

Testing for Drugs of Abuse and Review of Deaths caused by Drugs

Amy C. Gruszecki, MSFS, DO
Chief Forensic Pathologist



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Objectives

- Discuss screening and testing methods for drugs of abuse.
- Understanding toxicology report.
- Discuss certification of drug deaths.
- Discuss drugs of abuse and physical findings and how drugs cause death.

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Drugs to be discussed

Ethanol
Cocaine
Amphetamines
Opiates
Fentanyl
Marijuana
Synthetic Cannabinoids
Kratom

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Important terms

- Acute - current, ongoing, active.
- Chronic – consistent exposure over a period of time.
- Dose – the amount of drug taken.
- Half-life – the time it takes for a drug to decrease to half the dose.

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More terms


- Qualitative test
 - presence, absence, pink, stripe.
 - Usually requires additional testing.
 - May turn out to be negative.
 - Measures in broad categories i.e., opiates
- Quantitative test
 - tells the amount of substance
 - measures in gm, ng, ml etc.
 - Gives specific drugs i.e. morphine, codeine

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Limit of detection

- The lowest concentration of a drug that can be consistently detected.
- Determined by testing on the instrument.
- May differ by instrument, or by test

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NMS Labs
200 Wood Road, Hordsham, PA 19044-0206
 Phone: (215) 857-4800 Fax: (215) 857-2872
 E-Mail: info@nmslabs.com
 Robert A. Mollberg, Ph.D., FAPPT, DMSCC, FC Laboratory Director

CONFIDENTIAL

Dento Report
 Report Issued: 01/23/2023 09:49

To: 8888
 Example Report
 200 Wood Road
 Hordsham, PA 19044

Patient Name: NA
 Patient ID: 30528-POS
 Chain: 22902296
 DOB: Not Given
 Sex: Not Given
 WorkerID: 218521298

Page 1 of 8

Analyte	Result	Units	Matrix/Source
Ethanol	89	mg/dL	001 - Blood
Blood Alcohol Concentration (BAC)	0.085	g/100 mL	001 - Blood
Alprazolam	10	ng/mL	001 - Blood
Alprazolam - Free	10	ng/mL	001 - Blood
Valproic Acid/Propylene - Free	80	mg/mL	001 - Blood
Valproic Acid	8.0	mg/mL	001 - Blood

Analysis Summary and Reporting Limits:
 All of the following tests were performed for this case. For each test, the compounds listed were included in the scope. The Reporting Limit listed for each compound represents the lowest concentration of the compound that will be reported as being positive. If the compound is listed as None Detected, it is not present above the Reporting Limit. Please refer to the Positive Findings section of the report for those compounds that were identified as being present.

Test 50012B - Benzodiazepines Confirmation, Blood - Blood

-Analysis by High Performance Liquid Chromatography/ Tandem Mass Spectrometry (LC-MS/MS) for:

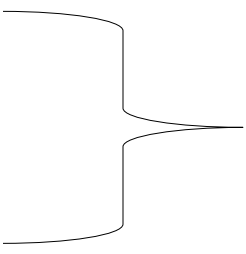
Analyte	Rpt. Limit	Analyte	Rpt. Limit
7-Amino Clonazepam	5.0 ng/mL	Desalkylflurazepam	5.0 ng/mL
Alpha-Hydroxylprazolam	5.0 ng/mL	Diazepam	20 ng/mL
Alprazolam	5.0 ng/mL	Estazolam	5.0 ng/mL
Chlordiazepoxide	20 ng/mL	Flurazepam	2.0 ng/mL
Clobazam	20 ng/mL	Hydroxyethylflurazepam	5.0 ng/mL
Clonazepam	2.0 ng/mL	Hydroxytriazolam	5.0 ng/mL

Example report

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Specimens for Testing

- Urine
- Blood (central, peripheral)
- Hair
- Stomach contents
- Bile
- Tissue (liver, brain)
- Vitreous



autopsy

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A word about hair testing...

- Does not determine timeline well
- Expensive
- Other factors influence – shampoo?
- External exposure?

- Not acute exposure



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Hospital Tox Screen – Urine Qualitative test

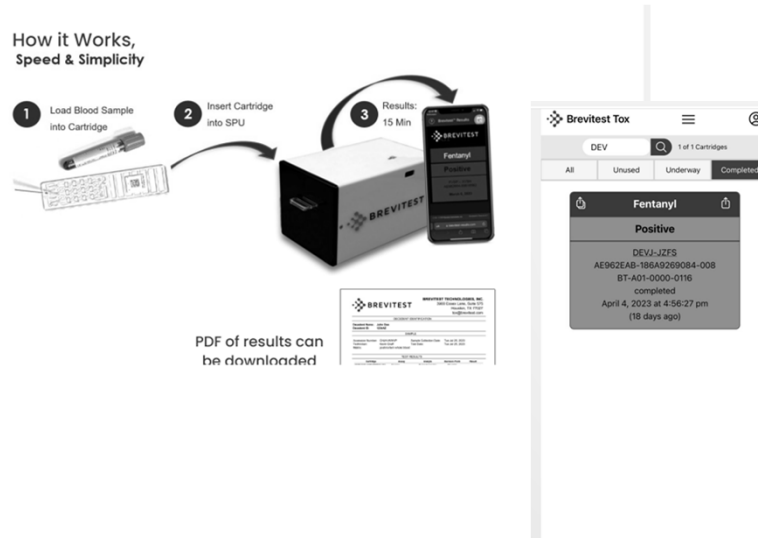
- | | |
|-------------------|----------------|
| • Alcohol | • Amphetamines |
| • PCP | • THC |
| • Benzodiazepines | • Opiates |
| • Cocaine | • Fentanyl |
| | • Barbiturates |



Make sure you know what is tested for!

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Brevitest – Qualitative test



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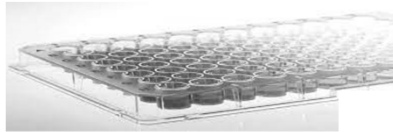
In the Toxicology LAB

- Use a screening test
- Then use a confirmatory test
- Accredited toxicology laboratories do calibrations and quality assurance to ensure that the results are valid and consistent.

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Screening tests (qualitative)

- Eliza plate (Randox)



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Forensic Toxicology Quantitative

- LC – MS/MS
- LC-QToF for identifying unknowns
- Alcohols – Headspace GC – FID or GC-MS

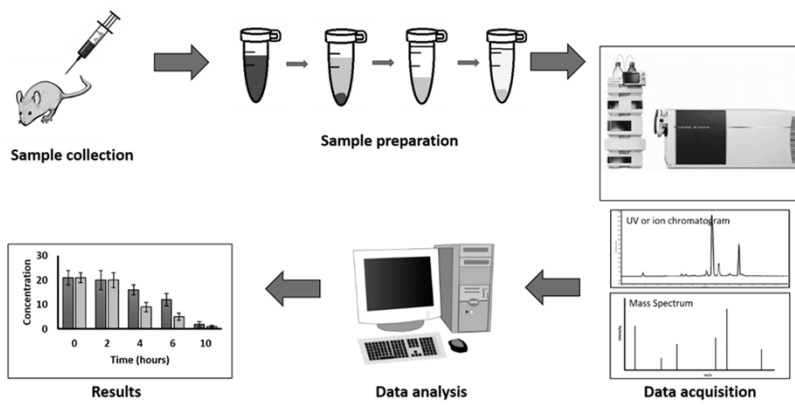
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LC- TOF



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LC-MS/MS



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GC/MS



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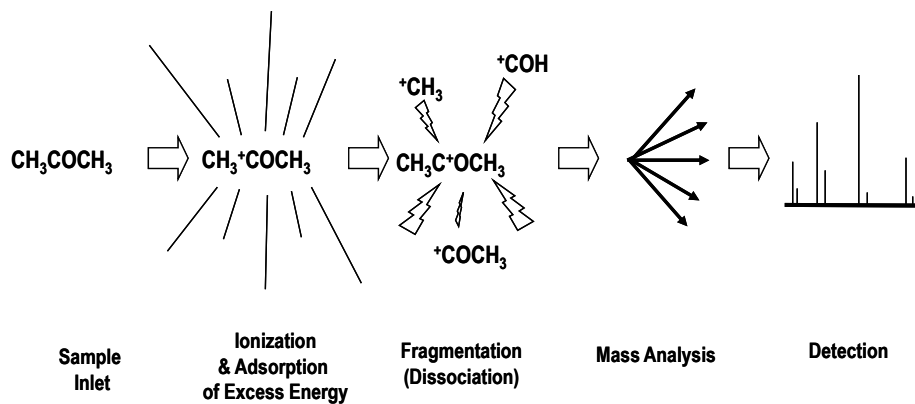
Gas chromatography

- Uses a separation technique to divide the extracts into the component parts
- An inert gas carries the extracts through columns
- Samples separated by boiling temperature and affinity for the column

- Compounds are identified by separation time - retention time
- The retention time is unique and reproducible for each drug in a given chromatographic column

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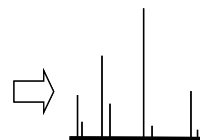
Mass Spectrometry



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Here's the catch...

- Drugs can only be identified if the lab knows “how” to look for them.
- If it is a “new drug” there may be new signal, but it will not be recognized as a drug.
- This makes detection of Designer drugs challenging.



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Storage requirements

- Blood stored for at least one year in a monitored refrigerator
 - Accredited Toxicology labs do this
 - Accredited autopsy facilities do this

Implications for:

- Prosecutions of fentanyl dealers
- Attorneys may ask for longer storage.

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Examples of requests

Dear Sir or Madam:

My firm represents [REDACTED] for a lawsuit in which he was sued for an accident that occurred on [REDACTED]. I understand that Dr. [REDACTED] performed an autopsy on [REDACTED] following the accident, on December [REDACTED]. I have enclosed a copy of the autopsy report, case number [REDACTED], for your reference.

The autopsy report indicates that all wet stock tissue and toxicology specimens collected at the time of autopsy will be retained for 1 year after the date examination unless otherwise requested in writing. Please let this serve as our written request to retain all wet stock tissue and toxicology specimens collected at the time of autopsy until further contact from us. **Please do not destroy or dispose of the tissue or specimens.**

2. Information to be released (check all that apply):

Progress Notes Radiology Diagnostic Tests Billing Records X-Ray Films
 Lab History & Physical EKGs Operative/Procedure Report Discharge Summary
 Complete Medical Record (indicates information regarding insurance, demographics, referral documents and records from other facilities).
 Other: any and all evidence related to [REDACTED] autopsy including but not limited to all slides, paraffin block evidence, physical evidence obtained, all photographs, video, writings, notes, and any and all other evidence.

3. Information is to be released to:

[REDACTED] Esquire
[REDACTED] Esquire
[REDACTED]
[REDACTED]
Philadelphia, PA 19103

4. Purpose of disclosure: Litigation.

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If you are testing at the scene...

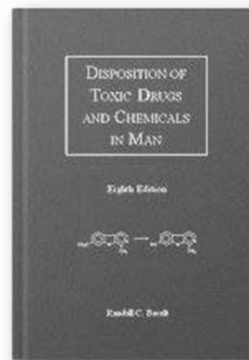
- What are you doing to ensure that the test is accurate?
- Storage of the specimen for further testing?
 - Testing of other drugs?
 - Getting a drug level?
 - Just because a drug is present doesn't mean it is lethal.

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Reading the report

Reference Comments:

1. 6-Monoacetylmorphine - Free (6-MAM; Heroin Metabolite) - Blood
6-monoacetylmorphine (6-MAM) is the 6-monoacetylated form of morphine, which is pharmacologically active. When present, it is generally indicative of heroin (diacetylmorphine) use. 6-MAM has also been reported to occur as an artifact in samples with unusually high blood morphine concentrations.
A healthy man administered 12 mg heroin intravenously achieved peak blood concentrations at two minutes post injection of 150 ng/mL of 6-MAM and 44 ng/mL of morphine, which declined with half-lives of 7 minutes and 33 minutes, respectively.
Eight subjects who died within fifteen minutes of heroin administration had postmortem blood 6-MAM concentrations averaging 19 ng/mL, with a range from less than 1.0 to 82 ng/mL.
2. Acetyl Fentanyl - Blood
Acetyl fentanyl is a novel non-prescription synthetic opioid that has been implicated in several deaths. This fentanyl analog was previously undocumented in illicit drug use and is estimated to be five times more potent than heroin. Several state agencies have issued public health warnings. The Centers for Disease Control (CDC) has recommended increased vigilance by public health agencies, emergency departments, state laboratories, medical examiners, and coroners for patients with symptoms consistent with opioid overdose. It is also recommended that if a fentanyl immunoassay (e.g., ELISA) produces a positive result additional confirmation testing be performed and that this testing should include fentanyl and its analogs, including acetyl fentanyl.
3. Alprazolam (Xanax®) - Blood
Alprazolam is a low-dose benzodiazepine used for the treatment of anxiety disorders and short-term relief of anxiety associated with depressive symptoms. Alpha-hydroxyalprazolam is an active metabolite of alprazolam. They share the actions and adverse reactions of other CNS-depressants. Common adverse effects of alprazolam include drowsiness and fatigue.
Reported therapeutic plasma concentrations of alprazolam are proportional to dose given: 3 mg/day produced steady-state levels of 50 ng/mL, 6 mg/day, 60 ng/mL, and 9 mg/day, 100 ng/mL.



Disposition of Toxic Drugs and Chemicals in Man
Baselt - 9th edition

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Assessing possible drug overdoses

- Did a single drug cause death ?
 - One drug in a high amount
- Metabolism?
 - Amount may be low
 - History is important

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Assessing possible drug overdoses

- Did multiple drugs together cause the death?
 - Same mechanism of action
 - e.g. Central nervous system depressants.
 - May not be in very high amounts

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My Doctor said "Only 1 glass of alcohol a day". I can live with that.

Ethanol



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Ethyl Alcohol (ethanol)

- Product of fermentation of carbohydrate and yeast
- Proof = strength
- Proof is twice the percentage
- 100 proof is 50% ethanol
- Each gram of ethanol = 7 calories

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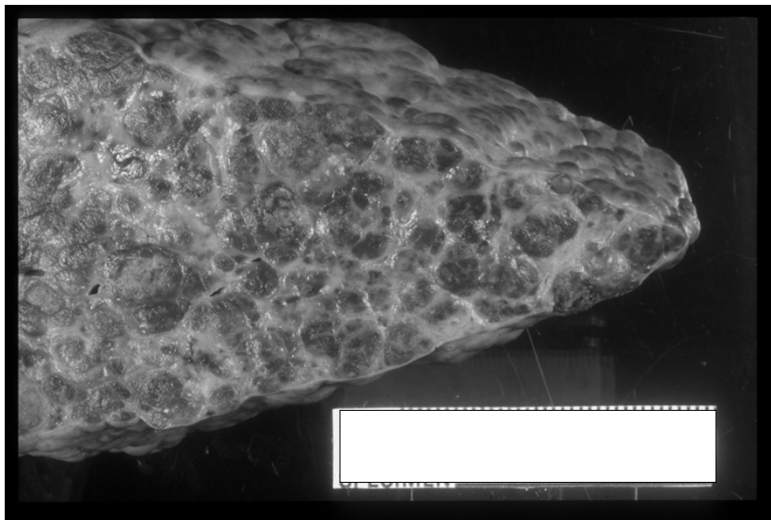
Ethanol

- Produces euphoria
- Tolerance
- Physical dependence
- Effects every organ system
 - Skin, GI, liver, cardiovascular, pancreas
 - CNS - depressant



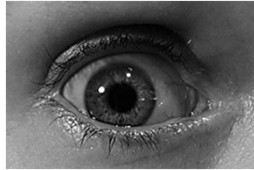
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Cirrhosis of the liver



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How Alcohol Kills: Long Term Effects

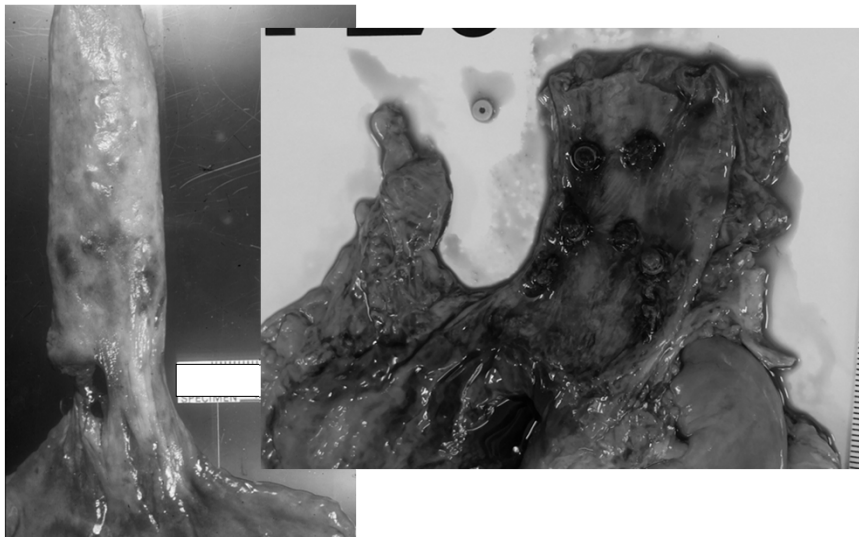


Jaundice



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Esophageal Varices – GI bleed



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Ethanol

- One 1.25 oz drink of ethanol contributes 0.02 g/dl to blood alcohol concentration
- Each hour post drinking 0.015 +/- .5 g/dl is metabolized
- Sort of/almost... everyone is different

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Ethanol effects

- Effects on task performance
- Slurred speech
- Vestibular functioning

- Driving drunk 0.08 g/dl
- Impairment at 0.03 g/dl

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Ethanol

- ~ 80% of single vehicle deaths involve alcohol
- Often seen in combination with other drugs
- Can also have acute alcohol intoxication

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Manner of death - Ethanol

- Effects of chronic ethanol abuse cirrhosis, Gastrointestinal bleed
- Manner - Natural
- Acute ethanol intoxication
- Manner - Accident

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Cocaine

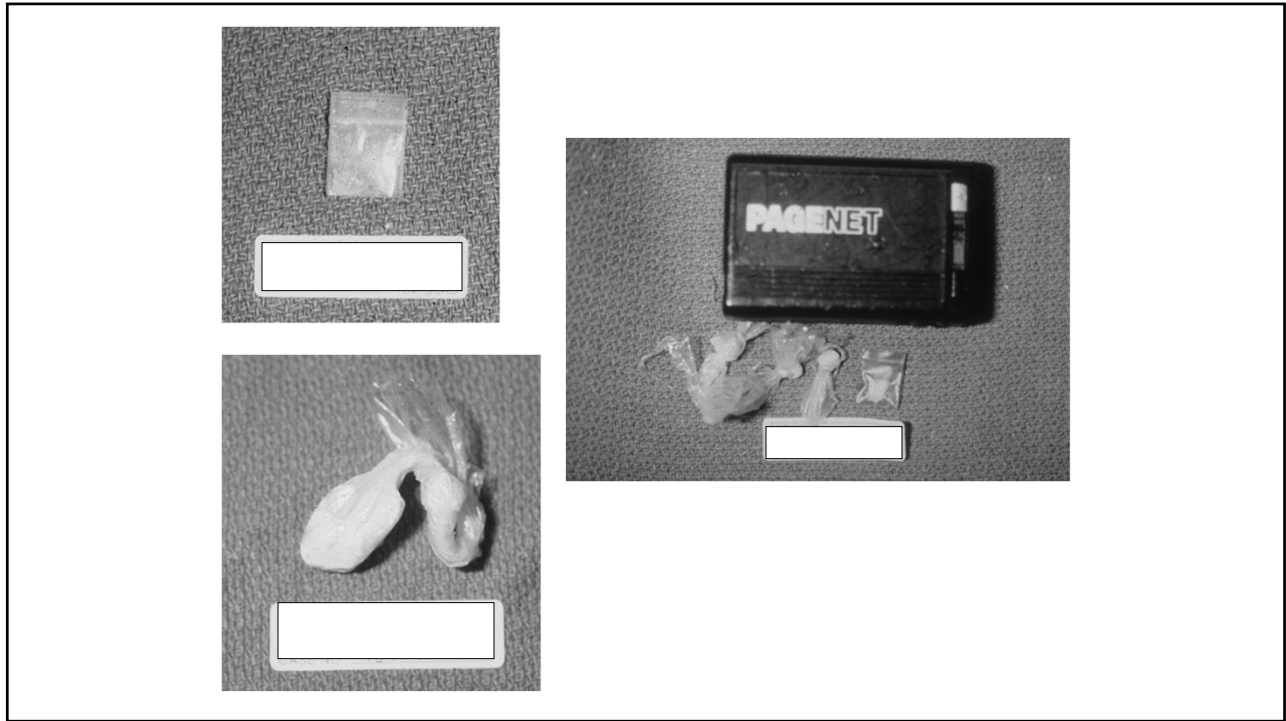


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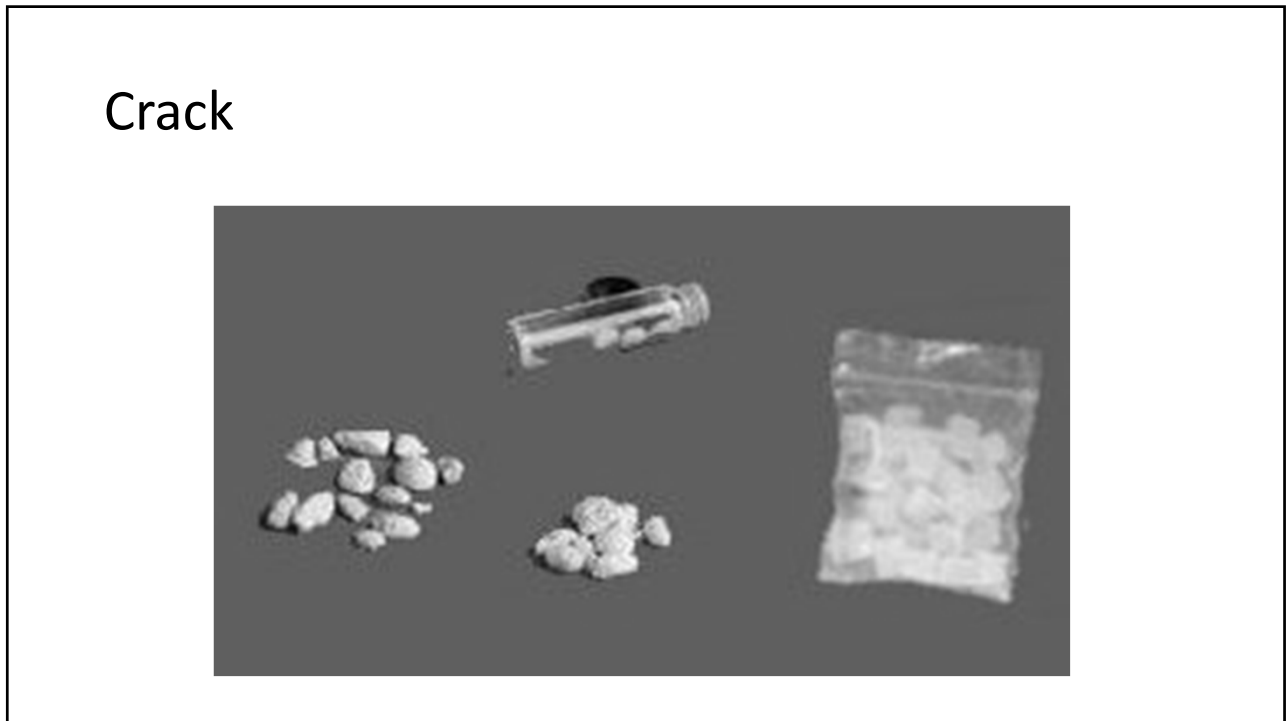
Cocaine - Administration

- "Snorting"
- Intravenous
- Smoking
 - Crack – introduced around 1986

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Cooking cocaine “Crack”

- Made by combining cocaine and bicarbonate (or other)
- Add sterile water
- Boil
- As it cools, forms ‘rocks’

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Effects of Cocaine

- Stimulant, decreased fatigue
- “High” Euphoria, sense of well being

- Hypertension
- Hyperthermia

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Cocaine associated agitated delirium syndrome

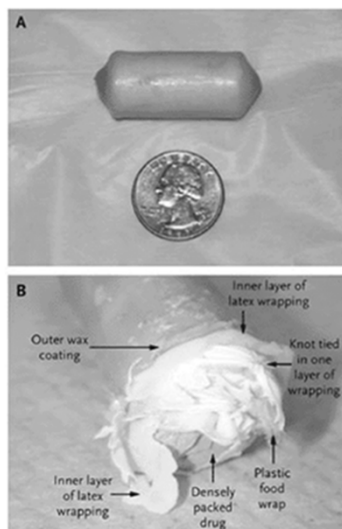
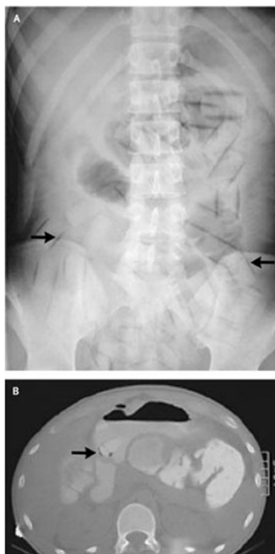
- Hyperthermia
- Agitated psychosis
- Respiratory arrest
- Death

- Related to catecholamine production

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Body packer syndrome

-



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Cocaethylene

- Cocaine and ethanol simultaneously
- Metabolic product in body – more toxic
- More pleasant, longer high
- Modified 'coming down'

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Cocaine metabolites

- Benzoylecognine (BE)
- Ecogoninie methyl ester (EME)

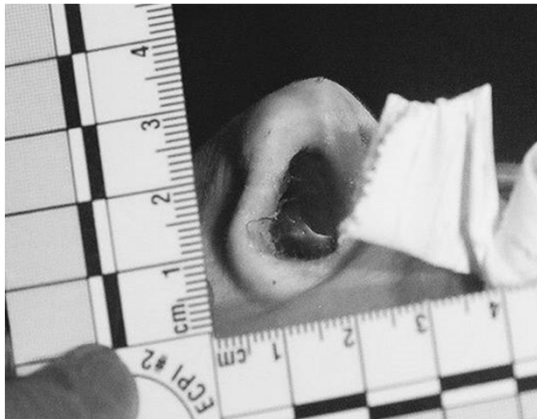
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Physical signs of cocaine abuse

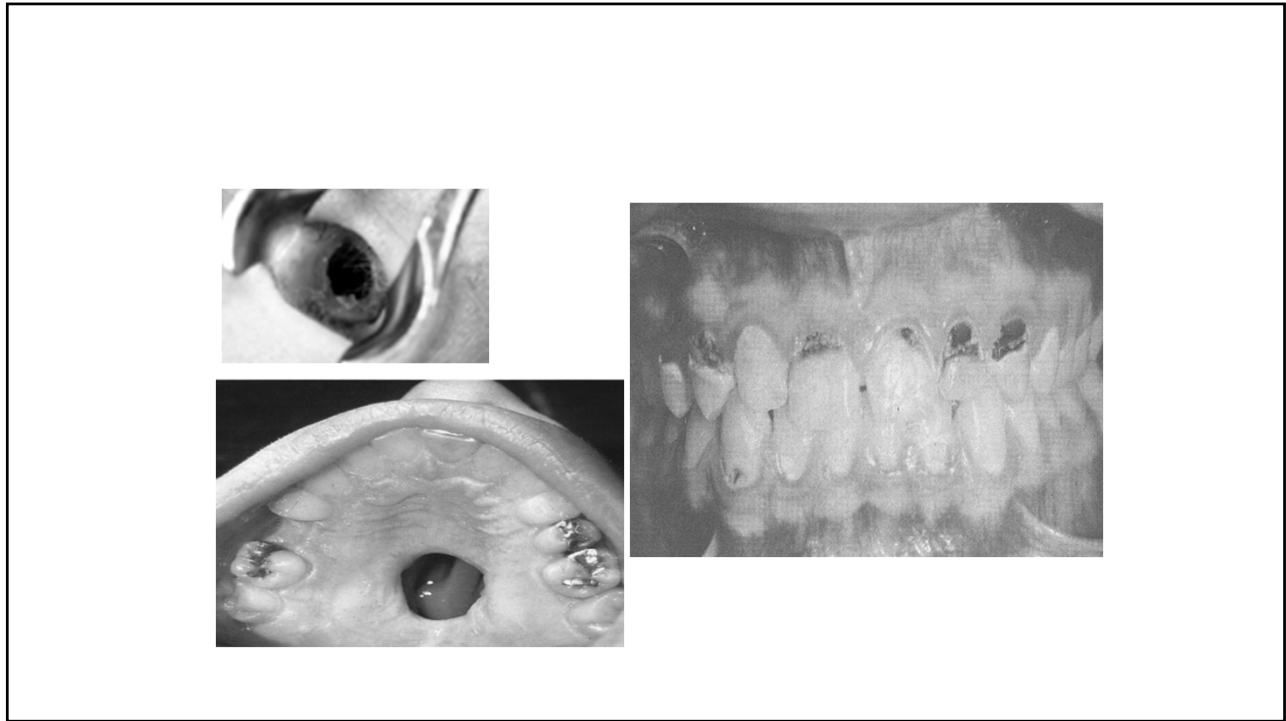
- Perforated nasal septum
- Crack thumb
- Dental erosions

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External Examination: Signs of Cocaine Abuse



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Methamphetamine



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Amphetamines

- Methamphetamines
- Stimulant effects similar to cocaine

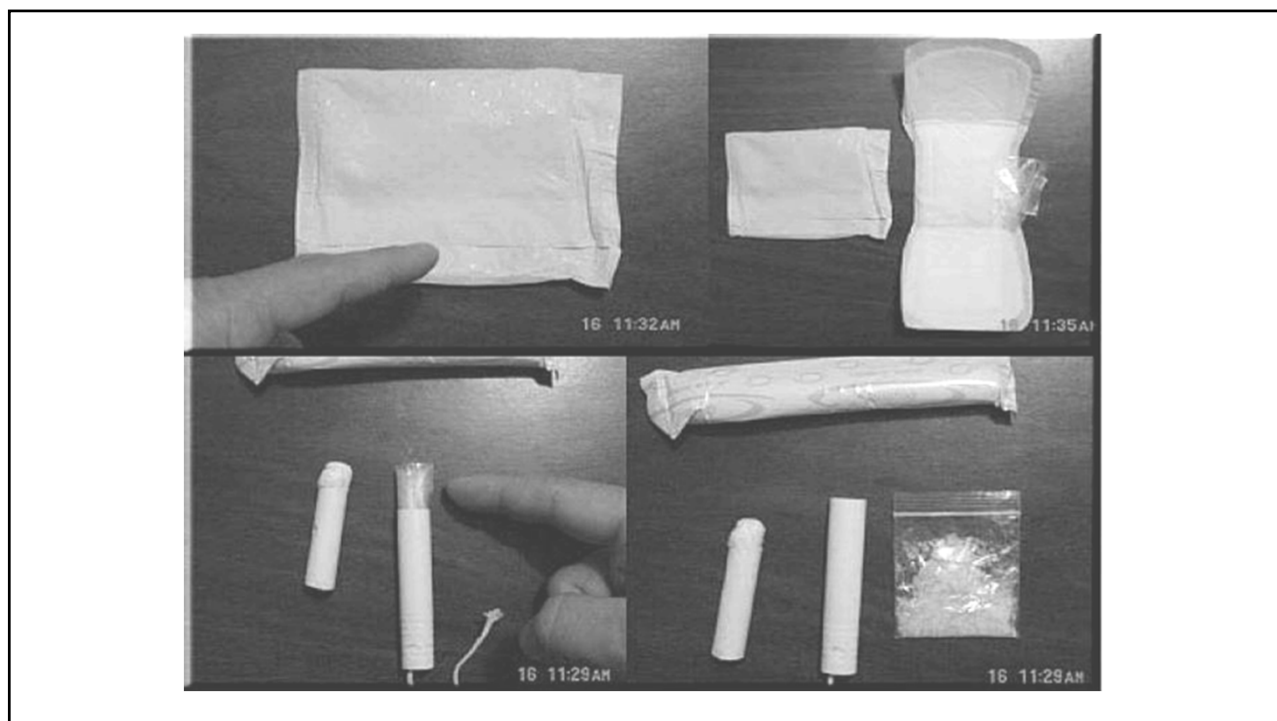
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Methods of administration

- Oral
- Injected
- Smoked
- Snorted



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Meth Labs

- Raids discussed in the news
- Methamphetamine synthesized from ephedrine
- Also used diphenhydramine, chlorpheniramine, dextromethorphan, etc.

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Meth Lab



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Physical Effects

- Euphoria
- Loss of appetite
- Inc. blood pressure - vasoconstriction
- Aggressiveness
- Convulsions
- Stroke – intracerebral hemorrhage
- Any dose can cause death

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Amphetamine psychosis

- More common than cocaine
- Lasts longer
- Longer agitated effects

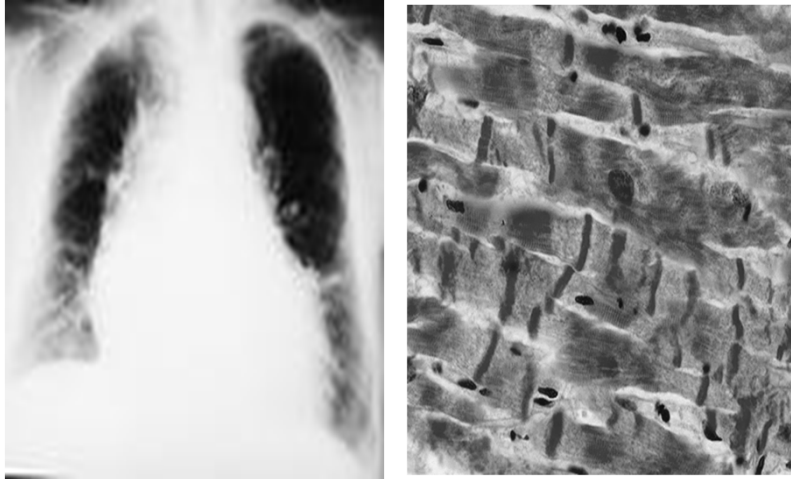
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Toxic dose - Death

- any dose of cocaine or methamphetamine can be cause of death
- Hypertension
- Make any hypertension disease worse.
 - Stroke, heart attack
 - Aneurysm

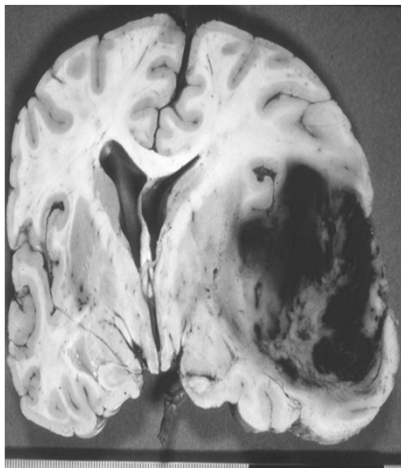
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MYOCARDIAL HYPERTROPHY & INFARCT



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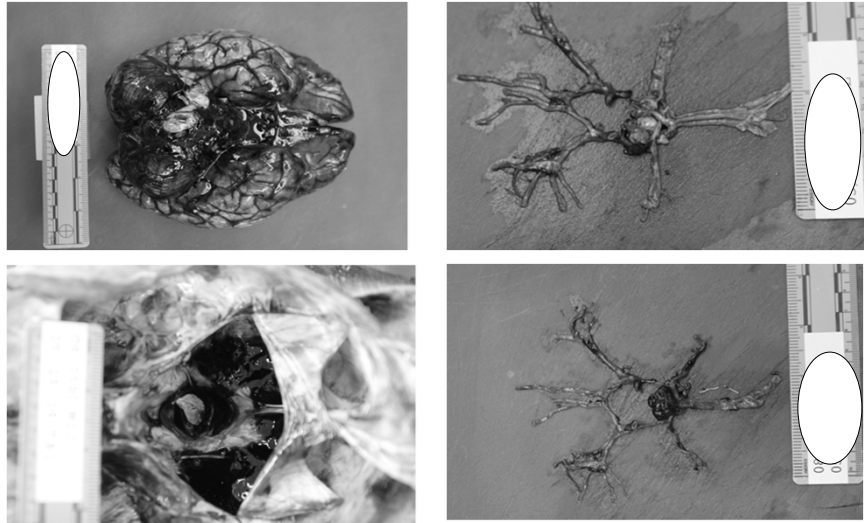
Cerebral infarcts



- Strokes in non drug users –
Usually infarcts
 - Arterial thrombus
 - Embolism
 - Vascular compromise
- Infarcts in cocaine or meth users
 - Hemorrhagic or infarcts
 - With 3 hours or morning after binge
 - Vascular spasm
 - Vasculitis.

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Sudden Intracranial Hemorrhage



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Opiates



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Opioid epidemic - Data from DEA Jan 2023

- In 2020 > 56,000 deaths in US
- Increase of 56% from 2019
- 18x higher than it was in 2013
- Fentanyl largely dominated the category.

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OPIOIDS

- Heroin
- Hydromorphone (Dilaudid)
- Oxycodone (Percocet)
- Hydrocodone (Vicodin)
- Meperidine (Demerol)
- Methadone
- Fentanyl (Duragesic)

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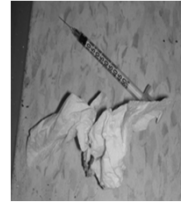
Routes of Administration

- Intravenous
- Subcutaneous (skin popping)
- Oral
- Patch
- Pills

- Varies with type

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SCENE INVESTIGATION



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SCENE INVESTIGATION



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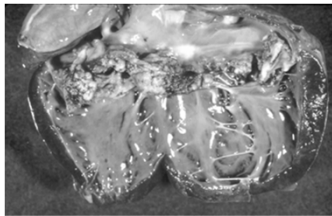
ORONASAL FROTH



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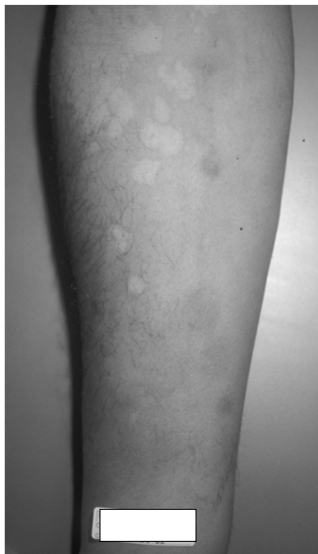
Physical effects

- IV drug use
- Endocarditis (left heart, tricuspid valve)



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External signs of abuse



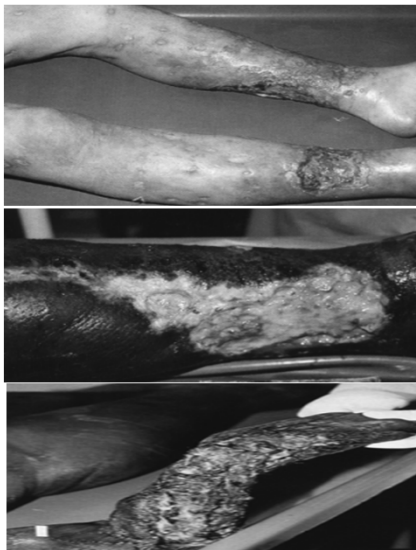
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Examples



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Changes due to skin popping

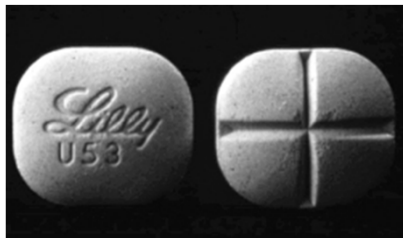


- Cellulitis to Necrotizing Fasciitis.

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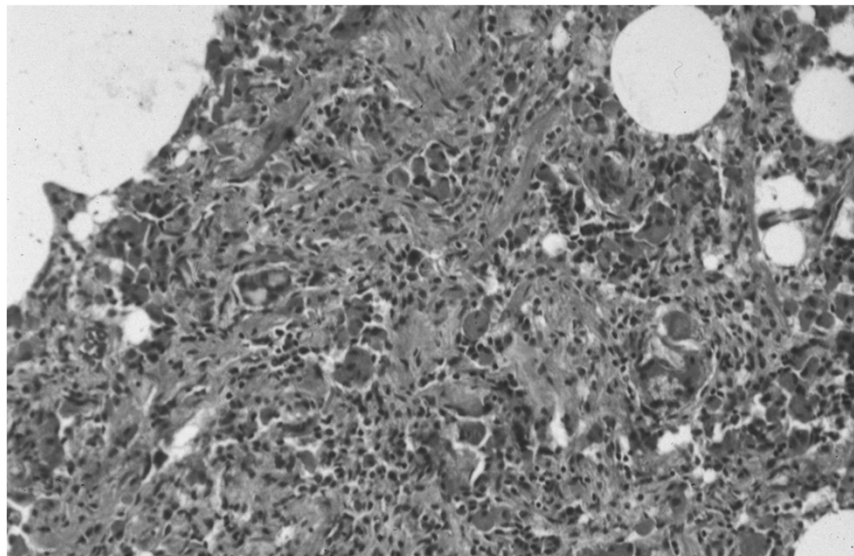
Methadone

- Synthetic
- Introduced in 1965 as maintenance drug for heroin addicts
- Increasingly used for intractable pain
- Can also be cause for overdose



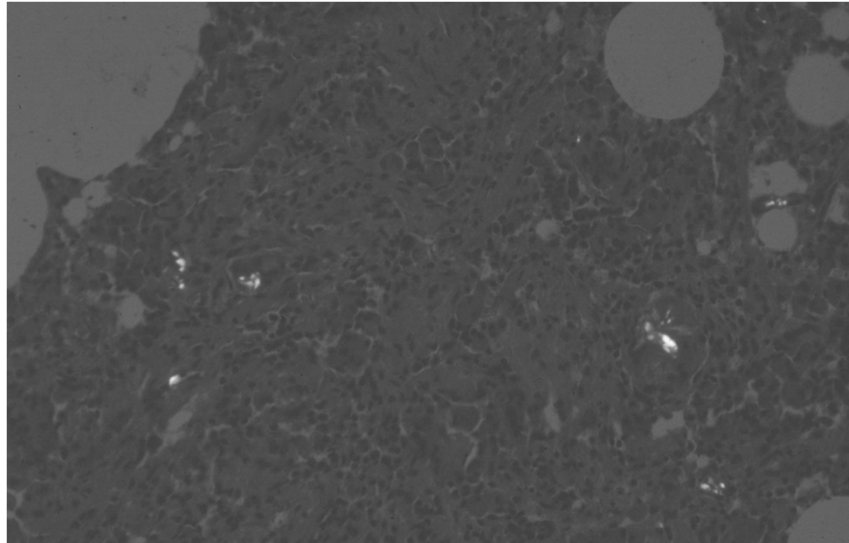
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Lung



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Lung with polarizing particles



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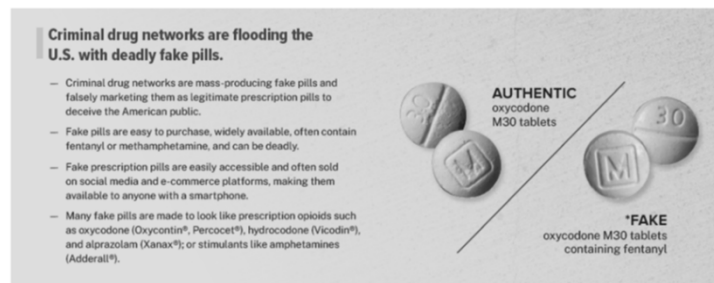
Fentanyl

- Potent synthetic opioid
- 100 times more potent than morphine
- Also more potent than heroin
- Rapid onset and short duration of effects.

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Fentanyl

- Open patches and chew and inject
- Fentanyl pills labeled OxyCodone —DEA fact sheet



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New Fentanyl Certification Guidelines

HB 6— Fentanyl & Death Certificates

HSC § 193.005; Applies only to a death that occurs on/after 9/1/23, or that occurs before that date but is discovered on/after 9/1/23

- Death certificate must include “fentanyl poisoning” or “fentanyl toxicity” if:
 - a toxicology examination reveals a controlled substance listed in Penalty Group 1-B present in the body in an amount/concentration that is considered to be lethal by generally accepted scientific standards; and
 - the results of an autopsy are consistent with an opioid overdose as the cause of death.
- Penalty Group 1-B is found in HSC§ 481.1022, and currently includes fentanyl, alpha-methylfentanyl and any other derivative of fentanyl.

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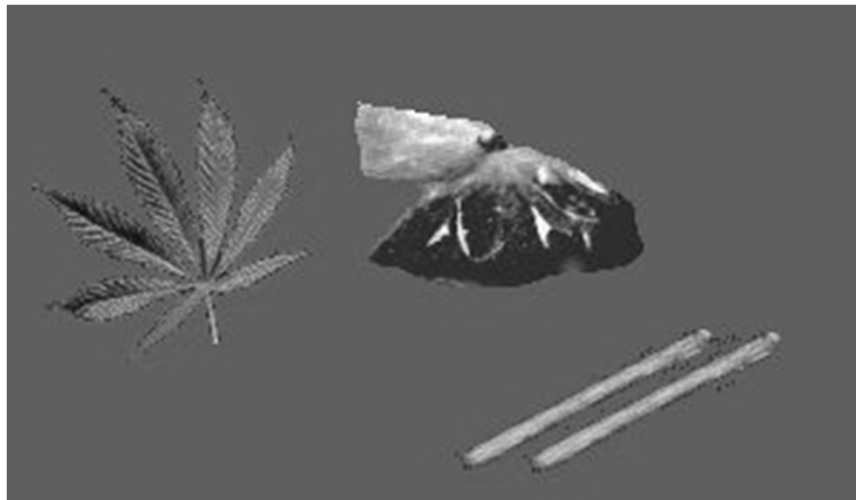
Physical Effects - opiates

- Euphoria
- Nausea
- Constricted pupils
- Constipation
- Sedation
- Decreased heart & respiratory rate

- Death by central nervous system and respiratory depression.

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Marijuana



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Marijuana

- Well-being
- Sedation
- Depersonalization
- Altered perception of time and space
- Hallucinations
- Paranoid ideation



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Marijuana

- Psychomotor and cognitive performance impairment
- Direct cardiovascular effects
 - Tachycardia
 - Blood pressure

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Marijuana- administration

- Smoke dried plant leaves
- Incorporation into food “brownies”, gummies,
- Hashish - resin of plant
 - More potent

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Marijuana

- Active ingredient Δ^9 tetrahydrocannabinol
- Δ^9 THC
- Lipophilic
- Extremely long half life – 28-56 hours

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Synthetic Cannabinoids

- K2/ Spice
- Opposite effects to Δ^9 THC
- Stimulant/ psychoactive substances
- May use with THC or vape



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Synthetic Cannabinoids

- Increased heart rate
- Seizures
- Psychosis
- Anxiety
- Depression
- Similar mechanism of death to Cocaine or methamphetamine.

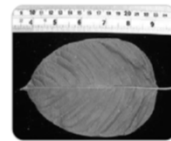
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Kratom

- Not a scheduled drug
- Stimulant effects
 - Tachycardia
 - Vomiting
 - Seizures
 - Delusions



Kratom tree



Leaf of kratom tree



Kratom capsules

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Guidelines for Assessing your cases

Refer to NAME position paper

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Scene is Important

- Any drugs around?
- What is the environment?
- Just because the scene is free of drugs doesn't mean the deceased is drug free.

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Medical History is Important

- Does the decedent have a history of drug use?
- Don't let age be your guide.
 - Numerous cases of 70 yos with methamphetamine.
- What is the medical history?
 - if you are not ordering an autopsy do you have a cause of death if you are sending for tox only?

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Tox on site with Qualitative test?

- Does the specimen need to be stored?
- Will there be future need for quantification? (Actual drug level)
- Are you certain that is the cause?
- Likelihood of prosecution/litigation?

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Physical Findings

- Physical Findings/ Medical conditions may worsen the effects of a drug on the body.

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Manner of death

Accident

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Thank you.

Dr. Amy Gruszecki
drg@usaforensics.com

**American
Forensics**

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