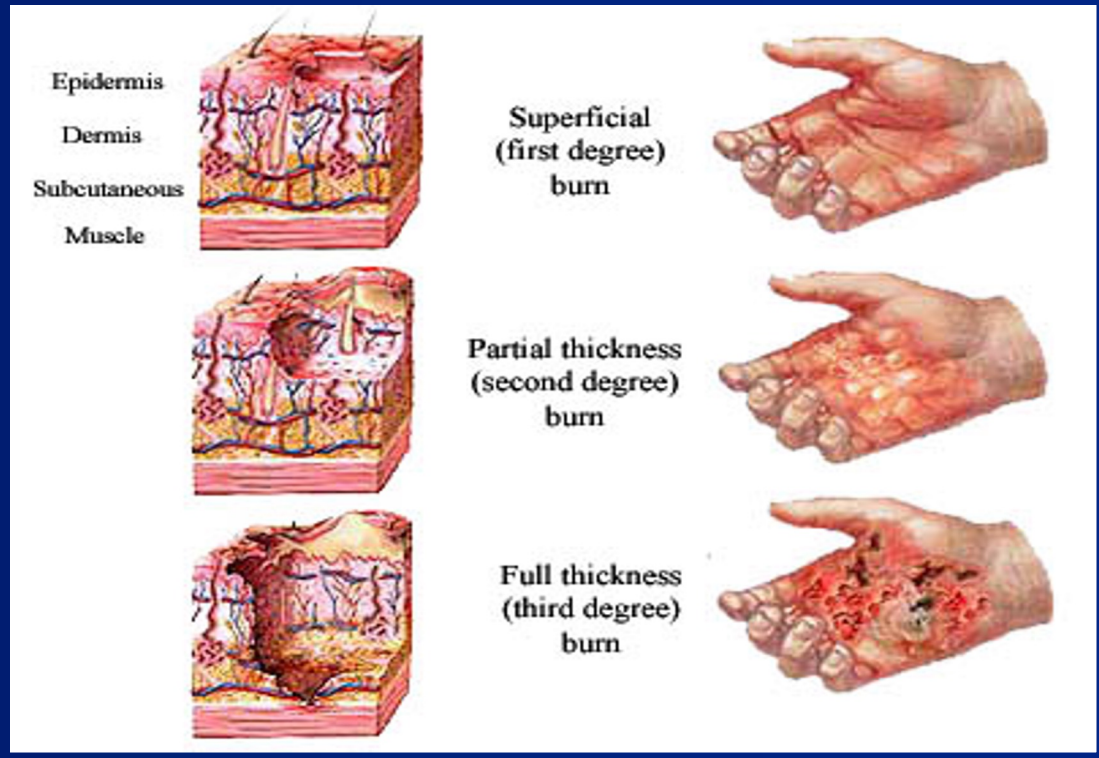
- Generally good
  - 75% of near-drowning victims survive
    - 6% have residual neurologic deficit
  - Depends on severity of anoxic brain injury
  - Predictors of improved neurologic outcome/survival
    - Early resuscitative efforts
    - Presence of spontaneous respirations and heartbeat on ED presentation

Prognosis

- Poor prognostic factors
  - Duration of submersion >5 min (most critical factor)
  - Time to effective BLS >10 min
  - Resuscitation duration >25 min
  - GCS <5
  - Age >14 years
  - Arterial pH <7.1 upon presentation
  - Persistent apnea and CPR on ED presentation

BURNS

- Common presentation to the ED
- First degree= redness and mild inflammatory response confined to the dermis
- Second degree= destruction of the dermis and less than 50% of the epidermis (blisters)
- Third degree= destruction of the dermis and epidermis (pale, leathery appearance; nontender)
- Fourth degree= extend through the subcutaneous tissue and expose muscle and bone



FIRST DEGREE BURNS

SECOND DEGREE BURNS

THIRD DEGREE BURNS

FOURTH DEGREE BURNS

INITIAL MANAGEMENT OF PEDIATRIC BURN PATIENTS

- Airway (Is the airway patent? Will it be patent in 12 hours?)
- Breathing (Are risk factors for inhalation injury present?)
- Circulation (Can IV access be established?)
- Estimate TBSA (2nd and 3rd degree burns only)

AIRWAY

Three rules of pediatric burn airway management

- 1. You must have a low threshold for intubation
- 2. You must intubate under ideal conditions (good lighting, good equipment, good drugs, most expert person available)
- 3. If you wait, it may be too late
- 4. If it’s too late, the patient may die

DAY 0

- Toddler pulled a pot of hot water off of the stove, splashing on his left face, left shoulder, chest and back (TBSA approx 15%)

DAY 2

BREATHING

- In most situations lung damage in pediatric thermal injury is due to:

1. Toxic byproducts of combustion of plastics and other synthetic materials in a closed space (house fire)
2. Inflammatory response to burn stress(especially scald injuries)
3. Aspiration

BREATHING-CO

- Carbon Monoxide is a toxic byproduct of combustion
- It causes systemic toxicity without specific lung damage
- “Cherry-red” appearance
- Requires special pulse oximeter
- The only treatments are time and oxygen

34 Bright cherry pink discoloration of the face, forehead, side of the neck and ears in a case of carbon monoxide poisoning, caused by incomplete combustion of gas in a water heater. Blockage of the flue had prevented the access of adequate air for total combustion of the fuel. Again there is a pale area where pressure has prevented the development of congestion which, in this case, is pink due to carboxy-haemoglobin

BREATHING-RESPIRATORY DISTRESS SYNDROME

- Approximately 5% of pediatric scald patients > 10% TBSA develop respiratory failure
- All of the patients who developed respiratory failure were less than 3 years old
- All had scalds > 15% TBSA
- Respiratory failure occurred without evidence of airway injury

PEDIATRIC SCALD INJURIES

- Toddlers with significant scald injuries have a higher risk of respiratory failure requiring mechanical ventilation
- •Even in the absence of airway injury, these patients should be admitted to the ICU

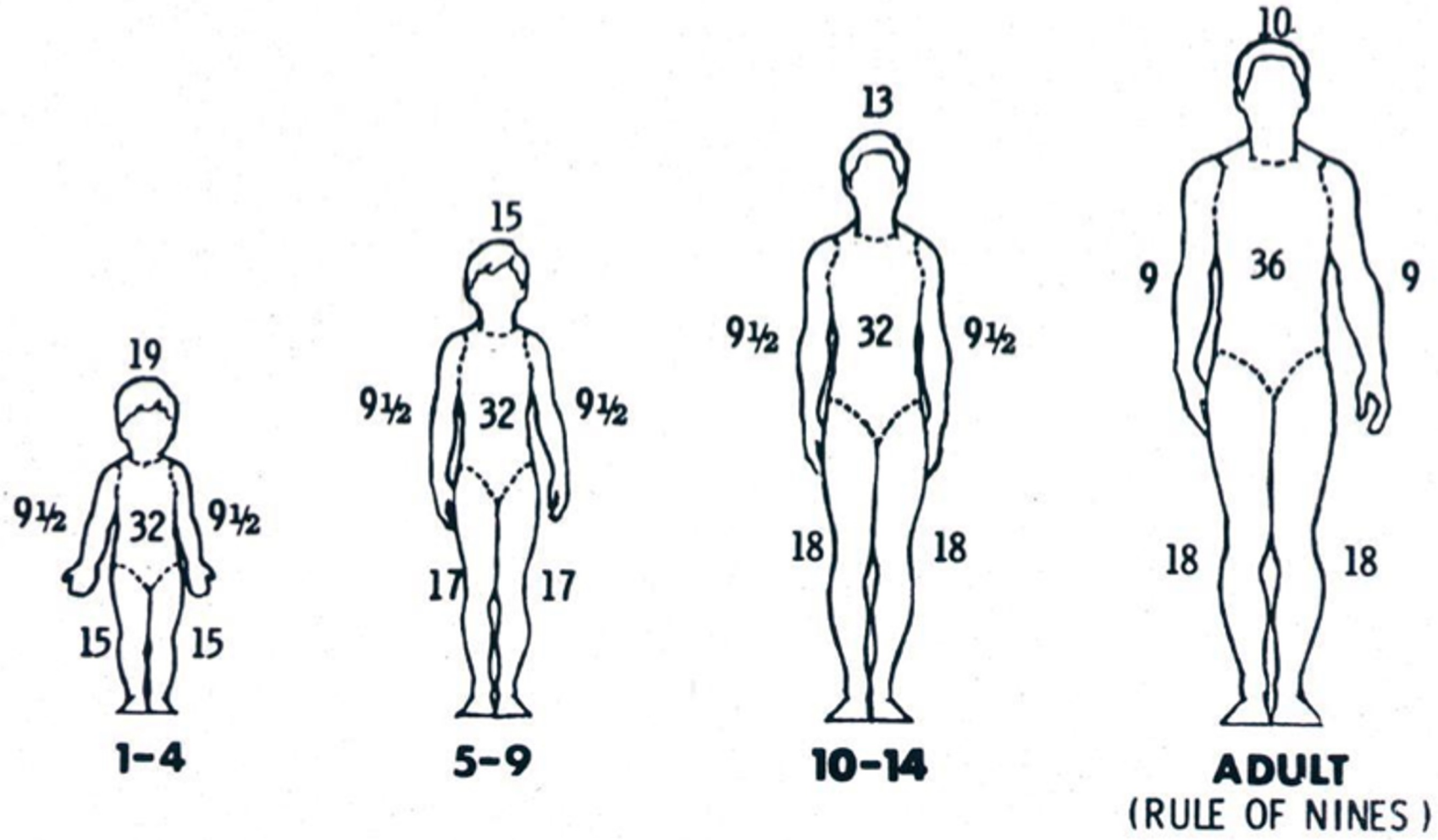
- Rocourt et al. Journal of Pediatric Surgery (2011) 46, 1753–1758

CIRCULATION

- Hierarchy for vascular access sites

1. Peripheral IV–unburned skin
2. Peripheral IV–burned skin
3. Intraosseous–unburned skin
4. Intraosseous–burned skin
5. Central line

BURN SIZE ESTIMATE



BURN SIZE ESTIMATE-

Palm 1%

FLUID RESUSCITATION: KIDS VS ADULTS

- Kids have higher metabolic rate (greater calorie needs)
- Kids have greater body to surface area ratio (greater fluid loss)
- Kids have less insulation (greater heat loss)

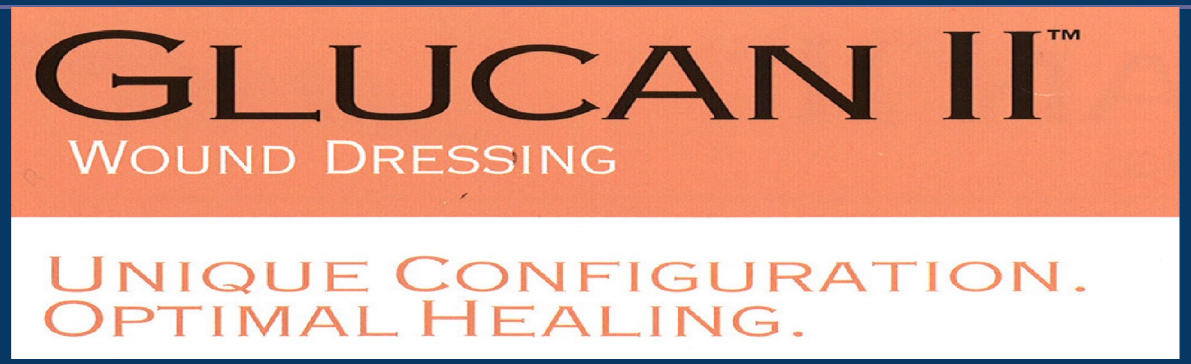
PEDIATRIC RESUSCITATION FORMULAS (PARKLAND)

- IF BURN ONLY: LR 3 ml x kg x %TBSA = _____
- IF BURN WITH INHALATION INJURY use:
- 4 ml x kg x %TBSA = _____
- First ½ given in first 8 hours and second ½ given in next 16 hours
- Maintain UOP 1mL/kg/hour

BURN DRESSINGS

- Old – silver based creams and liquids with daily or twice daily dressing changes- Very painful
- New – silver impregnated dressings- greater comfort -less frequent dressing changes

MATRIX



- Mesh matrix containing oat beta-glucan
- Smooth, gas permeable polymeric layer
- Conforms easily to the wound site
- Keeps the wound clean and moist
- Requires fewer dressing changes

BURNS

- Leave blisters intact
- Pain control
- Debride
- Silvadene or bacitracin, wrap with gauze
- Matrix dressing

I'm sorry to hear about your abdominal pain. If you could put down the Mtn Dew and wipe the Cheeto dust off your fingers, I'll jump right on your emergency.

someecards
user card

Thank you!