MAYO CLINIC

# TOXIDROMES

## IDENTIFICATION AND MANAGEMENT

Katie Finley, APRN, CNP

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Indian Wells, California
Finley.katie@mayo.edu

MAYO CLINIC

# NO DISCLOSURES

# OBJECTIVES

| | |
|---|---|
| Identify | Identify common toxidromes and their causes |
| Differentiate | Differentiate and describe management of each toxidrome |
| Recognize | Recognize the significance of anion and osmolar gaps, and know when to utilize them |
| Discuss | Discuss the pharmacological interventions for several classes of ingestions |
| Review | Review resources for providers caring for overdoses and ingestions |

# TOXIDROME

- Classifications of ingestions based on common presentations, and can assist the heath care provider in identification of unknown ingestions and focus initial treatment regimens

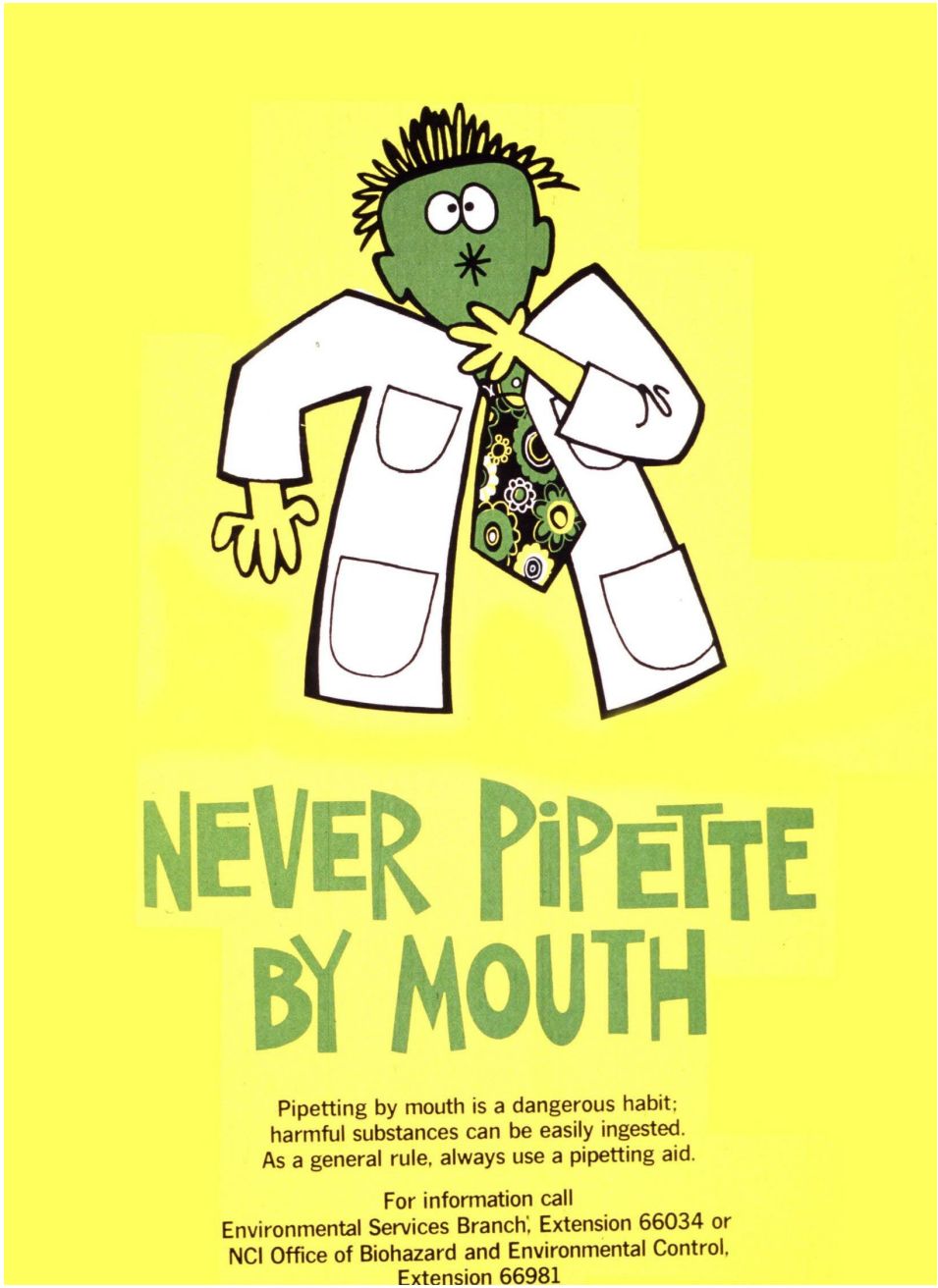

http://resource.nlm.nih.gov/101393328

Image in Public Domain

# BASIC PRINCIPLES

| | |
|---|---|
| Keep | Keep ingestion on your radar |
| Obtain | Obtain a detailed history |
| Know | Be familiar with common toxidromes |




http://resource.nlm.nih.gov/101454207

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# GENERAL MANAGEMENT

ABC’S

PATIENT AND PROVIDER SAFETY

LABS AND ADDITIONAL STUDIES

KNOW YOUR RESOURCES

# AGITATION MANAGEMENT

Benzodiazepines

Avoid Haldol

- Impairs heat dissipation
- Prolongs QTc
- Worsens anticholinergic toxicity
- Lowers seizure threshold

# VIOLENT PATIENT PROTOCOL

- Concentrated midazolam and droperidol at bedside
- Provider at bedside
- Plan


https://mcmedia.mayo.edu/asset-management/241HRGD55RRP?WS=SearchResults

# LABORATORY EVALUATION

- CBC
- Extended electrolytes
- Glucose
- Lactate
- ABG with coox (carboxyhemoglobin, methemoglobin)
- Acetaminophen, salicylates
- Ethanol
- Urine drug screen
- Pregnancy test

https://pixabay.com/photos/mouth-guard-stethoscope-4929133/

# URINE DRUG SCREEN (UDS)

- No uniformity of UDS
- Expected tests for:
  - Amphetamine
  - Cocaine
  - Tetrahydrocannabinol
  - Opioids
  - PCP
- Chain of custody
- False-positives:
  - Amphetamines: Pseudoephedrine, ephedrine, fluoxetine, trazodone, ranitidine, labetalololol, carbidopa/levodopa
  - Opioids: poppy seed ingestion
  - PCP: OTC cold medications
  - Cannabinoid: hemp-containing, Marinol
- False-negatives
  - Improper collection, transport, or testing

# ELECTROCARDIOGRAM

- Many toxins cause cardiotoxic effects
- ECG changes include:
  - QRS widening
  - Tall R-waves
  - QTc prolongation

# SODIUM CHANNEL BLOCKADE

| | |
|---|---|
| TCAs | Sodium bicarbonate if QRS > 100 msec |
| Cocaine | |
| Benadryl | 50-100 mEq bolus, then infusion 150 mEq/Liter D5W at 150 ml/hr |
| Flexeril | |
| Tegretol | Serum pH 7.45-7.55 |
| Propafenone | Check pH and K+ every 2 hours |
| Flecainide | |

# Classic toxidromes

- Opioid
- Sedative/hypnotic
- Sympathomimetic
- Hallucinogenic
- Serotonin
- Anticholinergic/Cholinergic
- Acetaminophen
- Salicylates
- Beta blocker/Calcium channel blocker

# Case presentation

RRT call for unresponsiveness

- 2nd RRT call in two hours
- Received 0.4 mg naloxone 90 minutes prior, with improvement in mentation

VS: HR 94, BP 102/62, RR 6

# WHICH TREATMENT WILL BE MOST HELPFUL?

1. Naloxone
2. Suboxone
3. Flumazenil
4. Lorazepam

# OPIOIDS

| |
|---|
| Morphine |
| Fentanyl |
| Methadone |
| Tramadol |
| Meperidine |
| Heroin |
| Hydrocodone |
| Oxycodone |
| Hydromorphone |

- Bind to opioid receptors:
  - Mu
  - Kappa
  - Delta

# OPIOIDS

- Central nervous system depression
- Hypoventilation
- Miosis
- Hypotension
- Rhabdomyolysis if found down
- Non-cardiogenic pulmonary edema with progression to ARDS

| Toxidrome | HR/BP | Pupils | Temp | Diaphoresis | RR | Bowels |
|---|---|---|---|---|---|---|
| Opioid | ↓ | Miosis | ↓ | ↓ | ↓ | ↓ |

# OPIOID TREATMENT

## Treatment

- Oxygen and airway support
- Supportive care
- Naloxone

## Naloxone

- 0.04 to 0.4 mg IV every 2-3 minutes; repeat dose or increase to 2 mg if inadequate
- If no response with 5-10 mg, likely NOT an opioid overdose
- May give IV, IM, intranasal, nebulized
- Continuous infusion at 0.05 mg/hour
- Half life: 30-81 minutes

# NALOXONE PRECAUTIONS

- May precipitate acute withdrawal symptoms and seizures
- May lead to pulmonary edema
- CNS depression may return after initial improvement due to short half life

# THE PATIENT DOES NOT RESPOND TO 2 MG IV NALOXONE. WHAT NEXT?

1. STAT head CT
2. STAT ABG
3. Flumazenil
4. Sleep enhancement protocol

# SEDATIVES & HYPNOTICS

- Benzodiazepines
- Ethanol
- Barbiturates
- Zolpidem

- Cause anesthesia with diminished reflex activity and loss of awareness

# SEDATIVES & HYPNOTICS

- CNS depression
- Hyporeflexia
- Depressed respiratory rate with large quantities
- Hypothermia
- Hypotension
- Mild bradycardia
- Ataxia

| Toxidrome | HR/BP | Pupils | Temp | Diaphoresis | RR | Bowels |
|---|---|---|---|---|---|---|
| Sedative/ Hypnotic | ↓ | Normal | ↓ | ↓ | ↓ | ↓ |

# SEDATIVE & HYPNOTIC TREATMENT

## Treatment

- Oxygen and airway support
- Supportive care
- ETOH: monitoring
- Benzodiazepines: Flumazenil

## Flumazenil

- 0.2 mg IV, followed by 0.3 mg, and 0.5 mg if no effect
  - One-minute intervals
- Max dose 3 mg/hour
- If no response with 5 mg in one hour, likely to be something other than benzodiazepine
- May give IV, IM, intranasal, nebulized
- Half life: 54 minutes

# FLUMAZENIL PRECAUTIONS

Black box warning: increased risk of seizures

Re-sedation may occur

May precipitate benzodiazepine withdrawal

# Case presentation

19 y.o. male involved in a police chase.

HR 172 Temp 102.7F

BP 180/96

RR 26

100% on room air

Exam: agitated, paranoid, diaphoretic, dilated pupils

# SYMPATHOMIMETICS

| |
|---|
| Designer drugs |
| PCP |
| Ecstasy |
| Caffeine |
| Cocaine |
| Synthetic cathinone |
| Amphetamines |
| Ephedrine |
| Beta-adrenergic agonists |

# SYMPATHOMIMETICS

- Tachycardia
- Hypertension
- Tachypnea
- Agitation
- Diaphoresis
- Mydriasis
- Seizures
- Arrhythmias

| Toxidrome | HR/BP | Pupils | Temp | Diaphoresis | RR | Bowels |
|---|---|---|---|---|---|---|
| Sympatho-mimetic | ↑ | Mydriasis | ↑ | ↑ | ↑ | ↑ |

# SYMPATHOMIMETICS

No antidote

Keep the patient safe!

Keep the staff safe!

- Violent patient kits, protocols
- IV fluids
- Airway and cardiac monitoring

- Treatment:
  - Benzodiazepines
    - 0.02 to 0.06 mg/kg IV every 2-6 hours
    - Patient dependent!
  - Sodium bicarbonate infusion for cardiac stabilization
    - 50-100 mEq bolus, then infusion 150 mEq/L D5W at 150 ml/hour

# Case presentation

- 52 y.o. female, hospital day 4. Admitted with perforated diverticulum and sepsis without shock

- PMH of VRE colonization, diverticulosis, diabetes mellitus type 2 on metformin, and depression on citalopram

- Currently receiving linezolid, lactated ringers at 100 ml/hour, acetaminophen PRN, aspart PRN, citalopram. Pain control with PRN tramadol, and IV fentanyl for breakthrough

# WHAT IS SHE AT RISK FOR?

1. Clostridium difficile
2. Pain crisis
3. Opioid overdose
4. Serotonin Syndrome

# SEROTONERGICS

| | | | | |
|---|---|---|---|---|
| Psychedelic stimulants, Exstasy | Tricyclic antidepressants (TCAs) | Lithium | Dextromethorphan | Monoamine oxidase inhibitors (MAOIs) |
| Meperidine | Fentanyl, Tramadol | Selective serotonin reuptake inhibitors (SSRIs) | Buspirone | Linezolid |

# SEROTONIN SYNDROME

**Clinical triad:**

- Sympathetic hyperactivity
- Mental status change
- Neuromuscular hyperactivity

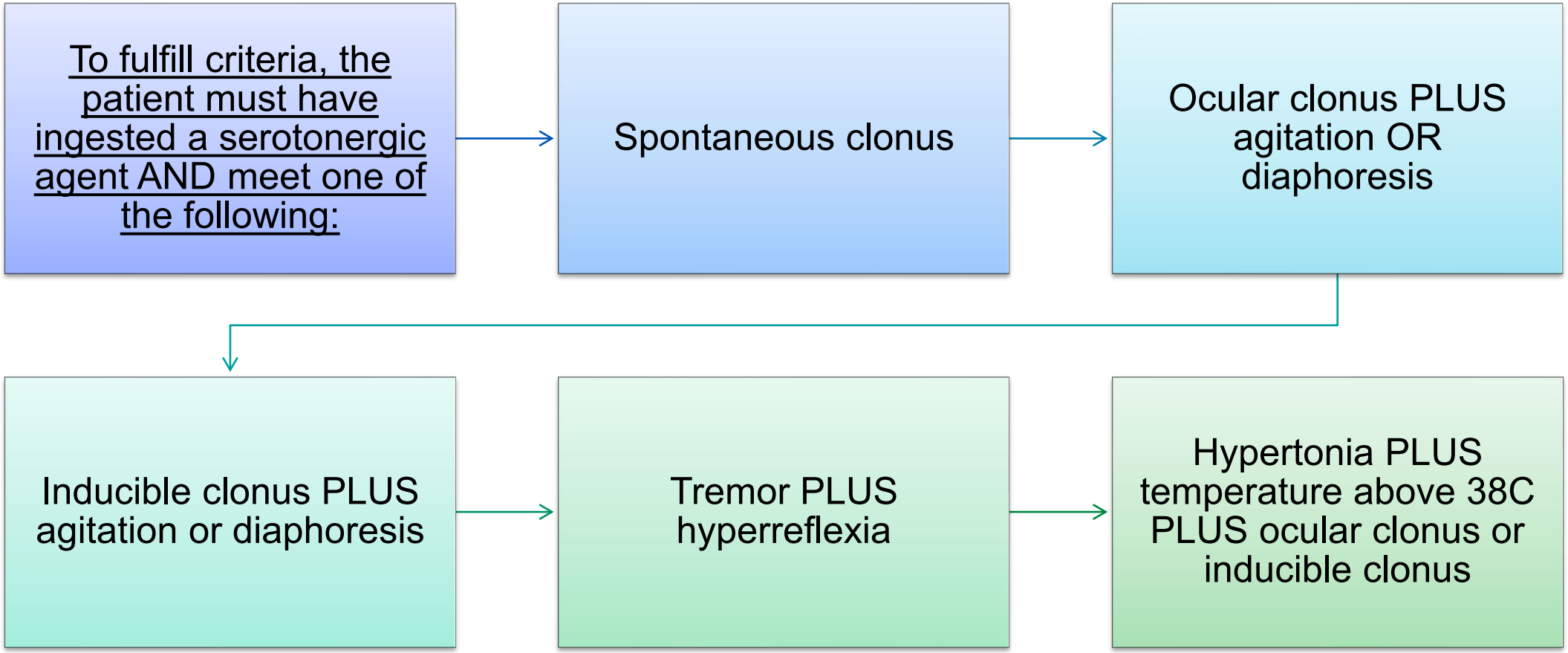
**May also see:**

- Akathisia, tremor, diaphoresis, diarrhea, rhabdomyolysis

| Toxidrome | HR/BP | Pupils | Temp | Diaphoresis | RR | Bowels |
|---|---|---|---|---|---|---|
| Serotonergic | ↑ | Normal | ↑ | ↑ | ↘ | ↑ |

# HUNTER CRITERIA FOR SEROTONIN SYNDROME



# SEROTONIN SYNDROME TREATMENT

- Supportive care
- Discontinue all serotonergic agents
- Intravenous fluids
- Avoid physical restraints
- Active cooling
- Benzodiazepines
- Propofol +/- paralysis
- Cyproheptadine vs. chlorpromazine
- Dexmedetomidine hydrochloride

# SEROTONIN SYNDROME TREATMENT

**Cyproheptadine**

- Nonspecific serotonin antagonist.
- Initial dose of 12 mg, followed by 4-8 mg every 6 hours until desired clinical response.
- Needs further research
- Only oral form

**Chlorpromazine**

- Antipsychotic
- Not well studied, not recommended as first line
- Exact mechanism is unknown, though thought to have mild anti-serotonin activity

**Dexmedetomidine hydrochloride**

- Alpha-2 adrenergic agonist with sedative characteristics.
- Loading dose 1 mcg/kg over 10 minutes
- Maintenance for < 24 hours 0.15 to 1.5 mcg/kg/hr
- Maintenance for > 24 hours 0.2 to 0.7 mcg/kg/hr
- Monitor for bradycardia and hypotension

# ANTICHOLINERGICS

- Medications associated with the parasympathetic nervous system
  - Innervates the eyes, heart, respiratory system, skin, GI/GU, sweat glands

# ANTICHOLINERGICS

- Tachycardia
- Hyperthermia
- Tachypnea
- Variable blood pressure
- Redirectable delirium
- Mydriasis

- *Red as a beet, dry as a bone, blind as a bat, mad as a hatter, full as a flask*

| Toxidrome | HR/BP | Pupils | Temp | Diaphoresis | RR | Bowels |
|---|---|---|---|---|---|---|
| Anticholinergics | ↑ | Mydriasis | ↑ | ↓ | ↑ | ↓ |

# ANTICHOLINERGIC TREATMENT

- Treatment:
  - Supportive cares
  - Monitor for seizures, treat with Benzodiazepines
  - Cardiac monitoring for prolonged QRS, QTc
  - Avoid haloperidol (seizure, dysrhythmias, qtc prolongation)
  - Physostigmine: contraindicated in TCAs

Do not use Haldol

Physostigmine

- Crosses blood/brain barrier to inhibit cholinesterase and makes more acetylcholine available
- 2 mg IV (slowly, 1 mg/min)
- May repeat dose for life threatening signs
- Works quickly, half life 4.9 hours
- Monitor for bradycardia and convulsions if administered too quickly
- Excessive cholinergic effects may occur

# CHOLINERGICS:

Activate the muscarinic acetylcholine receptors

Nerve gas

Insecticides

- Organophosphates

Physostigmine

Donepezil

Muscarinic mushrooms

# Cholinergics: All faucets on!

Defacation
Urination
Miosis
Bradycardia

Bronchospasm
Emesis
Lacrimation
Secretions
Seizures

| Toxidrome | HR/BP | Pupils | Temp | Diaphoresis | RR | Bowels |
|---|---|---|---|---|---|---|
| Cholinergics | ↓ | Mydriasis | — | ↑ | — | ↑ |

# CHOLINERGIC TREATMENT

- Decontamination
- Discontinue offending agent
- Supportive therapy
- IV fluids
- Atropine
- Glycopyrrolate

- Atropine
- Pralidoxime
- Glycopyrrolate

# CHOLINERGIC TREATMENT

- Atropine
  - 2 to 3 mg IV/IM/SQ; may repeat in 20 to 30 minutes
  - Titrate based on HR, PR interval, symptoms
  - In intubated ICU patients: initial dose 20 mg IV in combination with pralidoxime 2 g IV loading dose
- Pralidoxime Chloride
  - Reactives cholinesterase
  - Give after atropine
  - 1-2 g in 100 ml NS over 15-30 minutes
  - Repeat in one hour if muscle weakness persists
  - May give an additional dose every 10-12 hours
  - May also be given IM
- Glycopyrrolate
  - Cannot cross the blood-brain barrier
  - Longer duration than atropine at 2-4 hours
  - Inhibits salivary gland and respiratory secretions
  - 0.004 mg/kg

# Acetaminophen epidemiology 2022

- 56,000 emergency department visits for acetaminophen toxicity
  - 50% unintentional overdose
- 2,600 hospitalizations
- 500 deaths

- Acetaminophen toxicity has replaced viral hepatitis as the most common cause of acute hepatic failure
  - 2nd most common cause of liver failure requiring transplantation
  - 7.5 to 10 g within eight hours of acetaminophen is concerning and should be admitted

# Acetaminophen

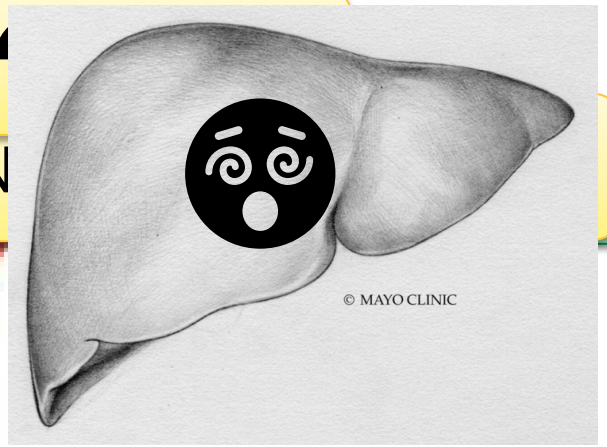
Glucuronide Conjugation (60%)

Sulfate Conjugation (30%)

Cytochrome P450 2E1 (5-10%)

Glucuronic Acid Conjugate

Sulfate Conjugate




Urine

Urine

Urine

# RISK FACTORS

Older age

Restricted diet

Underlying hepatic or renal disease

Compromised nutritional status

- Ethanol ingestion
- Tobacco smoking
- Isoniazid (INH)
- Rifampin
- Phenytoin
- Phenobarbital
- Barbiturates
- Carbamazepine
- Trimethoprim-sulfamethoxazole (TMP-SMZ)
- Zidovudine

# Phases of toxicity

| Phase | Time frame | Signs and Symptoms |
|---|---|---|
| Phase 1 | First 24 hours | Asymptomatic<br>Anorexia, nausea, vomiting, malaise |
| Phase 2 | 18-72 hours after ingestion (if untreated) | RUQ pain, anorexia, nausea, vomiting<br>Tachycardia and hypotension |
| Phase 3 | 72-96 hours (if untreated)<br>“Hepatic phase” | Nausea, vomiting, abdominal pain<br>Hepatic necrosis/synthetic dysfunction<br>--- Jaundice, encephalopathy, coagulopathy, hypoglycemia, LFTs extremely elevated and peak (AST>10000), acute renal failure possible |
| Phase 4 | 4 days to 3 weeks post-ingestion | Either: Death, complete recovery, or transplant |

# Rumack-Matthew Nomogram

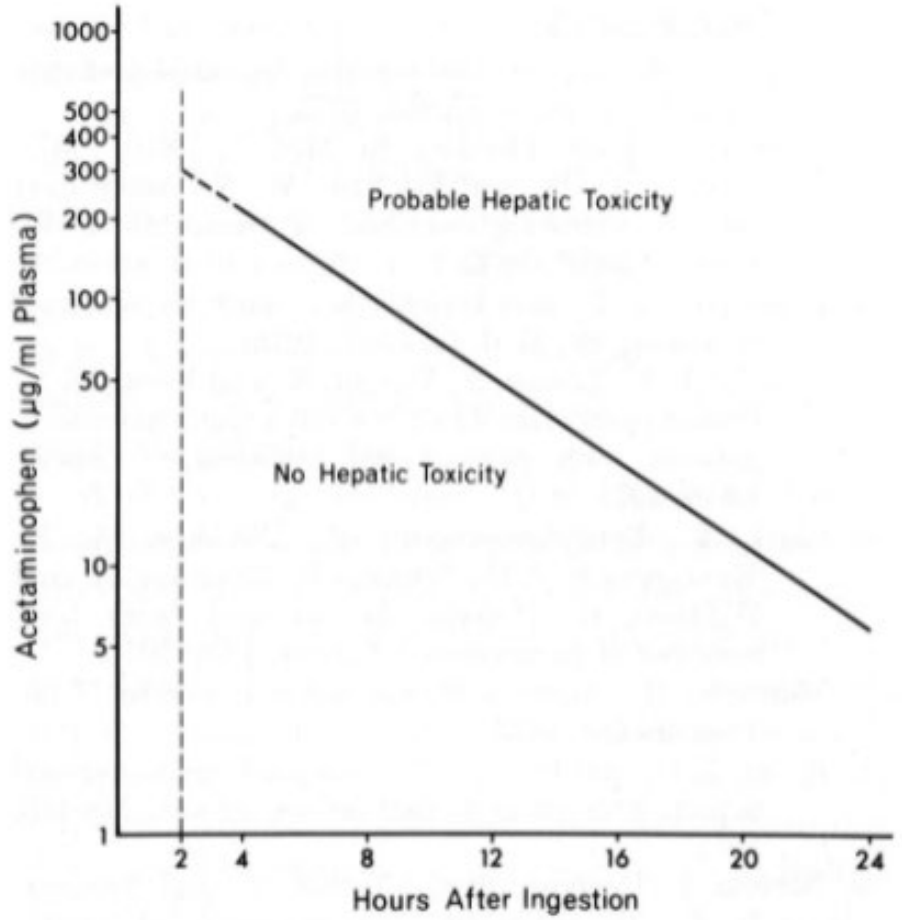


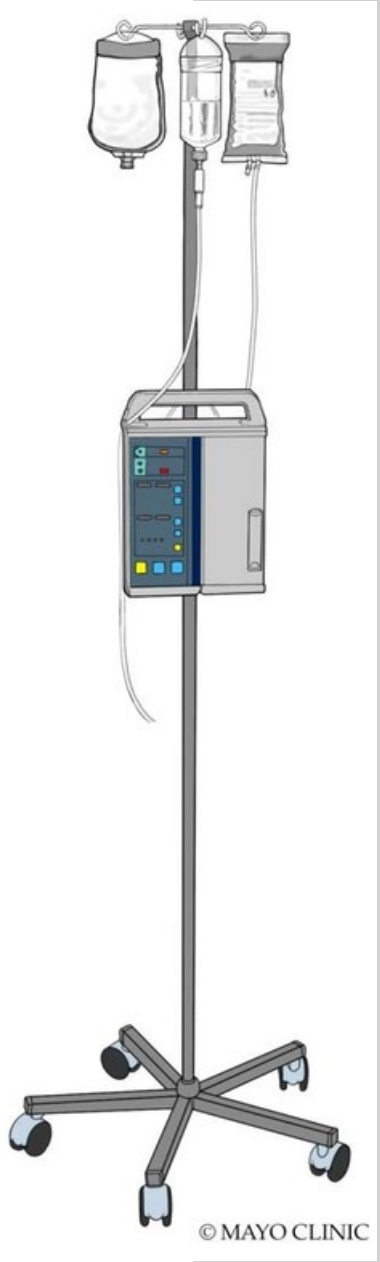

FIG. 1. Semilogarithmic plot of plasma acetaminophen levels vs. time.

Rumack BH, Matthew H, Acetaminophen Poisoning and Toxicity. Pediatrics 1975 (55)871-876

Semilogarithmic plot of plasma acetaminophen levels vs time. From: Rumack BH, Matthew H. Acetaminophen Poisoning and Toxicity. Pediatrics. 1975 (55)871-876.

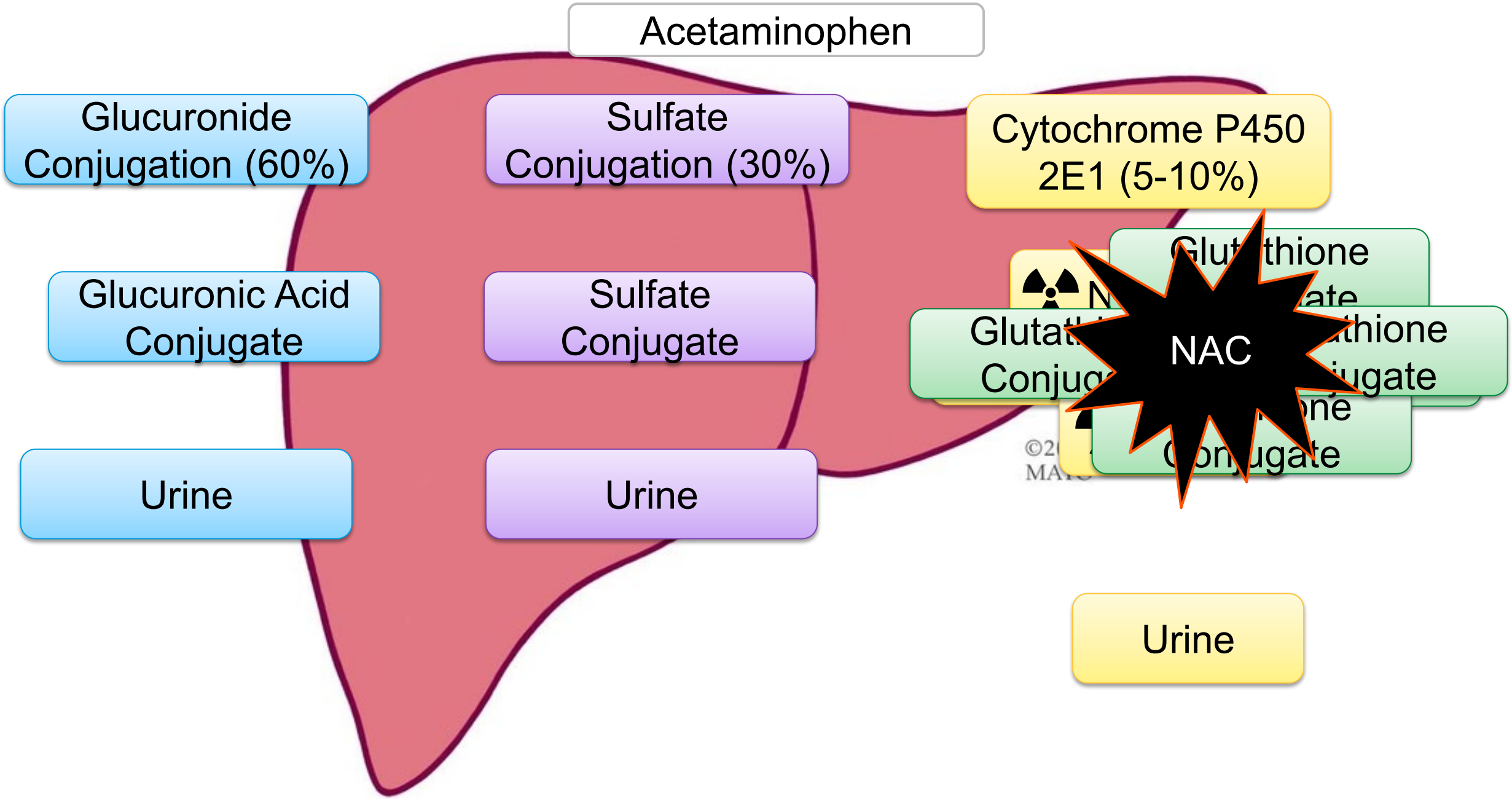
 

# Treatment




- Charcoal (within 4 hours of ingestion)
- N-acetylcystine IV or PO
  - IV Loading dose (41-99 kg): 150 mg/kg IV over one hour
  - IV Maintenance: 50 mg/kg over 4 hours; 100 mg/kg over 16 hours
  - Oral: 140 mg/kg PO initial dose; then 70 mg/kg every 4 hours over 16 hours
  - Ingestions > 30 g or twice the nomogram line may need higher doses
  - Repeat INR, acetaminophen level, and hepatic function panel at 20 hours



# TREATMENT

N-acetylcystine should be continued until:

INR < 2

Acetaminophen level < 10

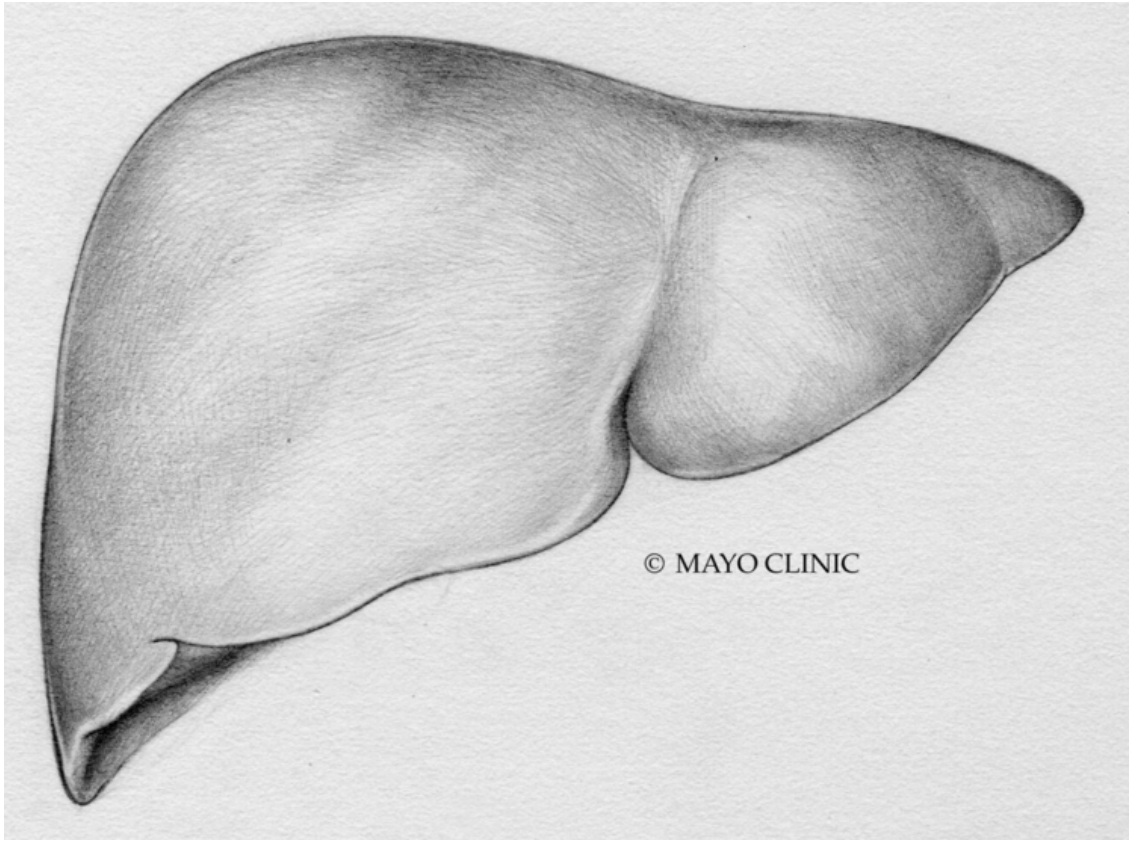
AST < 1000 and downtrending

Encephalopathy has resolved

Referrals to:
Poison Control
Transplant-capable center

# PROGNOSTICATION TOOLS




- King's College Criteria
  - Predict poor outcome and need for liver transplantation after an isolated acetaminophen overdose
    - pH less than 7.3 after volume resuscitation
    - Creatinine greater than 3.4 mg/dL
    - PT greater than 1.8 times normal, or INR greater than 6.5
    - Grade III or IV encephalopathy

# PROGNOSIS

Mortality rate is less than 2% if treated in a timely fashion

Most patients who survive return to prior level of hepatic function

Less than 4% of cases with severe hepatotoxicity develop hepatic failure

# Case presentation

26-year-old female presents with tinnitus, dizziness, and diarrhea

While in the ED, she becomes confused

VS: HR 120, BP 112/68, RR 36, normothermic

# LAB EVALUATION

ABG 7.48/22/82/18

Acetaminophen level: negative

Salicylate level: 50 ml/dL

Glucose 104

# WHAT INTERVENTION DO YOU PERFORM?

1. Contact Poison Control
2. Administer 25 g of D50
3. Give benzodiazepine
4. Find an otoscope

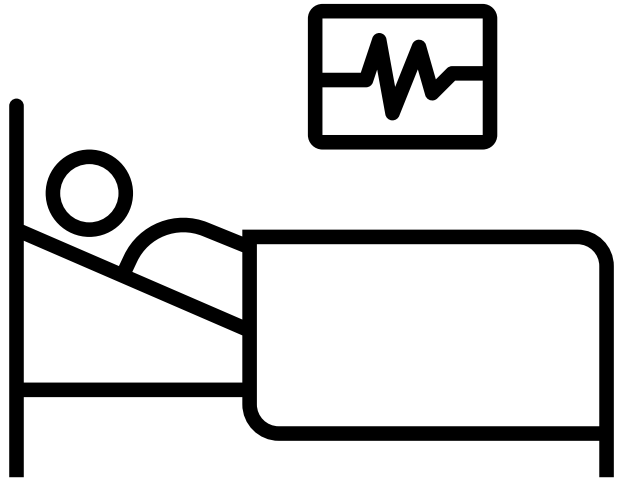
# SALICYLATE TOXICITY

Medical Emergency

Early/mild symptoms:  Tinnitus, vertigo, nausea, vomiting, diarrhea

Late/severe symptoms: Encephalopathy (from agitation to lethargy), hyperpyrexia, noncardiac pulmonary edema

Symptoms present 1-2 hours after ingestion



- After ingestion, acetylsalicylic acid is converted to salicylic acid
- Several organ systems impaired by poisoning

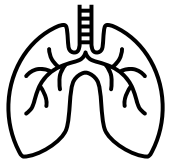
Uncoupling oxidative phosphorylation

Inhibit the Krebs cycle enzymes

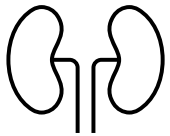
Inhibit amino acid synthesis

ACID-BASE



Respiratory center stimulated = respiratory alkalosis



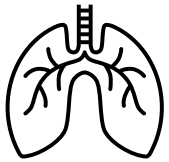
Uncoupling of oxidative phosphorylation causes renal impairment

Metabolism of fatty acids: ketone body formation

Anion gap metabolic acidosis

# RESPIRATORY



Direct and indirect stimulation of respiration

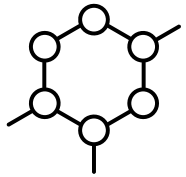
Salicylate level > 35 causes tachypnea and hyperpnea

Non-cardiogenic pulmonary edema

High mortality, indication for hemodialysis

# ENDOCRINE



- Increased cellular metabolic activity
- Discordant glucose levels
- Serum vs. CSF glucose
- Altered mentation

# NEUROLOGICAL

- Neurotoxic, manifests as tinnitus
- Hearing loss may persist
- CNS toxicity related to serum level
- Acidosis worsens toxicity: blood-brain barrier opens to salicylates
- Nausea, vomiting, encephalopathy, lethargy, hyperpnea, coma, seizures, cerebral edema

## GASTROINTESTINAL

Nausea and vomiting

Damage to gastric mucosa

May lead to GI bleeding

Pylorospasm, decreased motility, bezoar

Increased absorption of salicylate

# HEPATIC

Acute hepatitis

Nausea, vomiting, hypoglycemia

# HEMATOLOGICAL

Hypoprothrombinemia and platelet dysfunction

Inhibition of vitamin-K dependent enzymes

Hemorrhage

Inhibition of factors 2, 7, 9, and 10

# MUSCULOSKELETAL

Dissipation of heat and energy

Rhabdomyolysis

# MANAGEMENT

Admit for ingestions of 150 mg/kg or greater OR TOXICITY

Intubation →

- Altered mentation prohibiting care
- Pulmonary edema
- Airway protection during gastric lavage/charcoal
- Hyperventilation must be maintained
- Better outcomes if intubated patients are dialyzed

Decontamination (acute vs. chronic)

# TREATMENT

Volume status

Supplemental Glucose

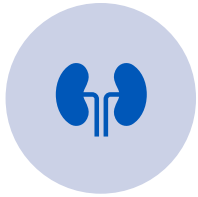
Alkalinization of Urine

- 1-2 mEq/kg bolus
- Infusion of 100-150 mEq/1 Liter D5W (1.5 to 2 times the rate of maintenance dose)
  - Urine pH 7.5-8.0
  - Lower potassium levels, measure hourly

# INDICATIONS FOR HEMODIALYSIS

Peritoneal dialysis is ineffective



Serum salicylate level greater than 120 mg/dL acutely or greater than 100 mg/dL 6 h post-ingestion

Refractory acidosis

Coma or seizures

Noncardiogenic pulmonary edema

Volume overload

Renal failure

# Case presentation

43-year-old female presents to ED with nausea, vomiting, abdominal pain

PMH: alcoholism, polysubstance abuse

VS: HR 140, BP 90/60, RR 38, 37.4C

Restless, toxic appearing, multiple bruises on body, pupils normal

Admits to 4 shots brandy per day, no other ingestions

# LABORATORY EVALUATION

- Hg 13.4
- WBC 18.8
- Sodium 141
- Potassium 3.7
- Glucose 112
- Creatinine 2.0
- BUN 10
- Chloride 75
- Bicarbonate 5

- Anion gap 61
- Lactate 13.5
- Osmolality 370
- Beta hydroxybutyrate 17
- Ethanol 182
- Acetaminophen <15
- Salicylate <0.3
- VBG 7.09/21/38/7
- Urine drug screen negative

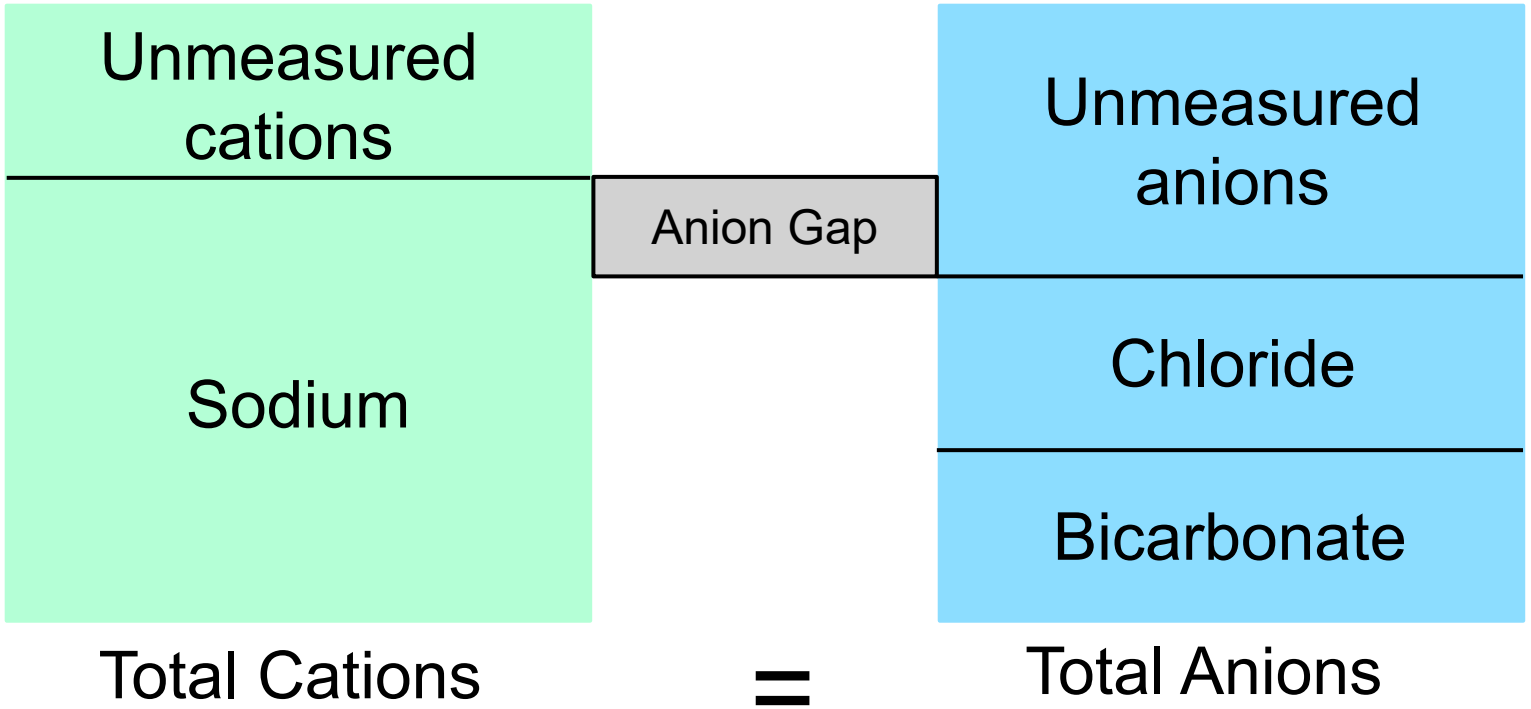
# ANION GAP

Na – (Cl + HCO3)

141 – (75 + 5)

Anion Gap = 61

Normal 4-12 mmol/L



# ANION GAP MNEMONICS

- **M**ethanol
- **U**remia
- **D**iabetic ketoacidosis
- **P**araldehyde
- **I**soniazid/Iron
- **L**actate
- **E**thylene glycol
- **S**alicylate

- **M**ethanol, metformin
- **E**thylene glycol
- **T**oluene
- **A**lcoholic ketoacidosis
- **L**actic acidosis
- **A**minoglycosides
- **C**yanide, carbon monoxide
- **I**soniazid, iron
- **D**iabetic ketoacidosis
- **G**eneralized seizure-producing toxins
- **A**spirin
- **P**araldehyde, phenformin

# OSMOLALITY AND OSMOLAR GAP

Osmolality is the concentration of independent particles dissolved in a liquid. Includes cations, anions, uncharged ions.

Osmolar gap detects unmeasured compounds in the serum

Normal value < 10

# Osmolar gap (<10)

A. Measured osmolality (All osmotically active substances)

B. Calculated osmolarity (Expected osmotically active substances)

(2 * Na) + (glucose/18) + (urea/2.8) + (ETOH/4.6)

A – B = Osmolar gap (unmeasured or unknown remaining solutes in the blood)

Osmolar gap
29

# OSMOLAR GAP MNEUMONIC

**M**ethanol

**E**thylene glycol

**D**iuretics (osmotic diuretics like mannitol)

**I**sopropyl alcohol

**E**thanol

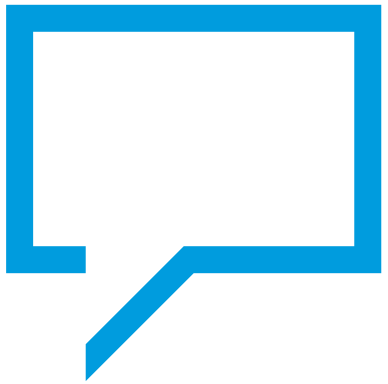
 

# THE CASE

- Emergent Nephrology consultation.
- Intubated, dialysis catheter placed.
- Severe metabolic derangements thought to be secondary to acute ethanol ingestion with ketosis.
- However, presence of osmolar gap suggests an osmotically active substance.
  - Volatile screen obtained (methanol, ethanol, isopropranol, acetone). All negative.
  - Possibly diethylene glycol.

# QUESTIONS & ANSWERS



# CALCIUM CHANNEL AND BETA BLOCKER OVERDOSE

2019 Annual Report of the American Association of Poison Control Centers' (AAPCC) National Poison Data System

- 11,166 single exposures to beta-blockers
- Propranolol is the most toxic beta-blocker and the most frequently used in suicide attempts worldwide
- 2 to 3 times the therapeutic dose is potentially life-threatening

# CALCIUM CHANNEL AND BETA BLOCKERS

- Bradycardia
- Hypotension
- 1st degree heart block
- Shock

Lipid-soluble medications have more CNS effects.

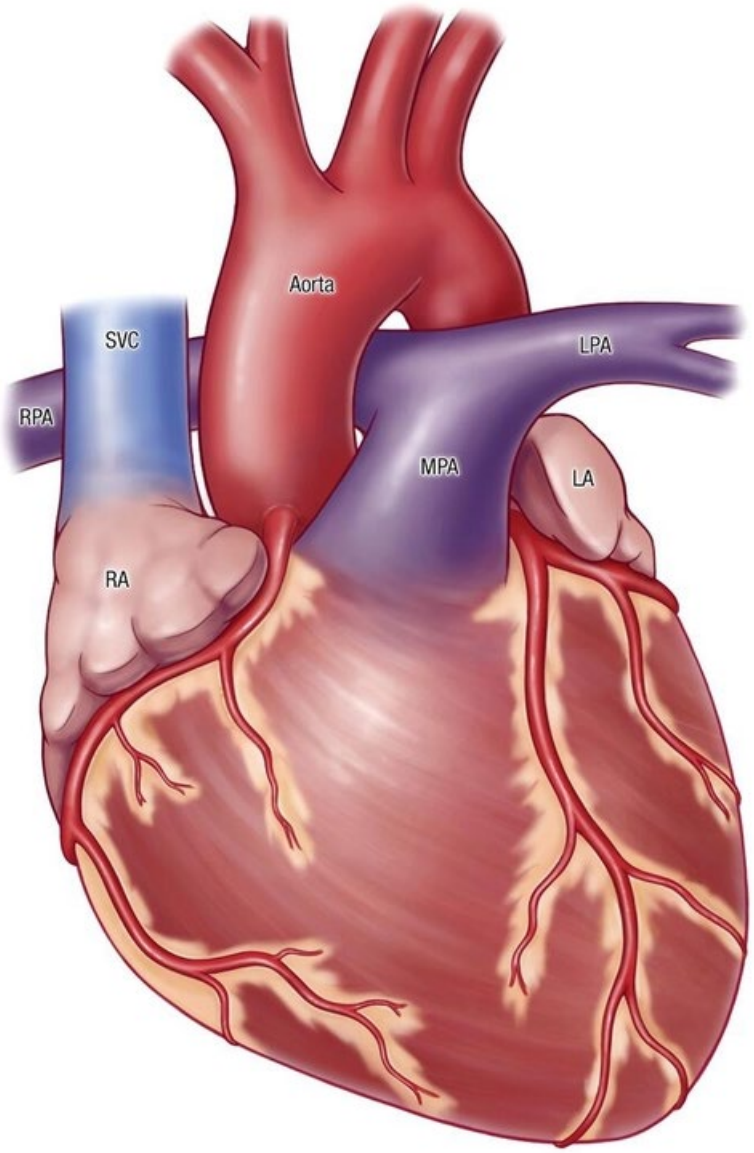
# MECHANISM OF ACTION

## Beta blockers

- Interfere with myocyte metabolism and inhibit pancreatic insulin release.

## Calcium channel blockers

- Disrupt fatty acid metabolism and create relative insulin resistance in the myocardium



# BETA BLOCKER EXAMPLES

**Propranolol**

- Depressed myocardial activity
- Conduction abnormalities
- Lipid soluble
  - Seizures, coma

**Pindolol**

- Partial beta activity
- Tachycardia, hypertension

**Sotalol**

- Type III antiarrhythmic
- Prolonged QTc
- Torsades de pointes

**Labetalol, carvedilol**

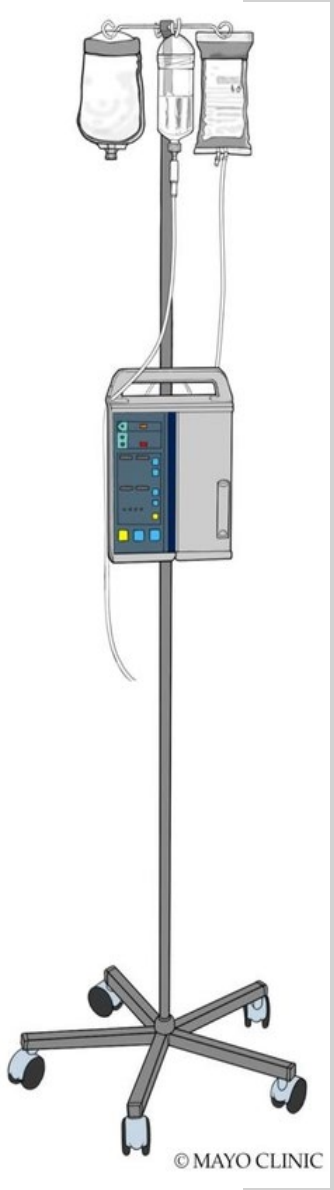
- Nonselective beta and alpha blocking
- Vasodilation and shock

# TREATMENT

- Historically treated with IV fluids, inotropes, pacing, glucagon, lipids

- If presentation is within one hour, give activated charcoal
  - If extended release, may give after one hour
- May trial atropine 0.5 to 2 mg IV
- External pacing
- Inotropic support
- +/- lipid therapy




- Evidence suggests that high dose insulin is superior to traditional treatments, and is beneficial in refractory cardiogenic shock secondary to CCB and BB overdose

# TOXICOLOGY INSULIN MECHANISM

Insulin is a potent inotrope, and increases cardiac output by improving contractility

Insulin improves intracellular energy utilization

Acts as a vasodilator by enhancing the endothelial nitric oxide synthase, which improve microvascular dysfunction seen in cardiogenic shock

Improves the metabolic dysfunction and hyperglycemia seen in CCB overdoses

ELSEVIER

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Original Contribution

# High dose insulin for beta-blocker and calcium channel-blocker poisoning ☆

Jon B. Cole M.D. [a], Ann M. Arens M.D. [a], JoAn R. Laes M.D. [b], Lauren R. Klein M.D. [c], Stacey A. Bangh PharmD [d], Travis D. Olives M.D., M.P.H., M.Ed. [a]

 

# TOXICOLOGY INSULIN

- Maintain cardiac output & perfusion
- Titrate off vasopressors
- Glucose 150-250 mg/dL
- Potassium 2.5-3 mmol/L
- Ionized calcium 5-6 mg/dL

Give calcium

Bolus dextrose, followed by infusion of D50 at 150 ml/hr

Regular insulin IV, bolus dose 1 unit/kg

Starting dose 1 unit/kg/hour
Titrate by 1-2 units/kg/hour every 5-15 minutes
Max dose 10 units/kg/hour

 

# QUESTIONS & ANSWERS