Forensic Toxicology

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"The desire to abuse drugs is limited only by one's imagination and resources."

-David Dolinak, M.D.

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Toxicology panels

- A = Alcohol
  - Gas Chromatography- Flame Ionization Detector (GC-FID)
- B = Common drugs of abuse (prescription and street)
  - Enzyme-linked immunosorbent assay (ELISA)
- C = More comprehensive panel than B
  - Gas Chromatography- Mass Spectroscopy (GC-MS)
- D = Carbon Monoxide
- E = Electrolytes
- NTP = No test performed

Toxicology specimens

- **Blood**
- **Vitreous fluid**
- **Urine**
- Bile
- Solid organs
- Gastric contents

Blood

- Central blood may absorb drugs from internal organs→ ↑ drug levels
  - Good for screening
- Peripheral blood is relatively separate/ isolated from internal organs (stomach, intestines)
  - Good for quantitation
- Preservative = Sodium fluoride
  - Inhibits microbes and enzymes

Vitreous fluid

- Sequestered from blood and bacteria post-mortem
- Used for EtOH and opiate levels
- Also used for vitreous chemistry
  - Urea nitrogen has most independent significance (↑ in uremia, dehydration)
  - Helpful to evaluate elevated glucose (>200 mg/dL suggests diabetic)

Vitreous fluid

- $EtOH_{blood} > EtOH_{vitreous}$ = absorptive
- $EtOH_{blood} < EtOH_{vitreous}$ = metabolic

Absorptive

Metabolic

Solid organs

- Liver
  - Right lobe (away from stomach)
  - Drugs, metabolites, ratio
  - Protein-bound drugs (TCAs)
- Lung: Volatiles
- Kidney: Heavy metals

Gastric contents

- Pill fragments
- “Packers” and “stuffers”
- Non-uniform, all should be collected and amount recorded

Urine

- High volume can *suggest* overdose
- Longer-lasting reservoir for drugs than blood
- Often has higher drug levels than blood

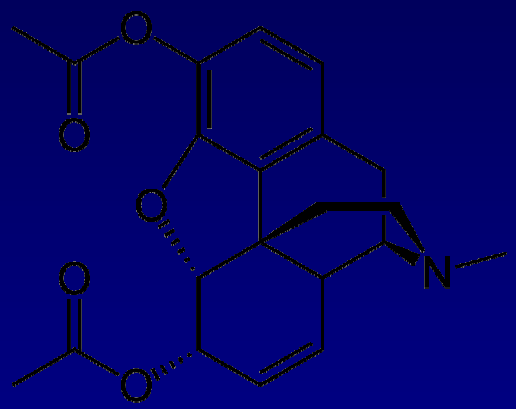
Other

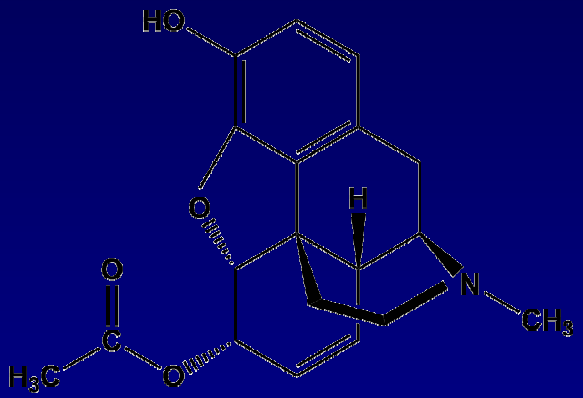
- Hair, fingernails, meconium, hematomas: Chronic/past drug use
- Maggots: Decomposed bodies
- Skeletal muscle
  - Buttock: Embalmed bodies
  - Thigh: Decomposed bodies

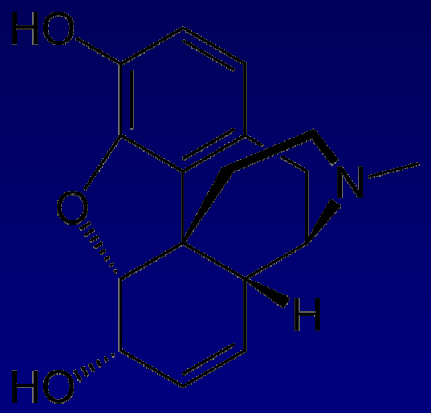
Possible artifacts

- Ethanol from bacterial fermentation
  - Usually < 0.05, reports up to 0.20
- Gamma-hydroxybutyrate (GHB)
  - Forms post-mortem in many tissues, not urine
- Metabolism can occur during prolonged death

Heroin metabolism







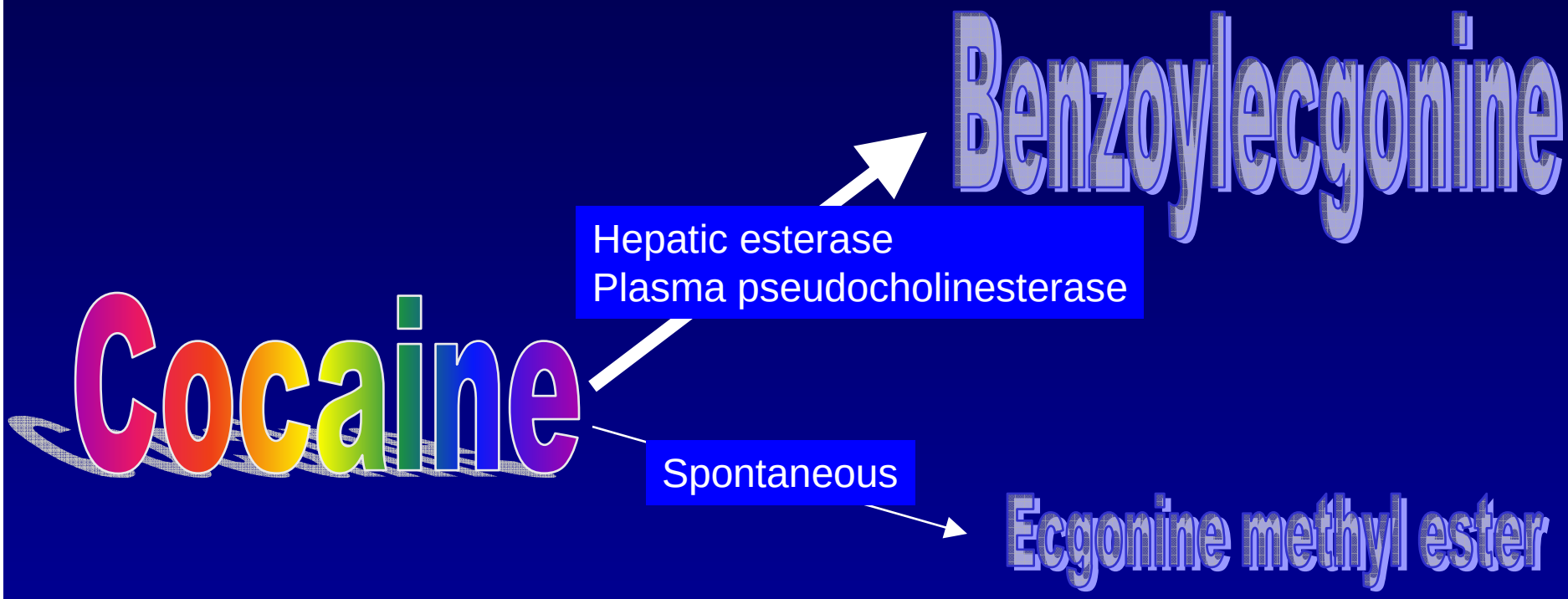
Heroin → **6-MAM** → **Morphine**

- **Pro-Drug**
- **½ life = minutes**

- **μ-opioid agonist**
- **Specific metabolite of heroin**
- **Excreted in urine**

- **μ-opioid agonist**
- **Metabolite of heroin, codeine, etc.**

Cocaine metabolism



- **Inhibits synaptic reuptake of E, NE, D, S**
- **Stimulates release of NE**
- **Metabolized by liver**

- **Inactive metabolites**
- **Excreted in urine**

Drug metabolism

- Heroin
  - Very short $T_{1/2}$, especially in blood (longer in vitreous)
  - 6-MAM specific metabolite, longer $T_{1/2}$
- Cocaine
  - Inactive metabolites (especially benzoylecgonine) have longer $T_{1/2}$

Agent Orange

- Agent Orange is a defoliant used during U.S. involvement in Southeast Asia
- Dioxin (2,3,7,8-Tetracholorodibenzo – P-Dioxin TCDD) is a very toxic synthetic chemical which arises as a by-product in the manufacture of Agent Orange (2, 4, 5-T)
- Toxicology specimens: blood, liver and 50 grams adipose tissue

Volatiles: Ethanol

- Widmark formula:
  - Used to calculate BAC as a percentage of TBW
  - TBW%/body weight higher in thin people
- Problems:
  - Factors vary from male to female, by individual
  - Alcohol in the stomach is being absorbed
  - Alcohol in body is being metabolized:
    - one standard sized drink raises the BA ~0.02%
    - an average adult metabolizes ~ one drink per hour or 0.017% per hour.

Ethylene Glycol

- Relatively inexpensive and easily obtainable
- Used predominately as an antifreeze-antiboil additive in motor vehicles, but also found in detergents, paints, cosmetics, and deicing products.
- Sweet taste, odorless and colorless, but commonly has fluorescent green or yellow dye added.
- Intoxicant: properties similar to Etoh when ingested.

Ethylene Glycol

- Stages:
  - 12-24 hours: CNS depression, measurable blood ethylene glycol, osmolal gap.
  - Past 24 hours, cardiopulmonary effects predominate, glycolic acid, anion gap metabolic acidosis.
  - 2-3 days renal failure.
- Rx: IV ethanol
- Oxalate crystals accumulate in the kidneys at all stages.
- Antifreeze: blue or green thick liquid in residence
- Usually suicide or accident (chronic alcoholics), Rarely homicide.

Crack Thumb

- Holding hot crack pipe

Cocaine: Septal Perforation

- Local vasoconstriction causes ischemia and nasal septal perforation

Specimen collection

- Blood:
  - Peripheral preferable to heart (RV) or central
  - Gray top tube:
    - sodium flouride
    - potassium oxalate
  - Serum separator: tryptase

Special Thanks

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