

# FORENSIC TOXICOLOGY: DETECTION OF HOMICIDAL POISONINGS



Barry K Logan PhD, DABFT,  
National Director Forensic Services, NMS Labs  
and  
Center for Forensic Science Research and Education,

Fredric Rieders Family Renaissance Foundation  
Willow Grove PA

# Forensic Toxicology

# Forensic Toxicology

- The Science of Drugs and Poisons and the Medicolegal consequences of their use
- Did a drug or poison, cause or contribute to, this person's death or intoxication?



# Poisoning

- Can be Accidental
  - Medication overdose or interaction
  - Confusion
  - Snake oil remedies
  - Wrong dosage
- ...or Intentional
  - Suicidal
  - Homicidal



# Death Investigation Team

- Investigator, Pathologist, and Toxicologist



# Role of the Investigator

- Secure the Scene
- Document the scene
  - Photograph
  - Survey
  - Video
  - Describe
- Examine the Scene
  - Wastebasket
  - Drawers
  - Under furniture
  - Storage



# Other Crime Scene Clues

- Odors
- Cleaned up scene
- Staging
- Vomiting, bleeding
- Residues
- Containers
- Paraphernalia
- Caustic or toxic chemicals



# Medical Clues

- Common symptoms in multiple individuals
- Sudden collapse of an otherwise healthy individual
- Nausea
- Vomiting
- Hair-loss
- Shortness of breath
- Metabolic acidosis
- Mees lines
- Change in mental status over time
- Temporal links



# Autopsy Clues

- Injection marks
- Residue in the GI tract
- Esophageal burns
- Hair loss
- No anatomic cause of death
- Pulmonary edema



# Other Investigative Clues

- Suspicious behaviors by family members/caregivers
  - Delay in reporting symptoms
  - Insistence on no autopsy
  - Insistence on rapid cremation
  - Attempts to guide/mislead the investigation
  - Knowledge of, or access to poisons
  - Recent large insurance policies



# The Toxicology Laboratory

# Drug Testing Procedures

- Review the History:
  - Major Trauma
  - Diagnosed and treated illness or disease
  - Palliative care
  - Natural deaths
- Scope can be small, large or selective:
  - Drugs of abuse
  - Alcohol
  - Carbon monoxide
  - Therapeutic drugs
  - Chemical agents
  - Metals/anions
  - Toxins



# Drug Testing Procedures

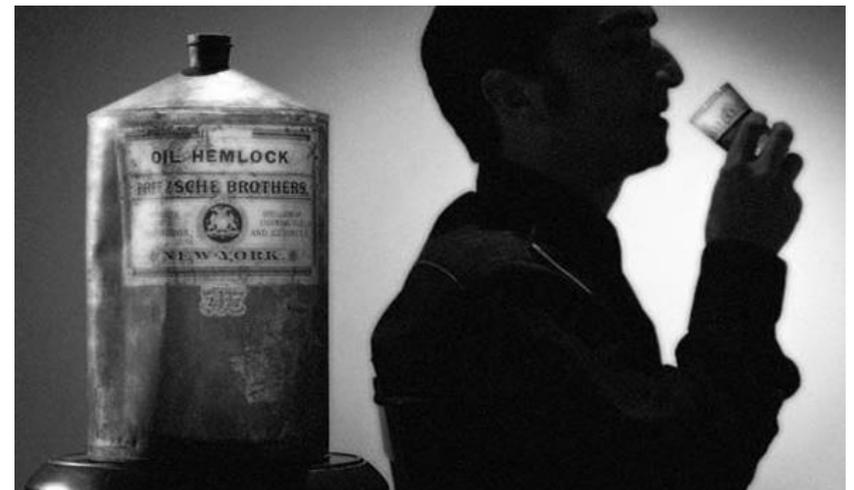
- In a Suspicious Death
  - Alcohol and other volatiles
  - Immunoassay (drugs of abuse and major centrally acting)
    - Opiates, cocaine, amphetamines, designer drugs, benzodiazepines, methadone, tricyclic antidepressants, fentanyl...
  - Chromatography/Mass Spectrometry
    - Acidic and basic compounds
    - Drugs and Chemicals
  - Metals
    - ICPMS
    - OES



# Homicidal Poisons

# Advantages of Poisoning

- Don't have to confront the victim
- The weak can overcome the strong
- No mess to clean up
- Mental distancing from the act
- Stealthy mechanism
- Time to establish an alibi
- Everybody is vulnerable
- No gore for the squeamish
- If at first you don't succeed...



# The Ideal Poison

- Should be obtainable without rousing suspicions
- Should be toxic in small quantities.
- Should be colorless, tasteless, and odorless
- Can be hidden in food or drink
- Should have delayed onset of action
- Should be undetectable
- Should be chemically stable
- Effects should mimic a natural disease



# The “Typical” Poisoner

- Means, Motive, and Opportunity
- Targeting a particular victim or group?
  - Pre-meditated
    - Unhappy marriage
    - Financial motive
  - Crime of Passion
- Random
  - Industrial blackmail
  - Sociopathic poisoning



# Poisoners

# Non-Fatal Poisoning

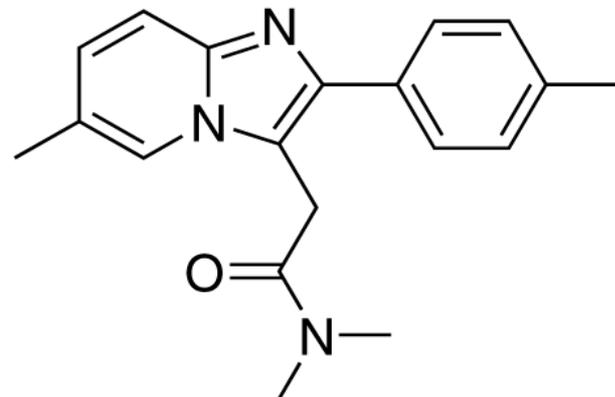
## ➤ R.A., GA, 2010

- Second grade teacher and husband are drinking and argue over his visiting his girlfriends house.
- She puts his sleeping pills in his drink, Ambien, and melatonin, which he drinks.
- Finds residue in his glass and calls 911.
- R.A. is charged with aggravated assault with intent to poison.
- Pleads guilty to a misdemeanor.



# Ambien (Zolpidem®)

- Zolpidem is a sleeping medication
- Pharmacologically related to benzodiazepines
- Has a half-life of 1.5 hours
- It is a basic drug
- Does not cross react on immunoassay tests
- Chromatographs readily by GCMS
- Can be detected in blood or urine



# Non-Fatal Poisoning

## ➤ Tina Beerens, 22, AZ, 2011

- Indicted for attempted first-degree murder, four counts of endangerment, and one count of adding poison to food, drink or medicine
- Beerens, living with her former fiance, his parents and siblings
- Seen carrying a bottle of pest-control poison (Ant Killer or Rat Poison)
- Next day boyfriend gets sick and mother notices unusual taste from the icemaker
- Beerens admits to police putting Rat Poison in the icebox because she wanted to be the mother of her fiance's siblings
- Released on bond, pending trial



# Ant Poison?

- Sodium Borate
- Not a drug
- Does not show up on drug tests
- Relatively non-toxic
- Lethargy, Hypotension
- Drowsiness, Fever, Blisters
- Collapse, Convulsions, Coma



# Rat Poison?

- Anticoagulants
- CoumWarfarin, Brodifacoum, Diphenacoum
- Half-life 14-28 hours
- Work by inhibiting an enzyme that uptakes and reuses vitamin K
- Inhibition results in disruption of clotting pathways
- Internal and external bleeding
- Vomiting, nausea, diarrhea



# Attempted Homicide

## ➤ **Kate Knight, UK, 2005**

- Married seven years, one son
- Disability assessment in 2004 for a trapped nerve
- Mounting debts and loans
- Takes out an insurance policy on her husband
- Researches ecstasy, iron and antifreeze poisoning on the internet
- On seventh wedding anniversary serves her husband 160mL of antifreeze in a curry and red wine
- He lapsed into a coma for ten weeks
- She makes unguarded comments to a neighbor
- Her husband recovers but loses vision, hearing, kidney function
- Sentenced to 30 years imprisonment



# Anti-freeze

- Ethylene Glycol
  - Engine coolant
  - Odorless, colorless, syrupy, sweet-tasting liquid
  - Metabolizes to toxic acid intermediates
    - *Glycolic Acid*
    - *Oxalic Acid*
  - Intoxication
    - Dizziness, incoordination, nystagmus
    - Headaches, increased heart rate, high blood pressure, hyperventilation, and metabolic acidosis



# Homicide and Cover-Up

- **Stella Nickell, Auburn WA, 1986**
  - Grown tired of “boring” marriage
  - Money was a problem
- Takes out an insurance policy on her husband
- Husband collapses and dies at home
- Nickell refuses to come to the hospital
- Coroner rules the death “accidental”
- Under terms of the insurance she stands to receive \$71,000



# Homicide and Cover-Up

- **Stella Nickell, Auburn WA, 1986**
- Victim II: Susan Snow
  - Lived 12 miles from Nickell
  - Took Excedrin from a drug store
  - Found unresponsive at home, never regained consciousness
- Toxicology confirms cyanide poisoning and police link it to the Excedrin
- Nickell calls police to suggest that her husband had taken Excedrin before his collapse
- Two additional tampered bottles are found in stores



# Homicide and Cover-Up

- **Stella Nickell, Auburn WA, 1986**
- Nickell developed as a suspect:
  - Insurance policy
  - She had two lots of tainted medication in her house
  - Cyanide contained traces on an algicide, which Nickell had in her home
  - Nickell's palm prints found in library book on cyanide
  - Husband's signature on insurance policy was forged



# Cyanide

- Sodium/Potassium Cyanide
  - Lab reagent
  - Industrial chemical
- Inhibits Cytochrome Oxidase
- Disrupts oxidative phosphorylation
- General weakness, giddiness, headaches, vertigo, confusion, and perceived difficulty in breathing, metabolic acidosis
- Coma with seizures, apnea, and cardiac arrest within minutes
- Characteristic almond odor
- Detected by color test/spectrophotometry



# Cyanide Copycat

- **Joseph Meling, Tumwater WA, 1991**
- **Case 1:**
- A 38 y.o. white woman collapses and enters coma
- Severe metabolic acidosis, hypertensive shock, and bradyarrhythmia
- Physician suspected cyanide poisoning, and ordered a test
- Level reported back as 6.14mg/L
- Physician notes that lot numbers on Sudafed package and blister pack are different



# Cyanide Copycat

- **Joseph Meling, Tumwater WA, 1991**
- **Case 2:**
- A week later, a second victim collapses at home in Tacoma, WA.
- Severe metabolic acidosis on admission.
- Pathologist orders drug screen and cyanide test.
- Cyanide concentration 6.5mg/L
- Leads to nationwide recall of Sudafed



# Cyanide Copycat

- **Joseph Meling, Tumwater WA, 1991**
- **Case 3:**
- A week later, a 44 y.o. man collapses at home
- Recent history of sinus infection
- Hospitalized in coma with severe metabolic acidosis
- Maintained on a respirator, and organs are harvested and given to 5 recipients
- 28 hour post admission samples 0.34mg/L cyanide



# Cyanide Copycat

- **Joseph Meling, Tumwater WA, 1991**
- Meling had taken out \$700,000 in insurance on his wife.
- Added a \$190,000 accidental death rider.
- Meling phoned 911 and feigned hysteria.
- Stunned doctors treating his wife by suggesting that they should look for signs of cyanide poisoning
- Called the police into her room and declared in front of her family that he expected to be the prime suspect because of the insurance he had purchased.



# Cyanide Copycat

- **Joseph Meling, Tumwater WA, 1991**
- Handwriting evidence linked Meling to a sodium cyanide purchase weeks before the poisoning
- Convicted of 2 counts of homicide, three counts of product tampering, and one count of causing grievous bodily injury
- Sentenced to life imprisonment
- Resulted in elimination of capsules and replacement with caplets and tablets



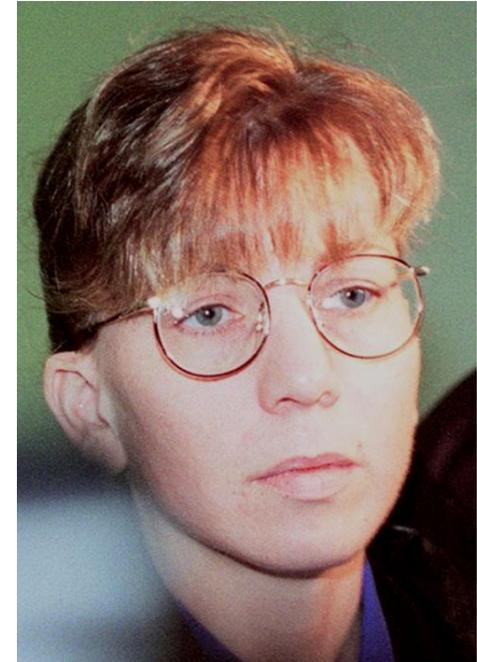
# Thallium

- **Joann Curley, 1991, Wilkes Barre PA**
- Robert Curley, 32 becomes ill, begins a series of hospital stays
- Dies in September
- His doctors went through several diagnoses for his puzzling symptoms, which included peripheral neuropathy, flu-like symptoms, numbness, weakness, repeated vomiting and rapid hair loss
- Diagnosed with Guillian Barre
- A heavy metals test shows elevated Thallium concentrations



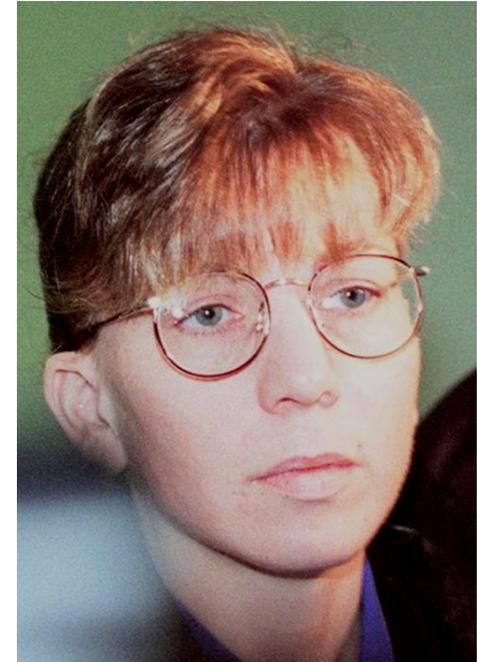
# Thallium

- **Joann Curley, 1991, Wilkes Barre PA**
- A search of his worksite at Wilkes University turned up five bottles of thallium salts
- None of his co-workers had experienced any symptoms from inadvertent thallium exposure.
- The levels measured in Curley at autopsy were so high it was determined that he'd been deliberately poisoned
- His death was ruled a homicide via severe hypoxic encephalopathy, secondary to thallium poisoning



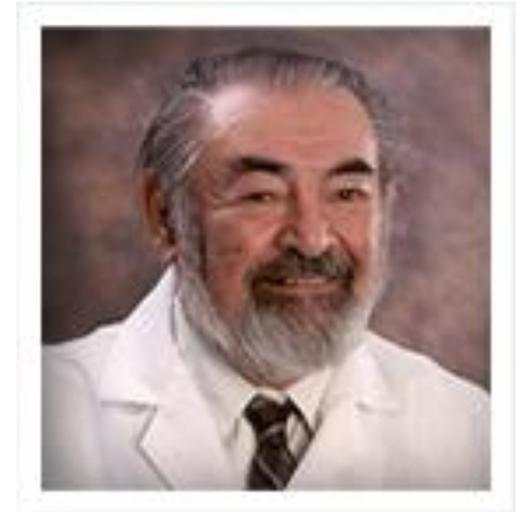
# Thallium

- **Joann Curley, 1991, Wilkes Barre PA**
- Investigators searched the Curley home, where Joann, his wife of 13 months, lived with her daughter from a previous marriage
- They found several thermoses that tested positive for thallium, which Mrs. Curley said her husband used to take iced tea to work
- In addition, tests done on Joann and her daughter showed elevated levels of thallium, but not in such toxic proportions



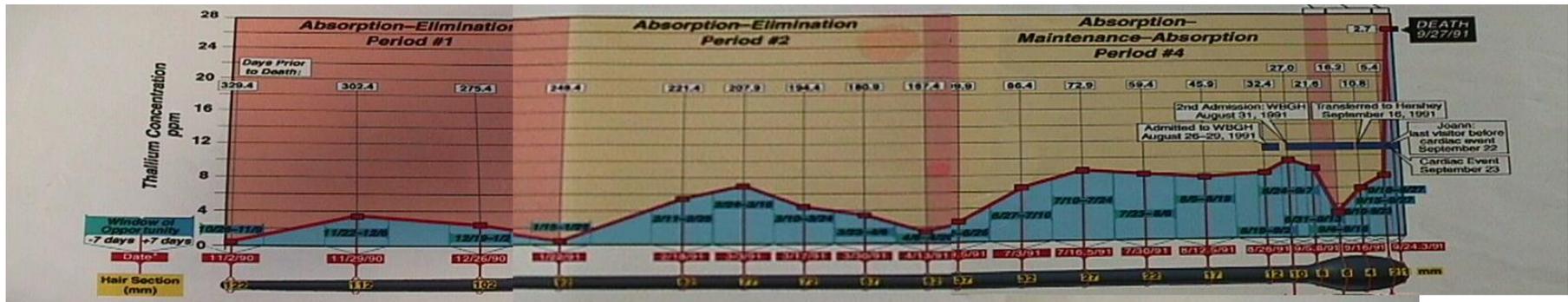
# Thallium

- **Joann Curley, 1991, Wilkes Barre PA**
- Joann Curley won \$297,000 from a wrongful death lawsuit against the University
- Dr Fredric Rieders is approached about doing segmental analysis of the hair from Robert Curley
- Exhumation takes place and segmented hair is analyzed by NMS Labs



# Thallium

- Joann Curley, 1991, Wilkes Barre PA
- Hair analysis shows multiple administrations of thallium in the months leading up to Curley's death
- Exposure began before his work at the University Lab.
- Peaks correspond to hospitalizations
- Massive spike in the days immediately before death
- 



# Thallium

- **Joann Curley, 1991, Wilkes Barre PA**
- Curley confesses to repeatedly poisoning her husband with thallium by administering rat poison in the iced tea she prepared for him to take to work throughout their 13 month marriage
- She feared he was going to use money from an insurance settlement to start a business
- She was sentenced to 10-20 years
- She was denied parole in 2010



# Thallium

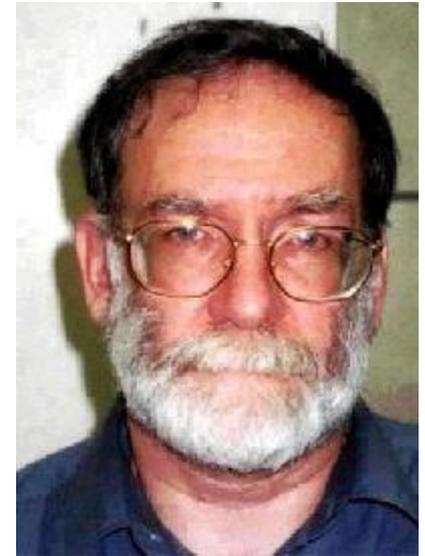
- Thallium
  - Heavy metal
  - Electronics
  - Rat Poison and insecticide
- Tasteless, odorless, water soluble
- $Tl^+$  allows absorption through  $K^+$  pathways
- High affinity for sulphur ligands
- Disrupts many cellular processes
  - Nausea
  - Vomiting
  - Hair-loss
  - Neuropathies



Mercury 80 lg .59 1.9	Thallium 81 TI 204.38 1.8	Lead 82 Pb 207.2
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# Heroin

- **Harold Shipman, UK, 1999**
  - General practitioner
  - Respected community doctor
- A colleague raised the alarm over the high death rates and number of cremation certificates on elderly women being issued
- Kathleen Grundy died in 1998, and a will surfaced naming Shipman as the sole beneficiary
- The signature on the will was found to have been forged



# Heroin

- **Harold Shipman, UK, 1999**
- Toxicology testing revealed the administration of heroin (diacetylmorphine)
- Fifteen other deaths were investigated and linked to Shipman
- He was convicted of all counts and sentenced to life imprisonment
- A subsequent enquiry suggested that he had killed at least 215 of his patients
- Motives for the other cases were never established



# Heroin

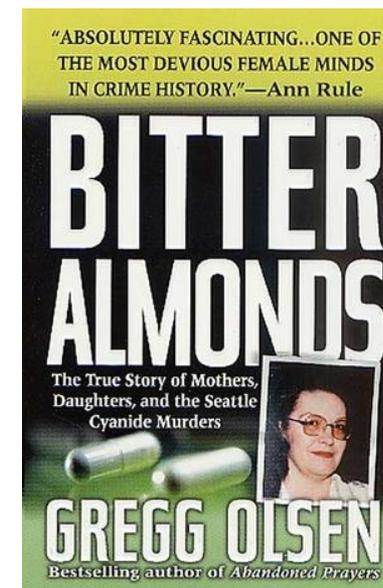
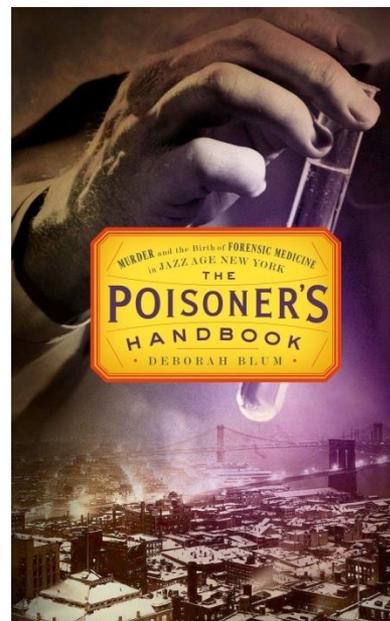
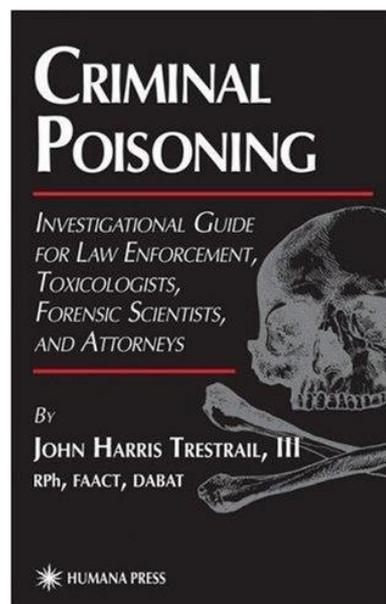
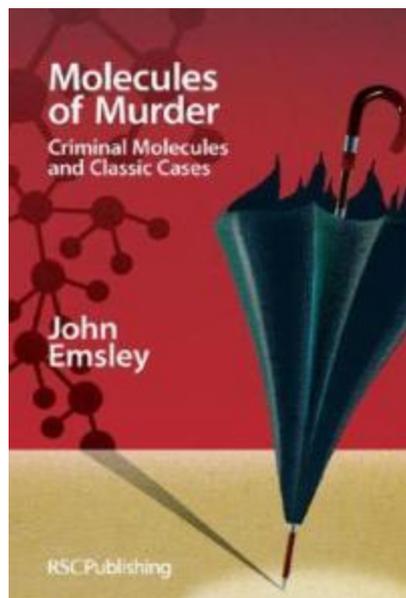
- Potent opiate, with 2-3 times the potency of morphine.
- Metabolized to 6-MAM and morphine.
- Administered typically by injection.
- Causes respiratory and CNS depression, coma, and death.
- Opiate signs are constricted pupils, profound relaxation, sleep, and congested lungs and edema postmortem.
- Detected by immunoassay, and confirmed by gas chromatography mass spectrometry.



# Conclusions

- Poisoning is an infrequent but significant mechanism for homicide
- Thorough investigation of the scene and circumstances, consideration of medical history, and comprehensive toxicology testing is necessary to detect most poisons
- Progressive application of toxicology tests to rule out the obvious agents, progressing to less obvious and considering the symptoms are key

# Resources



THANK YOU!

