CRUNCHTIME
The Official EM:RAP Board Review Course

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Tox

General Concepts Part 1 (Decontamination & Hemodialysis)

- If patient covered in toxic substance
  - FIRST decontaminate
  - THEN resuscitate
- Ipecac? NO
- Gastric Lavage? NO but consider if
  - Patient intubated
  - Colchicine, hydrofluoric acid, paraquat
  - Presents within one hour of ingestion
- Charcoal
  - Does not bind with metals, hydrocarbons, caustics, alcohols
  - Do not use if risk of aspiration
- Whole Bowel Irrigation - massive amounts of bowel prep for
  - Iron
  - Lithium
  - Body-packers
  - Extended release meds (e.g. calcium channel blockers, beta-blockers)
- Hemodialysis
  - Alcohols
  - Salicylates
  - Theophylline
  - Lithium
  - NOT digoxin or tricyclic antidepressants (TCAs)

General Concepts Part 2 (Anion Gap, Osmolar Gap, & Tox Screen)

- Formulas to know
  - Anion Gap

        - AG = (Na + K) - (Cl + HCO3)
        - Remember MUDPILES-CAT
            - Methanol, uremia, DKA, propylene glycol/paracetamol (IV Tylenol), INH/Iron, Lactic acid, ethylene glycol, salicylates, CO/CN, alcoholic ketoacidosis, toluene (paint thinner, contact cement, and used for huffing)
    - Osmolar Gap
        - (OG) = Measured Osm - Calculated Osm
            - Calculated Osm = [(2 x Na) + Glucose/18 + BUN/2.8 + Ethanol/4.6]
        - Only significant if high
        - May be caused by an alcohol
        - Remember to include ethanol in equation as will increase gap
- Urine tox screen shows an exposure, NOT a toxicity
    - Drugs that don't show on tox screen
        - Fentanyl
        - Methadone
        - Carfentanil

The Agent/Antidote Game

- Acetaminophen ➡ N-Acetylcysteine
- Aspirin ➡ Sodium bicarb and hemodialysis (HD)
- Organophosphates ➡ Atropine, pralidoxime, diazepam (for seizures)
- Carbamates ➡ Atropine, diazepam
- Warfarin ➡ Vitamin K, PCC
- Digoxin ➡ Fab fragments
- Ethylene glycol ➡ Fomepizole or ethanol, HD
- HFl acid ➡ Calcium, magnesium
- Isoniazid ➡ Pyridoxine
- Methanol ➡ Fomepizole or ethanol, HD
- TCAs ➡ Sodium bicarb
- Carbon monoxide ➡ Oxygen and hyperbaric oxygen
- Beta blocker ➡ Glucagon, calcium, high-dose insulin, intralipid = controversial
- CCB ➡ Calcium, glucagon, high-dose insulin, intralipid = controversial
- Heavy metals ➡ Chelators - BAL then calcium disodium EDTA (lead, mercury, arsenic)
- Iron ➡ Chelator deferoxamine
- Cyanide ➡ Hydroxocobalamin, sodium nitrate, amyl nitrate, sodium thiosulfate

Ethanol

- Most commonly abused substance

    - Particularly dangerous in co-ingestion
- Levels don't necessarily correlate with toxicity
- Metabolism - zero order kinetics (rate is constant)
    - Rate of metabolism = 15-30 mg/dL/hour
- Complications
    - Acute and chronic pancreatitis
    - Alcoholic hepatitis versus transaminitis
    - Hypothermia (very common)
    - Hypoglycemia (particularly in peds)
- Alcoholic ketoacidosis
    - Metabolic acidosis
        - May not see ketones on urinalysis
    - Treatment
        - Dextrose
        - Stop drinking
- Wernicke's acute/subacute triad
    - Ophthalmoplegia
    - Gait disturbance
    - Altered mental status
    - Vitamin B1 deficiency
    - Treatment = high dose thiamine
- Korsakoff's
    - Presentation
        - Irreversible confabulation
        - Anterograde and retrograde amnesia
        - Apathy, lack of insight
    - Treatment
        - Stop drinking
        - Thiamine
- Alcohol withdrawal
    - Seizures can be part of initial presentation
    - Anxiety, delirium, unstable vitals
    - High mortality
    - Benzos, benzos, phenobarb
    - Worse at 3-5 days
- Consider CT if altered (especially if any signs of trauma)
- Consider possibility of toxic alcohol (ethylene glycol/methanol)

Ethylene Glycol & Methanol

- Consider if intoxicated patient
  - Is getting worse instead of better
  - Has massive acidosis
  - May not have an osmolar gap if already metabolized to the toxic metabolite
- Antifreeze is most common source of ethylene glycol
  - May see fluorescein on clothes or beard (Wood's lamp exam)
  - Ethylene glycol ➔ glycolic acid & oxalic acid ➔ renal failure
- Methanol
  - "Moonshine" and windshield washer fluid
  - Methanol ➔ formic acid ➔ blindness
- Treatment
  - Hemodialysis (HD)
  - Treat with medications to prevent formation of toxic metabolites
    - Fomepizole - 1st line for ethylene glycol or methanol
    - Ethanol Drip - 2nd line for ethylene glycol or methanol
    - Magnesium/Calcium/pyridoxine - helps with ethylene glycol toxicity
    - Folic acid - helps with methanol toxicity
      - Remember "folic acid for formic acid"

Isopropanol

- Patients often extremely intoxicated
- Does not cause severe metabolic acidosis or anion gap
- The only toxic alcohol that doesn't
- Metabolized to acetone (not an acid)
- Fruity odor as they blow off ketones
- Hemorrhagic gastritis is common
- Generally supportive care
- Might need HD

Acetaminophen

- Toxic dose
  - 150 mg/kg (100 mg/kg in UK)
  - Approximately 7-10 grams in adult
- Nomogram is for toxic dosing in single acute ingestion (not for chronic)
- Different stages
  - Stage I ➔ Asymptomatic, may see N/V (0-24 hours)

- Stage II → RUQ pain, transaminitis, INR first lab to increase (24-48 hr.)
- Stage III → Encephalopathy, jaundice, coagulopathy, organ failure, death (72-96 hr.)
- Stage IV → Resolution, usually without lasting liver injury

- Treatment
  - If single acute ingestion and time of ingestion is known → wait 4 hours and assess level
  - Any other form of ingestion → start N-Acetylcysteine (NAC) immediately, even >12-18 hours post ingestion
  - Continue NAC until
    - Toxicity resolves
    - Patient receives transplant
    - Patient dies
- Use IV NAC in pregnancy because the fetus is at risk
  - Otherwise, NAC can be IV or PO
- Refer for liver transplant if
  - pH <7.3
  - Serum Creatinine >3 mg/dL
  - INR >3
  - Grade III or IV encephalopathy by the West Haven Criteria (available on **MDCalc**™)

NSAIDs

- Acute poisonings are common and generally well-tolerated
- Might see N/V
  - Acute GI bleeds are uncommon
- Massive poisonings are rare
  - Sedation
  - Coma
  - Metabolic acidosis that requires hemodialysis
- Usually conservative management

Opioids

- Toxidrome
  - Decreased mental status → coma
  - Pinpoint pupils
    - Except meperidine (Demerol) which causes mydriasis
  - Respiratory depression
  - Decreased bowel sounds
  - Urinary retention
  - Look for skin popping or track marks

- Naloxone in respiratory depression
  - Lowest possible dose = 0.04 mg
    - Methadone and fentanyl may need up to 10 mg
  - Remember re-dosing and observation
  - Naloxone drip - for long acting opioids (e.g. methadone)
- Methadone
  - Watch for QT prolongation and Torsades
  - May need overdrive pacing
  - Admission
- Loperamide
  - Can cause QT prolongation
- Fentanyl/synthetics
  - If given quickly by IV → rigid chest syndrome
  - Give naloxone
  - Might need intubation
- Propoxyphene (Darvocet)
  - Present like TCA overdose
  - QRS widening
  - Treat with sodium bicarb
- Lomotil
  - Combination medication (diphenoxylate hydrochloride and atropine sulfate)
  - Toxicity = antimuscarinic AND opioid syndrome (biphasic course)
  - Admit
- Meperidine
  - Toxic metabolites accumulate in renal failure → seizures

Salicylates

- Aspirin, oil of wintergreen, muscle balms, Pepto-Bismol
- Hypermetabolic state, resembles DKA or sepsis
- Acute ingestion
  - Hyperthermia, tinnitus, nausea/vomiting
- Chronic
  - Looks like sepsis or DKA
  - Confusion and dehydration
- Labs
  - Elevated ketones and low potassium
  - Glucose and WBC
    - Can be elevated (stress response)

        - Can be normal
    - Mixed respiratory alkalosis with metabolic acidosis
        - Peds - usually only metabolic acidosis
- Treatment
    - Hemodialysis (HD) need determined by
        - Signs or symptoms
        - By drug levels
            - Acute > 100 mg/dL
            - Chronic > 60 mg/dL
    - If not a candidate for HD
        - Sodium bicarbonate to ionize the salicylate
        - Follow potassium levels (sodium bicarbonate decreases potassium)
    - Don't intubate if possible, but if must
        - Set high minute ventilation rates
        - Use short acting paralytic

Anticholinergics

- Toxidrome
    - "Red as a beet, dry as a bone, blind as a bat, mad as a hatter"
        - Large pupils
        - Dry mucous membranes
        - Tachycardia
        - Don't sweat
        - Red skin
        - Decreased bowel sounds
        - Urinary retention
        - Delirium
- As compared to sympathomimetics
    - Pupils stay open in light
    - Bowel sounds are absent
    - Axillae are bone dry ("Toxicology Handshake")
- Consider over the counter medications and other causes
    - Cold preparations
    - Sleep aids
    - Antihistamines
    - Jimson weed
- Check acetaminophen levels in case combination medication/toxicity (e.g. Tylenol-PM)
- Is it pure anticholinergic toxidrome or mixed with opiates/tricyclics?

  - Cannot give physostigmine if mixed
- Treatment
  - Supportive care
  - If agitated or confused → benzos
  - Cool if hyperthermic
  - Physostigmine (carbamate) → can cause seizures, lowers seizure threshold
    - Use caution with physostigmine if you suspect a mixed overdose

Antidepressants

- Tricyclic antidepressant toxicity (e.g. amitriptyline, desipramine)
  - Get sick quick - neuro & cardiovascular syndromes
  - Tachycardia → seizure → decreased pH → QRS widens → hypotension → V-tach
  - Treat seizures with benzodiazepines
  - Treat V-tach with sodium bicarb IV push
    - Maintain serum pH 7.45-7.55
  - Hypotension is caused alpha blockade → phenylepinephrine/norepinephrine
  - Can see anticholinergic toxidrome
    - Don't give physostigmine (lowers seizure threshold)
  - If the patient is asymptomatic at 6 hours, they are out of the woods
  - Do not send TCA serum levels
  - If see widened QRS, push sodium bicarb
    - Other toxins (e.g. diphenhydramine, cocaine) can cause this too
- MAOIs
  - Hypertension, then treatment-resistant hypotension
  - Compounded by serotonin syndrome
    - Eating tyramine-containing foods
- SSRI/SNRIs
  - Somnolence, sometimes tachycardia
  - Serotonin syndrome if drug-drug interactions
- Trazodone
  - Priapism
- Bupropion
  - Seizures
  - Admit - extended release form means delayed onset

Antibiotics

- Mostly well tolerated in overdose but some adverse events
- Aminoglycosides

- Ototoxicity
- Nephrotoxicity
- Prolonged neuromuscular block

- Cephalosporins
  - Crystalluria
  - Prolonged bleeding time
- Chloramphenicol
  - Grey baby syndrome (cardiovascular depression)
- Dapsone
  - Prolonged methemoglobinemia (MetHb)
    - Causes hemolysis in G6PD deficiency
    - Treat with methylene blue infusion
- Ethambutol
  - Optic neuritis
  - Peripheral neuropathy
- Isoniazid
  - Seizures from GABA inhibition
    - Treat with pyridoxine
  - Can get MetHb
  - Inhibits CYP450, look for drug-drug interactions
- Macrolides
  - QT prolongation
- Metronidazole
  - Disulfiram-like reaction with ethanol
  - CNS effects
- Nitrofurantoin
  - MetHb → hemolysis in G6PD deficiency
- Penicillins
  - High dose penicillin → seizures
  - Amox/ampicillin → rash with mono
  - Methicillin → interstitial nephritis
- Quinolones
  - QT prolongation
  - Tendinopathy
  - Avoid in pediatric population
- Rifampin
  - CYP450 inducer → decreases other drug potencies, i.e. oral contraceptives
  - Dark urine

- Sulfonamides
  - Photosensitivity
  - MetHb - hemolysis in G6PD deficiency
  - Stevens-Johnson syndrome
- Tetracyclines
  - Photosensitivity
- Vancomycin
  - Ototoxicity
  - Nephrotoxicity
  - “Red man” syndrome
    - Related rate of infusion, not an allergy, can be severe
    - Diphenhydramine
    - Slow infusion rate next time

Antimalarials, Antivirals, & Antiretrovirals

- Antimalarials
  - Quinine
    - Hypokalemia
    - Hypoglycemia - treat with octreotide
  - Chloroquine/hydroxychloroquine
    - Acts like TCA
    - Watch out for hypokalemia
    - Treat with sodium bicarbonate
  - Primaquine
    - Methemoglobin inducing agent
  - Mefloquine
    - Hallucinations
    - Psychosis
    - Vivid dreams
    - Seizures
- Antivirals/Antiretrovirals
  - Acyclovir
    - Crystalluria
  - Nucleoside reverse transcription inhibitors
    - Pancreatitis
  - AZT (zidovudine)
    - Neutropenia
    - Myopathy

- Protease Inhibitors
  - Dyslipidemia
  - Cardiovascular disease
  - Insulin-resistance

Antipsychotics & Antiemetics

- Phenothiazines
  - Examples
    - Chlorpromazine (Thorazine), Prochlorperazine (Compazine)
  - Both antipsychotic and antiemetic properties
  - Act like TCAs in overdose
  - QRS widening and prolonged QT
  - Lower seizure threshold
  - Movement disorders
    - Dystonias
    - Drug-induced parkinsonism
- Butyrophenones
  - Examples
    - Haloperidol, droperidol
  - Both antipsychotic and antiemetic properties
  - Cause dystonias and Neuroleptic Malignant Syndrome (NMS)
  - NMS
    - Rigidity, hyperthermia, rhabdomyolysis, death
    - Cooling, benzodiazepines, intubation, supportive care
    - Do not give dantrolene (that is for MALIGNANT hyperthermia)
- Atypical antipsychotics
  - Examples
    - Quetiapine, risperidone
  - Usually well tolerated, can cause somnolence or coma
  - Mildly anticholinergic → resting tachycardia
- Antiemetics
  - Ondansetron
    - QT prolongation
  - Metoclopramide
    - QT prolongation
    - Dystonia
- Acute extrapyramidal reactions are often missed so look for
  - Spasmodic torticollis

- Oculogyric crisis
- Laryngospasm
- Treat with anticholinergic such as diphenhydramine

See EM:RAP HD 2018 June - Dystonic Reaction

Carbon Monoxide

- #1 cause of poisoning death worldwide
- Source = any combustible material (heater, smoke inhalation, houseboat or car exhaust)
- Look for
  - "Cherry red" skin
  - Multiple people in same house with the "flu" at same time
- Remember
  - Don't use pulse oximeter because it will appear normal
  - Use co-oximetry
    - Normal to have < 5%
    - Smokers can have 8-10% at baseline
  - Apply non-rebreather oxygen immediately
- Hyperbaric chamber indications
  - LOC
  - Carboxyhemoglobin > 25% (15-20% if pregnant)
  - > 50 years old
  - Metabolic acidosis persists after fluid rehydration
  - Cerebellar dysfunction or other hard neurologic findings
- Mimics
  - Cyanide poisoning
    - History of fleeing a burning building then suddenly collapsing
    - Extremely cyanotic
    - Low pH and high lactate (over 8) despite fluid resuscitation
  - Methylene chloride
    - Wood stripper agent, no combustion source involved
    - Patient will be found down
    - Look for carboxyhemoglobin
- Half-life of Carboxyhemoglobin
  - Room air = 6 hours
  - 100% non-rebreather oxygen = 1 hour
  - Hyperbaric dive = 20-30 minutes

Clonidine, Digoxin, BBs & CCB's (The Cardiovascular Brady Bunch)

- All present with bradycardia and hypotension
- Digoxin (or cardiac glycosides)
  - Might have visual and GI syndromes
  - Hyperkalemia
  - Accelerated junctional rhythms, paroxysmal atrial tachycardia, PVCs
  - Various degrees of AV block
  - Treat with Fab fragments
- Clonidine
  - Toxidrome resembles opioids
  - Pinpoint pupils, respiratory depression, bradycardia, hypotension
  - Supportive treatment
  - Intubate as needed
- Beta-blockers and Calcium Channel Blockers
  - Hard to distinguish between as both cause
    - Bradycardia
    - Hypotension
    - AV blocks
  - How to tell apart?
    - CCB overdose is harder to treat
    - Beta blockers = hypoglycemia or euglycemia
    - CCB = hyperglycemia (inhibits insulin release)
  - Treatment
    - IV fluids
    - Direct acting pressors (phenylephrine, norepinephrine)
    - Glucagon
    - Calcium
    - High dose insulin (1u/kg insulin) and follow glucose closely
    - Whole bowel irrigation with bowel prep if overdose of extended-release pills
    - ECMO or aortic balloon pump if patient otherwise well
    - Gives body a chance to metabolize the drugs

Cholinergics

- Cholinergic crisis
  - Copious secretions from everywhere
  - SLUDGE (salivation, lacrimation, urination, defecation, GI, emesis)
  - Bradycardia

- Pinpoint pupils
- Secondary to organophosphates or carbamates

- Classic presentations
  - Farmer who ingested an insecticide
  - Exposure to nerve agent
- Treatment
  - High dose atropine (up to 20-30 mg is ok)
  - Titrate treatment to drying of secretions
  - Benzodiazepines to prevent seizures
  - Pralidoxime (2-PAM)
  - Organophosphates can bind permanently to acetylcholinesterase (called aging)
    - Need 2-PAM to dislodge
  - Carbamates do not “age”
    - Give atropine alone (2-PAM not needed)
- If unsure of which exposure, give 2-PAM and atropine

Cyanide & Hydrogen Sulfide

- Cellular asphyxiants that quickly drop people to the floor
- Cyanide
  - Suspect it with suicide
  - Suspect in homicide with structural fires
  - Severe lactic acidosis
  - Hypotension and cardiovascular collapse
- Hydrogen sulfide
  - Exposure to sewer or cesspool gas
  - Often multiple victims
  - Can discolor coins
- Treatment
  - Cyanide has 3 options for treatment
    - Amyl nitrate (via inhalation) and sodium nitrate
      - Induces MetHb → makes excretable metabolite
      - Be careful if simultaneous CO poisoning - too much MetHb can kill
    - Sodium thiosulfate converts cyanide → thiocyonate excreted by kidneys
      - Ok to give if simultaneous CO poisoning
    - Hydroxycobalamin which in presence of cyanide gets converted in B12 (non-toxic)
  - Hydrogen sulfide
    - Remove victim from the source

Heavy Metals Toxicities (Iron, Lead, Mercury, & Arsenic)

- Iron
  - Typically toddler who ingests prenatal vitamins
  - Presents as gastroenteritis but more unwell than expected
  - Stages
    - GI stage
      - Vomiting and hypotension
      - Need more fluid resuscitation than usual
    - Quiescent stage
    - Stop vomiting but labs worsening
    - Multi-organ failure
      - GI hemorrhage
      - Shock
  - Treatment
    - Whole bowel irrigation
    - Fluid resuscitation
    - Supportive care
    - Deferoxamine chelator
      - Give if symptomatic, even if level is pending
      - Give if asymptomatic and level between 350-500
      - Can cause hypotension
      - Can cause “vin rose” urine (pinkish-red)
  - Different iron salts have different proportions of elemental iron (i.e. fumarate > than sulfate)
- Mercury
  - 3 forms
    - Elemental (thermometer)
      - Problem if inhaled, not if ingested
    - Inorganic
      - Caustic
      - Ingestion causes kidney failure
    - Organic
      - Chronic neurotoxin to fetus
- Lead
  - Acute toxicity
    - Encephalopathy
    - Seizures
  - Chronic toxicity

        - Anemia
        - Chronic abdominal pain
        - Wrist drop
        - Pica (particularly in children)
        - Neuropsychiatric changes
        - X-ray of child with growth restriction→ lead lines (horizontal opacities across metaphyses)
    - Treatment = chelators
        - Chelator IM BAL (British anti-Lewisite)
        - IV CaNa2EDTA (calcium disodium versenate)
        - Oral succimer
- Arsenic
    - Insecticides
    - GI toxicity (watery diarrhea)
    - QT prolongation and torsades
    - Treat with IM BAL

Rodenticides

- Strychnine
    - Gopher poison or adulterated heroin
    - Presents similar to tetanus
    - “Awake” seizures (painful muscle spasms)
    - Opisthotonus, risus sardonicus
- Vitamin K antagonists (super warfarin)
    - Longer half-life than warfarin
    - Do not give Vit K prophylaxis unless bleeding as can lose monitoring parameter (INR)
    - Follow INR in a few days
    - Do not need to admit, can follow as outpatient

Caustic Agents

- Alkali
    - Liquefaction necrosis
- Acids
    - Coagulation necrosis
    - May not burn as deeply as alkali
    - Gastric outlet obstruction
    - GI bleed
    - Metabolic acidosis
- Treatment

- Protect yourself and your staff
- Initially same for both
- Decontaminate but do NOT neutralize
- Cautious NG tube aspiration
- Scope within 24-48 hours
- Corticosteroids controversial, generally not recommended
- Intubate as needed

- Hydrofluoric acid
  - Glass etching, semiconductor industry, rust removers
  - Dermal exposure
    - Pain out of proportion
    - Delayed onset
    - Treatment
      - Topical calcium gluconate
      - Bier block (IV regional anesthesia) if limited to extremity
        - Regional anesthesia technique using injection of IV lidocaine into the distal extremity with a tourniquet in place after the arm/leg has been "exsanguinated" by a compression wrap
      - Intra-arterial injection calcium gluconate
  - Ingestions cause hypoglycemia and are often fatal
    - Treatment
      - NG tube aspiration
      - Calcium and magnesium into NG tube to bind the acid
      - Intra-arterial calcium if resistant

Hydrocarbons (Naphthalene, Camphor, & Paradichlorobenzene)

- Inhalation more dangerous than ingestion
  - Destroys surfactants
- Less viscous forms are more dangerous
- Treatment
  - Supportive
  - Intubation
  - Do not force them to drink (vomiting could lead to inhalation)
  - If no symptoms after 6 hours → discharge
- Huffers/Baggers/Sniffers
  - Sniffer → sniff glues, etc.
  - Huffers → spray into a rag and inhale
  - Baggers → spray into a bag and inhale

- Acutely
  - Patients appear drunk
  - Can develop VT
    - Treat with beta-blockers
- Chronically
  - Cerebellar degeneration is a late sign

- Camphor (i.e. Tiger balm)
  - Status epilepticus at higher concentrations
  - Treat with benzos
- Naphthalene (mothballs)
  - Hemolysis
- Paradichlorobenzene
  - Not very toxic
  - Used as insecticide, disinfectant, and also for mothballs

Inhaled Irritants

- Chlorine
  - Greenish/yellow gas
  - Ammonia, toilet cleaner, pool supplies
  - Strong irritant
  - Can cause ARDS
- Chloramine
  - Irritant gas
  - Bleach and ammonia
  - Airway irritant
  - ARDS
- Phosgene
  - “Pure evil”
  - Smells like fresh mown hay
  - Delayed effects
  - Converted to hydrochloric acid in lungs
  - Warfare agent
  - ARDS
- Treatment
  - Remove from exposure
  - Inhaled sodium bicarbonate or sodium chloride
  - Intubate if sick → ICU
  - If asymptomatic at 4-6 hours and CXR OK → discharge

Insulin and Antidiabetics

- Accidental short acting insulin ingestion (not an overdose)
  - Discharge home after short observation period
  - Feed, check glucose while observing
- Accidental longer acting insulin ingestion OR overdose
  - Depot effect = prolonged hypoglycemia risk
  - D50W bolus
    - Up to 2 amps at a time
    - Might have to repeat
  - If possible, ingest complex carbohydrates
- Oral agents
  - Sulfonylureas (e.g. Glyburide, “glitinides”)
    - Admission as long acting
    - Octreotide
  - Metformin
    - Not so much hypoglycemia
    - MALA (Metformin Associated Lactic Acidosis)
      - Supportive care or dialysis
  - SGLT2 Inhibitors (i.e. empagliflozin)
    - Can cause DKA even in DM 2

See EM:RAP 2018 April - Rural Medicine - Insulin OD

Lithium

- Symptoms/signs
  - Nausea/Vomiting
  - Confusion
  - Ataxia
  - Fine tremor
  - Somnolence
  - Myoclonus
  - Seizures (rare)
  - Nonspecific T wave inversions, rarely blocks
  - Nephrogenic diabetes insipidus
- Acute poisonings
  - Elevated levels but often less toxic as lower total body burden
- Chronic poisonings

- Mild elevation in levels
- More symptomatic as larger total body burden
- Total body burden often greater due to drug-drug interactions and dehydration

- Treatment
  - IV fluids
  - Maintain adequate urine output
  - Whole bowel irrigation for sustained release
  - When to dialyze?
    - If rebound signs/symptoms
    - If very sick
    - Chronic toxicity
      - >3-4 mmol/liter
    - Acute toxicity
      - >6 mmol/liter

Local Anesthetics

- Lidocaine and bupivacaine
  - Toxic Doses
    - Lidocaine without epinephrine = 4 mg/kg
    - Lidocaine with epinephrine = 7 mg/kg
    - Cardiac toxicity (class 1b agents)
    - Perioral numbness often the first sign
  - Treatment
    - Intralipid infusion
- If lidocaine allergy and requires anesthesia
  - Use diphenhydramine or preservative free lidocaine from crash cart
- “Amides” vs “Esters”
  - Amides have 2 “i’s in the name (e.g. lidocaine, bupivacaine)
  - Esters have 1 “i” (e.g. procainamide and cocaine)
  - If allergy to one class, use the other
- Cetacaine spray
  - Can produce methemoglobinemia
  - Treatment = methylene blue

Critter Bites (Snakes, Spiders & Scorpions)

- Jellyfish
  - Whip-like lesions, from nematocysts on tentacles
  - Scrape off with credit card

- Irrigate but NOT with urine
- Puncture Injury (stingray, lion fish, etc.)
  - Heat labile toxins
  - Place limb in hot water
  - Look for broken off spine (X-ray, explore wound)
  - Update Tetanus
  - Cover for Vibrio
- Snakes
  - Crotalidae
    - Not all are rattlesnakes (copperhead and cottonmouth)
    - Thrombin-like venom
    - Cytotoxicity
    - Characteristic physical findings
      - Arrow-shaped head, elliptical pupils, heat-sensing facial pits, single row scales below anal plate
      - Do not recommend capturing
    - Classic description is of patient is respiratory paralysis, may also see fasciculations
    - Treatment
      - No ice, no "cut and suck," no tourniquet or wraps
      - Antivenom
      - Compartment syndrome is rare → antivenom
  - Coral snakes
    - Elapidae similar to cobra
    - "Red on yellow kills a fellow, red on black venom lack,"
    - Lack of physical findings common early on
    - Neurotoxic and respiratory depression
    - Treatment
      - Admit all due to delayed onset
      - Anti-venom
- Spiders
  - Black, brown and red widow with hourglass on abdomen
    - Classic in wood piles
    - Painful bite
    - May have bull's eye lesion
    - Can mimic acute abdomen
    - Can cause priapism
    - Sweating around bite site
    - Treatment

        - Supportive care
        - Antivenom available but some deaths reported
        - Widow spiders not fatal in general
    - Brown recluse
        - Midwest, most are not brown recluse in rest of United states
        - Painless bite
        - Two presentations
            - Early hemolysis
            - Poor wound healing → ulcer
        - Treatment
            - No antivenom, ± dapsone
            - Supportive therapy
- Scorpions
    - Centruroides
        - Small scorpion from Arizona
        - Opsoclonus (rotatory nystagmus)
        - Respiratory weakness
        - Treat with antivenom

Methemoglobinemia

- Hemoglobin that cannot carry O2
    - Oxidized from ferrous (Fe2+) → ferric (Fe3+)
- Common oxidizers
    - Nitrates, nitrites, dapsone, antimalarials, sulfa, local anesthetics
- Global tissue hypoxia
- "Chocolate" blood
- Cannot rely on pulse oximeter
    - False reading around 85%
    - Need co-oximeter
- Presentation correlates with levels
    - 15-20% = cyanosis
    - 20-40% = moderately symptomatic
    - 40-70% = severely symptomatic
    - 70% = death
- Treatment
    - Methylene blue (can cause hemolysis in G6PD deficiency)

Mushrooms

- Amanita ("Destroying Angel," "Death Cap")
  - White mushrooms with white "gills"
  - Hepatotoxicity and liver failure
  - Inhibits protein synthesis
  - Treatment
    - NAC (with similar time course to acetaminophen)
    - Milk thistle
    - Liver transplant
- Other syndromes
  - Early vomiting has better prognosis than delayed vomiting (e.g. 6 hours later)
  - GI irritants
    - Common
    - Chlorophyllum
    - N/V/D
    - Supportive care
  - Cholinergic
    - Clitocybe, inocybe
    - SLUDGE (salivation, lacrimation, urination, defecation, GI, emesis)
    - Supportive care and atropine
  - Disulfiram-like
    - Coprinus
    - Inky caps with ethanol
  - Hallucinogens
    - Psilocybin
    - LSD-like
  - Monomethylhydrazine
    - The false morel
    - INH-like, seizures
    - Pyridoxine, MetHb
  - Amanita muscaria
    - Hallucinations
    - "Alice in Wonderland" syndrome (distortion of size and senses)
    - Seizures

Caffeine & Theophylline

- These are adenosine antagonists with narrow therapeutic ranges

- Sources
  - Energy drink
  - COPD treatment
  - Treatment for neonatal apnea
  - Methylxanthines
- Signs
  - Hypokalemia
  - Hypotension
  - Multifocal atrial tachycardia
  - VT
- Treatment
  - Treat symptoms (levels do not correlate well with toxicity)
  - IV fluids
  - Beta blockers for hypotension and VT
  - Benzodiazepines for seizures
  - Activated charcoal
  - Intubate early
  - Hemodialysis

Plant Toxicities

- Antimuscarinics
  - Jimson weed
    - Use seeds to get high
    - Confusion and anticholinergic syndrome
    - Consider physostigmine
  - Angel's trumpet
    - Antimuscarinic effect
    - Anisocoria from eye rubbing
      - Neurologically normal
- Cardiac glycosides
  - Looks like digoxin
  - Oleander, lily of the valley, foxglove
  - Presentation
    - Bradycardia
    - N/V
    - Hyperkalemia
  - Treatment
    - FAB fragments

Cannabis

- Common terms
  - Marijuana, spice, K1, edibles, wax
- Natural cannabis
  - Forms
    - Smoked, oil (includes wax), edibles
  - THC concentration = very high in edibles
  - High rates of psychosis
  - High rates of sedation in pediatric population
- Synthetic forms
  - Psychosis and seizures can predominate
- Treatment is supportive
- Cannabis Hyperemesis Syndrome
  - See with chronic daily use
  - Hyperemesis, cyclic vomiting
  - Better with hot showers, haloperidol
  - Treatment = Abstinence
  - A diagnosis of exclusion

Gamma Hydroxybutyrate (GHB)

- Acute toxicity
  - Fast onset, fast offset
    - GCS 3 then wakes up hours later
- Chronic use
  - Withdrawal syndrome like ETOH
  - Resistant to treatment with benzos
  - Supportive care

Sedative Hypnotics

- Benzodiazepines
  - Antidote = flumazenil
    - Can lead to seizures in chronic users
  - Flunitrazepam (rohypnol) = “date rape” drug
    - Does not show up on routine tox screen
- Barbiturates
  - Coma with
    - Low heart rate

        - Low temperature
        - Low respiratory rate
    - Supportive treatment
    - In phenobarbital OD
        - Na Bicarb drip can aid excretion
        - Removed by hemodialysis

Sympathomimetics

- Agitation, tachycardia, hypertension, diaphoresis, psychosis
- Hyperthermia KILLS → Actively cool
- Cocaine
    - Wide QRS tachycardia → give bicarb
    - Treat with benzodiazepines
- Cocaine chest pain
    - Nitrates and calcium channel blockers
    - If hypertensive crisis
        - Phentolamine (alpha-blocker)
        - Avoid beta blockers (can cause unopposed alpha crisis)
- MDMA, Ecstasy, Molly
    - Very serotonergic
    - Hallucinations
    - Hyperthermia a big concern
    - HYPOnatremia (SIADH plus water intoxication)
    - Seizures
- PCP and Ketamine
    - Rotatory nystagmus and “superhuman strength”
    - Treatment
        - Supportive care
        - Look for injuries as these are anesthetics

Serotonin Syndrome, Neuroleptic Malignant Syndrome, & Malignant Hyperthermia

- Serotonin Syndrome
    - Presentation
        - Mental status changes
        - Neuromuscular hyperactivity
        - Autonomic overactivation
        - Agitation, anxiety and confusion
        - Clonus (key finding), including ocular clonus

        - Classic - also see hyperreflexia
        - Diaphoresis, hypertension and hyperthermia
        - Muscle rigidity - lower extremities > upper extremities
    - Classic patient = MAOI + tyramine containing food
        - E.g. fluoxetine plus cheese and wine
    - Treatment
        - Cyproheptadine (PO or NG)
        - Supportive
- Neuroleptic Malignant Syndrome
    - Less common than serotonin syndrome
    - See in chronic dopamine antagonists use (e.g. haloperidol and droperidol)
    - Associated with recent dose increases
    - Presentation
        - Confusion
        - “Lead pipe” rigidity
        - Hyperthermia
        - No clonus
        - Bradyreflexia
        - Hypertension and diaphoresis
    - Treatment
        - Similar to serotonin syndrome
        - Rapid cooling
        - Benzodiazepines
    - Takes approximately one week to resolve
- Malignant hyperthermia
    - Inherited defect
    - Precipitants
        - Inhalational anesthetics
        - Case reports post-succinylcholine
        - Rarely can occur following vigorous exercise (rarely) and
        - Excessive heat exposure
    - Symptoms/signs
        - Tachycardia
        - Severe hyperthermia
        - Acute onset rigor mortis like muscle rigidity
        - Increasing ETCO2
    - Treatment
        - Benzodiazepines

- Intubation
- Cooling
- Specific antidote = Dantrolene
  - 2.5 mg/kg rapid IV bolus, repeat PRN
- Supportive care

See EM:RAP 2012 - Serotonin Syndrome