Basic Toxicology for the Death Investigator and Medical Examiner

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A people who will not face
death cannot revere life.

Ramsey Clark
Identity of the Deceased
Cause of Death
Manner of Death
Mechanism of Death
Circumstances Surrounding Death

– Interpretation
Cause

The disease or injury responsible for lethal sequence of events.

- drug intoxication
- cardiovascular disease
- infection/neoplasm
- stroke
- gunshot wound
- stab wound
Manner

Explains how cause of death came about

- Natural
- Homicide
- Suicide
- Accident
- Undetermined
Mechanism

Physiological &/or biochemical alteration produced by the cause of death, resulting in death

– Hemorrhage due to stroke, GSW, stabbing
– Anoxic encephalopathy due to drowning
– Septicemia due to bowel perforation

*Modified by circumstances surrounding death
The Death Investigator / ME and:

- The Dead
- Their Families
- Other Medical Personnel
- Law Enforcement
- The Legal Profession
- Organ Procurement Agencies
The teamwork aspect can never be overemphasized, especially in this preliminary examination at the scene.

Vernon Geberth
Conferences and exchanges of information often result in modification of an investigator’s approach to a case or to a particular aspect of it.

Vernon Geberth
In a large proportion of instances, crime can rapidly be excluded in favor of accident, suicide, or even natural causes.

Bernard Knight
Case 1

- 22 year old with history of depression
- Dead at home with multiple rocks of crack cocaine, vials of methamphetamine, bottles of alcohol, and bags of marijuana
- What is the significance of the lesions of the forearm/wrist?
- If you are the primary investigator, whom would you call first for medical records?
Case 1
Case 2

With what causes/mechanisms of death do you associate the finding shown?

Is this finding pathognomonic of any particular disease/condition?
Case 2
Case 3

32 year old male

Found dead in apartment after a “wellness call” 24 hours after last being seen

No anatomic cause of death

What do the items found next to him represent?

What is the most likely cause, manner, and mechanism of death?

What class of medication/drug is most likely involved?
Case 3
Case 4

47 year old female with history of chronic pain
On multiple meds from multiple physicians
Does the fluid from her mouth indicate trauma?
What does the green discoloration of the skin represent?
What cause of death is high on your differential, given no anatomic cause of death?
What is the most likely manner of death?
Case 4
Forensic Toxicology

Not only identification and quantifying of drug, poison, or substance, but also interpretation of such results
Toxic Deaths

- Often determined some time after autopsy
- First suspected because of scene/hx
- If possible, don’t move body until investigator arrives (positional asphyxia, etc)
- Others may have “cleaned up” scene
  - Suicide stigma, illicit drug use
Toxic Deaths

- Pertinent negatives as important as positives
- Best to perform complete autopsy to rule out other causes and to provide tissues/body fluids
- Autopsy also provides extent of disease/injury
  - Death can result from tox + disease/injury
- May see no findings, or may see foam cone, injection sites, needle tracks, pills in stomach
Toxic Deaths

- No boundaries or limits
- Infant drugged to promote sleep
  - Intent? Several cases pending
- Cocaine / meth / opiate abuser
- Chronic pain victim
- Contribution to motor vehicle crashes
- Drugging of homicide victim
Beware: it is not possible to determine precise degree of impairment based on drug concentration

Unlimited variables regarding drug concentrations and their effects, drug interactions, interactions of drugs with disease states
Results of Toxicologic Analyses are correlated with:

- Medical history of the deceased
- Autopsy findings
- Circumstances surrounding death

This is done in order to determine if a substance:

- Is *cause* of death
- *Contributed* to death
- Played *no role* in death
Drug Screening & Confirmation

Screens first, followed by confirmation
Drug Screening & Confirmation

Detection and quantification important, but determining *absence* of drug just as important

Over-the-counter (OTC) meds can also be toxic!
  – Ex: acetaminophen or diphenhydramine in children
Caveat

Do not interpret drug concentrations ("levels" in a vacuum)

- Often see "fatal" drug levels in which drug did not cause or contribute to death

  - Tolerance – habituated person can tolerate drug levels fatal to another

  - ED personnel see addicts and alcoholics who are awake and alert with "textbook fatal" levels
Caveat

Do not interpret drug concentrations ("levels" in a vacuum)

- One can also see relatively "low" drug levels in cases in which intoxication ("OD") was the cause of death
  - Respiratory failure with opiates, prolonged agonal period with metabolism of drug
  - Special case of sympathomimetics eg cocaine and meth
Ethanol (Alcohol)

- Most commonly abused drug
- 12 oz beer = 6 oz wine = 1.5 oz 90 proof spirits
- Peak blood levels in $\frac{3}{4}$ to two hours
Ethanol

- Impairment at as little as 0.02 gm/100 ml
- Reaction time markedly impaired at 0.07
- Illegal *per se* to operate vehicle at 0.08
  - Australia 0.05, Japan 0.03, Norway 0.02, Czech Republic 0.00
- Gross intoxication at 0.20
- Many lose consciousness at 0.30
- Many die at > 0.35 – mechanism of death is respiratory and CNS depression
Ethanol

- Alcoholics can mask impairment to a degree
- Average person metabolizes EtOH via zero-order kinetics at 0.015 – 0.02 / hr
- Alcoholics may metabolize circa 0.03 / hr
- COD not always apparent in chronic alcoholics (next slide)
Ethanol

- May see sudden death w/ negative autopsy
- May be related to alcoholic ketoacidosis
  - Binge drinking followed by anorexia
- Mechanism may be hemodynamic collapse assoc w/ critical fall in blood pH
- Ketone bodies in blood/vitreous
  - β-hydroxybutyrate marker of choice for PM dx
- Alcohol withdrawal seizures, delirium tremens
- Check for empty containers of mouthwash, hairspray, etc
Other Drug Abuse

Check for paraphernalia at scene
- Syringes, needles, spoon “cookers,” small cooking sheets, lighters, bongs, crack pipes

Drugs may be ingested in unusual manners
- Opioids, esp “time release,” ground and injected percutaneously or insufflated (“snorted”)
- Fentanyl patch: applied or ground
Opioids

- The oxycontin “explosion”
- Oxycodone, methadone, morphine, hydrocodone
  - Respiratory suppression, especially with alcohol
- By mouth, percutaneous (IV, subQ), insufflation, cooked & inhaled (“chasing the dragon”)
Heroin

- Suburban drug, not just inner city
- Often, needle still in arm
- Foamy pulmonary edema ("foam cone")
- Needle site, scars, tracks
- 6-monoacetylmorphine (6-MAM) specific for heroin
- Metabolized quickly to morphine
Heroin

- Necrotizing fasciitis ("flesh-eating" bacteria)
- Bacterial endocarditis
- Pulmonary abscesses
- Septic emboli
  - Cerebral and other abscesses
- Hepatitis, HIV, others
Cocaine

- Inhibits synaptic reuptake of epinephrine, norepinephrine, serotonin, dopamine
- Stimulates presynaptic release of norepinephrine
- Vasoconstrictor, enhances in situ thrombosis and platelet aggregation
- No minimum fatal level established: mere presence of cocaine or one of its metabolites (benzoylecgonine, ecgonine methyl ester) may indicate cocaine-related death
Cocaine

“intoxication” therefore better than “overdose”

Cocaine + etoh = cocaethylene
  – Longer half-life (> 1 hr) than cocaine
  – Dysrhythmogenic

Cocaine can be secreted in breast milk, along with: PCP, amphetamine, heroin, cannabis, others
Cocaine

- Excited delirium (cocaine psychosis)
- Bizarre behavior with hyperactivity and hyperthermia
- Cocaine-induced dysregulation of CNS dopamine homeostasis
- Not unusual for these individuals to die when taken into custody, opening multiple questions
Cocaine

Must consider total circumstances

Moment-by-moment reconstruction of incident

Autopsy findings, medical history, witness statements, complete toxicologic analysis

Death often attributed to combination of factors, including cocaine and/or other drug toxicity, obesity, ASCVD, HTN, physical injury/stress, various means of asphyxiation, eg traumatic and positional
Methamphetamine, Amphetamine, Derivatives

- Increases norepinephrine release, which increases sympathomimetic effects
- Promotes release of dopamine, serotonin
- Similar to cocaine intoxication
- No minimum concentration needed to explain death, no correlation of levels with impairment or death
- Cases overlap cases where drug present but not causal
Methamphetamine, Amphetamine, Derivatives

- Like cocaine, may cause death by stroke, seizure, dysrhythmia, excited delirium
- Qualitative presence alone, in lieu of other findings, explains death
- Hyperthermia, tachycardia, HTN, rhabdomyolysis, DIC, death
- Same with “designer drugs” eg MDMA (Ecstasy), MDEA (Eve)
- If meth and amph both detected, amphetamine considered a metabolite of methamphetamine
  - Amph sometimes Rx’d for narcolepsy, obesity, ADHD
Hallucinogens

- Alter perception of reality
- LSD – lysergic acid diethylamide
- PCP – phencyclidine
- Mescaline – from peyote cactus; legal in some Native American services
- Psilocybin – from mushrooms

Rarely *directly* cause death, though PCP may cause resp depression, coma, sz, hyperthermia with rhabdomyolysis
Marijuana

- Most widely used illicit drug in the world
- No known death due to direct toxicity or withdrawal

Harper’s April 2016
Gamma-hydroxybutyrate

- GHB used as bodybuilding agent, growth hormone stimulator, narcolepsy tx, “rave” drug, date-rape drug
- Depressive effect on CNS
  - Respiratory depression, coma, death
- Normally in low levels in the living
- Artifactually in high levels in decomposed bodies
Gamma-hydroxybutyrate

- Can be detected and quantified in urine
  - more reliable, as GHB not formed *de novo* in bladder
- As with many drugs, even if concentration does not seem fatal in itself, combination with alcohol or other depressants may be fatal
- Often not in routine screens, so high index of suspicion should be maintained
  - “club scene,” “rave crowd,” suspected date rape
Other Drugs

Desire to abuse drugs limited only by imagination and resources

New drugs constantly appear, older ones fade and then reappear from use, eg heroin

Trends always change in response to geography, interdiction efforts
  – Like “stepping on a balloon”
  – Cigarettes laced with embalming fluid, PCP
  – Huffing
Body “Stuffer” vs “Packer”

- Ingested for concealment
- Stuffer: not packaged with intent of being ingested, but hurriedly swallowed to escape detection
- Packer: carefully packaged with intent of being swallowed and carried “internally” into a jurisdiction
- Both hazardous and may lead to death intoxication via leakage
Interpreting Drug Concentrations

Chronicity of drug use/abuse

– May lose tolerance with discontinuation of use, eg rehab
– Individual often dies when released from jail or rehab, then takes former dose
– Drug levels must be interpreted in overall context of clinical history
– Cross-tolerance between opioids
Drug Metabolites

- Much higher level of parent drug – acute toxicity
- Higher metabolite – less recent ingestion
- High levels not necessarily recent consumption
  - Liver failure, renal failure
- Normeperidine more toxic than meperidine
  - Longer half-life, convulsant
In Summary

- Toxicologic report is only a printed list of drugs detected and their concentrations.
- Do not take numbers at face value without consideration of the context of the case.
- Drug levels may be artifactually changed, e.g., by postmortem redistribution.
- Drug-drug interactions may occur.
- Idiosyncratic/anaphylactic reactions to drugs may occur.
In Summary

- Take into account the chronic drug user and differences such victims may present to the investigator.
- Be wary of hasty MOD determinations (suicide, accident, homicide, natural).
- Be aware of natural disease, injury, use/abuse history, scene investigation, & circumstances of death when deciding whether drugs caused or contributed to death.
In Summary

- Drugs may be the cause of death
- Drugs may have played minor role in death and therefore be listed as a contributory condition
- Victim may have died with the drugs in their system but not from the them; therefore, in such a case the drugs played no role in the death