Addendum to “Bath Salts” Video…

☐ As of 2/19/14, “Bath Salts” are illegal in 41 states with legislation pending in others.

☐ In July of 2012 President Obama signed a bill amending federal drug policy to ban “bath salts.”

☐ “Bath salts” are bad news!!! Stay away!
What is toxicology?

- **Toxicology** is the study of drugs and poisons, and their interactions with or effects on the body.
- **Forensic Toxicology** is the application of toxicology to the law, including:
  - Workplace or Forensic Drug Testing
  - Postmortem Toxicology
  - Human Performance Testing

helps determine cause-and-effect relationships between

- Exposure to a drug or other substance and
- Toxic or lethal effects from that exposure
Poisonous substances are produced by plants, animals, or bacteria.

- Phytotoxins
- Zootoxins
- Bacteriotoxins

Toxicant - the specific poisonous chemical.

Xenobiotic - man-made substance and/or produced by but not normally found in the body.
History of Toxicology

- Socrates was one of the earliest reported victims of poisoning, by hemlock, in 399 BC.

- By the 17th century, it was not uncommon for rich European families to use poisoning as a means of settling disputes.
  - Arsenic became known as “inheritance powder.”
History of Toxicology

- **Mathieu Orfila** (1787-1853) is considered one of the fathers of toxicology as he helped to develop a method of chemical analysis to identify arsenic and other toxins in human tissue.

- Today, less than 0.5% of all homicides result from poisoning.
Poison—Murder, Accidental Overdoses, and Drug Offences

• Poisoning causes less than $\frac{1}{2}$ of 1% of all homicides

• Accidental drug overdoses are more common
• Famous accidental overdoses cases: Anna Nicole Smith, John Belushi, Chris Farley, Steve Clark.

• Drug offenders
• More than 50% of the federal prison population
• About 20% of the population in state prisons
You Know?

92% of all poisonings happen at home.

The household products implicated in most poisonings are: cleaning solutions, fuels, medicines, and other materials such as glue and cosmetics.

Certain animals secrete a xenobiotic poison called venom, usually injected with a bite or a sting, and others animals harbor infectious bacteria.

Some household plants are poisonous to humans and animals.
Role of the Toxicologist

- Studies body fluid, tissue, and organs for drugs and/or poisons
- Must detect, identify, quantify, and assess toxicity
  - May have extremely minute quantities to test
- May conduct postmortem pathological examinations, and examination of personal effects and empty containers, etc.
People can be exposed to toxic substances:

- intentionally—by treating illness or relieving pain
- accidentally—by harmful combinations or overdoses
- deliberately—by harming or killing others, or by suicide
Collecting Toxicological Evidence

- When possible, collect both blood and urine
  - Collect two voids (samples) of urine in separate specimen containers
  - Collect a sample of blood if a physician or registered nurse (RN) is available
Drugs

“Drug” can mean different things...

- **Illicit or illegal drugs** that have no accepted medical use in the US

- **Controlled substances**: legal drugs whose sale, possession, and use are restricted because of their effects and the potential for abuse.

Drugs can fall into one of several different classes: **narcotics, hallucinogens, depressants, stimulants, club drugs, and steroids**
Controlled Substances

- Hallucinogens
- Narcotics
- Stimulants
- Anabolic steroids
- Depressants
Types of Drugs: Hallucinogens

- **Hallucinogens** alter the user’s perceptions, thinking, self-awareness, and emotions.
- Often derived from plants
- Some hallucinogens can cause panic attacks, seizures, headaches, and sometimes psychosis that can last for weeks.
- Many hallucinogens, particularly PCP, increase the user’s heart rate, which could lead to heart failure.
**Varieties of Hallucinogens**

- **Marijuana** (from cannabis plant)
  - The most widely used illicit drug in the U.S.
  - Contains tetrahydrocannabinol (THC)
  - Has medical uses such as treating glaucoma and relieving nausea due to chemotherapy

- **MDMA** (“Ecstacy”)

- **Mescaline** (from Peyote cactus)

- **LSD** (Lysergic Acid, or simply “Acid”)

- **PCP** (phencyclidine or “Angel Dust”)

- **Mushrooms** (contain psilocybin)
**Types of Drugs: “Club Drugs”**

- **Club drugs** are called such because they are most often used at nightclubs, bars, and raves (all night dance parties).

- **Varieties of Club Drugs**
  - Methylenedioxymethamphetamine (aka MDMA or Ecstasy)
    - Chronic use can cause body system breakdown, severe brain damage, memory loss, and seizures
  - Ketamine or “Special K” is an animal anesthetic used by veterinarians
Types of Drugs: “Club Drugs”

- **Date Rape Drugs** are called that because they are often associated with drug-facilitated sexual assault, rape, and robbery.
- These drugs can produce increased libido and depress the central nervous system, resulting in loss of consciousness and memory.
- Varieties include **GHB** and **Rohypnol** (also called “Roofies”)
Types of Drugs: Narcotics

- **Narcotics** reduce pain by suppressing the central nervous systems ability to relay pain messages to the brain.
  - Pain relievers are called **analgesics**

- **Narcotics** induce sleep and depresses vital body functions such as blood pressure, pulse, and breathing.
Types of Drugs: Narcotics

- Varieties of narcotics:
  - Opiates: derived from the Asian Poppy
    - Herion, morhpine, codeine
  - Synthetic opiates: man-made
    - Methadone: given to heroine addicts to try and break their addiction
    - Oxycodone (OxyContin or Percocet)
    - Hydrocodone (Vicodin)

- Overdose on narcotics can result in difficulty breathing, low blood pressure, loss of consciousness, and possibly coma and death.
Types of Drugs: Stimulants

- **Stimulants** increase feelings of energy and alertness while suppressing fatigue and appetite.
- Also called “uppers.”
- **Depression** often results as the drug wears off.
- Stimulants are highly **addictive**.
- Overdose can result in irregular heart beat, heart attack, stroke, seizures, coma, and **death**.
Types of Drugs: Stimulants

- **Varieties of Stimulants**
  - **Amphetamines**, also called “speed.”
  - **Cocaine**, including **crack** cocaine
    - Derived from the South American coca plant
    - Addictions to cocaine are very difficult to overcome
  - **Methamphetamines**, also called “meth.”
    - Typically methamphetamines are more potent and dangerous than amphetamines
Meth Addiction
Types of Drugs: Anabolic Steroids

- A chemical structure similar to testosterone
- **Anabolic Steroids** promote cell division and tissue growth
- Athletes may take steroids to increase muscle mass
- Anabolic steroids are chemically related to testosterone
- **Side effects** include liver malfunction, cancer, breast development in males, masculinizing effects in females, diminished sex drive in males, unpredictable moods ("roid rage"), personality changes, depression, hypertension, and high cholesterol
Types of Drugs: Depressants

- **Depressants** are used to relieve anxiety and produce sleep.
- Depressants **reduce body functions** such as heart rate.
- **Overdose** can cause coma and death.
- **Mixing** depressants with other drugs or alcohol can increase their effects and health risks.
Types Of Drugs: Depressants

- Varieties of Depressants:
  - Alcohol
  - Barbiturates: “downers” such as Phenobarbital and Methaqualone (also called Quaaludes, illegal)
  - Anti-psychotic and anti-anxiety drugs including benzodiazepines such as Diazepam (Valium)
  - Inhalants ("huffing")
  - Sedatives, muscle relaxers, etc.
  - Marijuana and opiates (like morphine) are also considered depressants.
Toxicology of Alcohol

- Approximately 40% of traffic deaths in the U.S. are alcohol-related (2008)

- Toxicologists have had to develop specific procedures for measuring the degree of alcohol intoxication

- Methods for diagnosis must be defensible within the framework of the legal system
Toxicology of Alcohol

- Alcoholic beverages contain **ethanol**, also called ethyl alcohol, which is obtained by the fermentation of sugars from grains, fruits, and vegetables.

- Alcohol is a **depressant**, a chemical that slows the heart rate and brain activity, and causes drowsiness.
Alcohol Metabolism

- Alcohol is absorbed through the walls of the stomach and small intestine, and distributed by blood throughout the body.

- In the liver, the enzyme \textit{alcohol dehydrogenase} (ADH) breaks down ethanol into acetylsaldehyde (causes hangovers), then eventually into carbon dioxide and water.

- The liver can normally metabolize 1-2 drinks (15-30 mL or up to 1 ounce) an hour. When a person drinks more than the liver can metabolize, the excess is distributed to the tissues of the body which can damage them.
Alcohol in the Blood

- Blood Alcohol Content (BAC) is usually written as a decimal
  - Example: 0.08
  - This means there are 8 g of alcohol per 10,000 mL of blood; your blood is 0.08% alcohol.

### Effects of Alcohol at Different BACs

<table>
<thead>
<tr>
<th>BAC</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03 – 0.12</td>
<td>euphoria</td>
</tr>
<tr>
<td>0.25 – 0.40</td>
<td>vomiting, loss of bladder control</td>
</tr>
<tr>
<td>0.35 – 0.50</td>
<td>circulatory and respiratory system impairment</td>
</tr>
<tr>
<td>0.40 and up</td>
<td>coma and death</td>
</tr>
</tbody>
</table>
BAC and the Law

- A BAC greater than 0.08 is considered to be “drunk driving”

- **Implied consent** says drivers who receive a driver's license are automatically consenting to be tested for blood alcohol content if a police officer has probable cause.
  - While a driver can refuse to take this test, implied consent laws often automatically revoke licenses on the spot.
Parts of the brain affected by Alcohol

- Alcohol 1st affects the forebrain and moves backward
- Last affected is medulla oblongata
Field Sobriety Tests

- If a police officer smells alcohol on a driver, he/she may perform field sobriety tests, including:
  - Horizontal gaze nystagmus (HGN) test
    - Nystagmus is involuntary jerking movements of the eyes; more pronounced when intoxicated
  - Walk and turn
    - Heel to toe in a straight line, following directions
  - One leg stand
    - Count aloud by 1000’s for 30 seconds or recite alphabet backwards
- Watch walk and turn video
  - https://www.youtube.com/watch?v=5BG48Bt2_u8

- Try it out with a partner
Alcohol Breath Test

- 90% of alcohol is processed by the liver. The remaining 10% is excreted through breath, perspiration, and urine.

- A breath test, such as a Breathalyzer, measures the amount of alcohol in exhaled air.

- The amount of alcohol in breath is 1/2100 the amount in blood.
  - 2100 mL of air has the same amount of alcohol as 1 mL of blood.
Negative Effects of Alcohol

- All alcohols are toxic to the body.

- Consumption of alcohol can lead to liver damage, possibly cirrhosis. Chronic alcohol abuse can lead to Korsakoff’s Syndrome.

- Driving while intoxicated can have deadly results.

- Alcohol may change the effect of medications.

Never consume alcohol while taking drugs with a sedative effect.
Be careful...

- All of these drugs, even the legal ones, can have harmful side effects. Overdose can be deadly.
The Dose Makes the Poison

An apparently nontoxic chemical can be toxic at high doses. (Too much of a good thing can be bad).

Highly toxic chemicals can be life saving when given in appropriate doses. (Poisons are not harmful at a sufficiently low dose).

Adverse effects can also produce toxicity.
## Lethal Doses

**Approximate Lethal Doses of Common Chemicals**  
(Calculated for a 160 lb. human from data on rats)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Lethal Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar (sucrose)</td>
<td>3 quarts</td>
</tr>
<tr>
<td>Alcohol (ethyl alcohol)</td>
<td>3 quarts</td>
</tr>
<tr>
<td>Salt (sodium chloride)</td>
<td>1 quart</td>
</tr>
<tr>
<td>Herbicide (2, 4-D)</td>
<td>one half cup</td>
</tr>
<tr>
<td>Arsenic (arsenic acid)</td>
<td>1-2 teaspoons</td>
</tr>
<tr>
<td>Nicotine</td>
<td>one half teaspoon</td>
</tr>
<tr>
<td>Food poison (botulism)</td>
<td>microscopic</td>
</tr>
</tbody>
</table>
Duration & Frequency of Exposure

Duration and frequency are also important components of exposure and contribute to dose.

Acute exposure - less than 24 hours; usually entails a single exposure, high dose – short period

Repeated exposures are classified as:
Subacute - repeated for up to 30 days
Subchronic - repeated for 30-90 days
Chronic - repeated for over 90 days
Toxins and Poisons

- A **poison** is any substance that causes disturbance to an organism.

- More specifically, a **toxin** is poison produced naturally by an organism.
  - Examples: snake venom, poison ivy
  - Also known as organic toxin
Controlled Substances
—Bacterial Toxins

- **Tetanus** (also called *Lockjaw*)
  - Produced by the Clostridium tetani bacteria
  - Causes violent muscle spasms

- **Botulism**
  - Produced by Clostridium botulinum—botulism
  - Paralyzes muscles
  - Causes irreversible damage to nerve endings
  - Extremely deadly in very small amounts
  - Most poisonous biological substance known to man
Intake of Poisons

- Poisons enter and affect the body in different ways:
  - **Ingestion** (poisons are eaten)
    - 90% of all poisonings involve children swallowing household products or medicine
  - **Inhaled**
    - Example: carbon monoxide, sarin nerve gas
  - **Injected** (puncture, cut, animal bite)
    - Heroine
  - **Absorbed** (through skin, eyes, or mucous membranes)
    - Poison sumac
Poisons: Pesticides

- **Pesticides** are by definition poisons as they are used to kill organisms that threaten plants such as food crops
  - Example: DDT (for mosquitoes)

- These chemicals lead to an excess of the neurotransmitter acetylcholine
  - Overdose can lead to muscle spasms, seizures, anxiety, rapid heartbeat, sweating, diarrhea, and at high concentrations coma and death
Poisons: Heavy Metals

- Metal compounds can enter the body by ingestion, inhalation, or absorption through the skin or mucous membranes.
- Metals are stored in soft body tissues and damage organs.
- Examples: Common Poisons Today
  - Lead
  - Mercury
  - Arsenic
  - Cyanide
  - Strychnine
Poisons: Heavy Metals

- **Arsenic Poisoning**
  - Within 30 minutes: abdominal pain, severe nausea, vomiting and diarrhea, muscle cramps, convulsions, kidney failure, delirium, and death.

- **Cyanide Poisoning**
  - Can be fatal in 6-8 minutes.
  - Signs of poisoning include weakness, confusion, coma, pink skin, and an almond-like odor.
A bioterrorism attack is the deliberate release of viruses, bacteria, toxins or other harmful agents used to cause illness or death in people, animals, or plants. Examples include:

- Ricin
- Anthrax
- Mustard Gas
  - used in World War I
  - A man-made gas
  - Forms large blisters on exposed skin and the lungs
Poisons: Bioterrorism Agents

- **Ricin** comes from castor beans.
  - Can be inhaled as a mist or powder, or ingested in food
  - Amount the size of a pin head can be deadly!
  - Within a few hours of exposure the victim may die
    - If inhaled effects include fever, cough, nausea, sweating, low blood pressure, fluid in the lungs, and death
    - If ingested effects include vomiting diarrhea, dehydration, low blood pressure, hallucinations, seizures, and death
Poisons: Bioterrorism Agents

- **Anthrax** poisoning is caused by the spores of the bacteria *Bacillus anthracis*
- Anthrax can enter the body through inhalation, ingestion, or skin absorption
- Symptoms depend on exposure type:
  - **Inhalation**: flu-like symptoms that become progressively worse and usually result in death.
  - **Ingestion**: vomiting, fever, abdominal pain, and severe diarrhea. 25 - 60% fatal.
  - **Skin**: itchy bumps that develop into sores with a black center. Death is rare with appropriate treatment.
Drug Control Laws

☐ There are varying levels and penalties based on:
  ■ manufacture vs. distribution vs. possession
  ■ type, amount, concentration
The Controlled Substance Act – the federal law that establishes five classifications ("schedules") of controlled dangerous substances on the basis of a drug’s potential abuse, potential for physical and psychological dependence, and medical value.

The U.S. Attorney General has the authority to add, delete, or reschedule a drug as needed.
Controlled Substances Act

Schedule I

- High potential for abuse
- No currently accepted medical use in the U.S.
- Examples: heroin, marijuana (some states), methaqualone, LSD
Controlled Substances Act

Schedule II

- High potential for abuse
- Some accepted medical use with severe restrictions,
- Potential for severe physiological and psychological dependence
- Examples: morphine, cocaine, methadone, PCP, most amphetamine preparations, most barbiturate preparations, and medical marijuana (some states)
Controlled Substances Act

Schedule III

- Less potential for abuse
- Currently accepted medical use
- Potential for low to moderate physiological and high psychological dependence
- All barbiturates not included in Schedule II, such as codeine preparations and anabolic steroids
Controlled Substances Act

Schedule IV
- Low potential for abuse
- Current medical use
- Examples: tranquilizers such as Valium

Schedule V
- Low abuse
- Medical use
- Less potential for dependence than Schedule IV
- Examples: Robitussin cough syrup, non-narcotic medicinal ingredients and some opiate drug mixtures in low concentrations
Criminal Penalties

- Schedule I and II have the most severe penalties
- The Controlled Substance Act controls substances that are chemically similar or related to controlled substances such as “designer drugs”
- It also regulates the manufacture and distribution of chemical compounds used by clandestine labs to make drugs
Testing For Drugs

- Bodily fluids and tissues might be tested for the presence of drugs, especially:
  - **Blood** (drug remains for 24 hours)
  - **Urine** (drug remains for 72 hours)
  - **Hair** (drug is permanently embedded in hair’s protein structure)

- Location along hair shaft gives clues to time of drug use. If drug is found closer to the root, use was more recent.
Testing For Drugs

- There are several types of tests to screen for the presence of drugs
  - **Screening test**: preliminary test that reduces number of possibilities
  - **Confirmatory test**: a single test that identifies a specific substance
  - **Color test**: changes color when a specific substance is present
  - **Microcrystalline test**: identifies drug based on color and shape of crystals formed
  - **Immunoassay**: uses drug specific antibodies to detect low concentrations of drugs
Testing For Drugs

- **Chromatography**: separates a chemical into its components (often different colors) so they can be identified.

- **Spectrophotometry**: Examines the wavelength and frequencies of light absorbed by a substance to identify it.
The Scott Reagent Modified “Scott Test” is a presumptive test designed not only to identify Cocaine but to distinguish the difference between Cocaine HCl (powder) and Cocaine Base (crack or freebase). Cocaine HCl will dissolve a Blue solution in the 1st ampoule, where Cocaine Base will not dissolve and form Blue specks in a Pink solution. Both forms of Cocaine will develop a Pink solution in the 2nd ampoule and a Pink over Blue solution in the 3rd ampoule.
- Watch drug dog video