

A Lawyer's Guide to Drug Testing: What the Various Tests Do & Don't Tell

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Tests Tell Us Nothing
Test Data Do Not Speak For Themselves
We Draw Conclusions From Test Data

23°

$$PV=nRT$$

$$n = 6.02214076 \times 10^{23} \text{ mol}^{-1}$$

$$R = 8.21 \times 10^{-2} \text{ L atm/mol K}$$

Drug Testing

- Purpose
- Venue
- Execution

Drug Testing

- Purpose
 - Health
 - Performance
 - Ingestion/Exposure
- Venue
- Execution

Drug Testing

- Purpose
- Venue
 - Personal
 - Diagnostic
 - Administrative
 - Evidential/Forensic
- Execution

Drug Testing

- Purpose
- Venue
- Execution
 - Analysis
 - Analytes
 - Substances detected with analysis
 - Specimens
 - Interpretation

Drug Testing

- Purpose
- Venue
- **Execution**
 - Analysis
 - Analytes
 - Substances detected with analysis
 - Specimens
 - Interpretation

Analysis Basics



Analysis Basics

- Presumptive Testing
 - Bulk specimen analysis
 - Hand-held, spot tests
 - “Strip” immunoassays
 - Typically limited to urine testing
 - Blood
 - Evidential/Forensic



Analysis Basics

- Presumptive Testing
 - Instrumental immunoassays
 - Large-scale testing

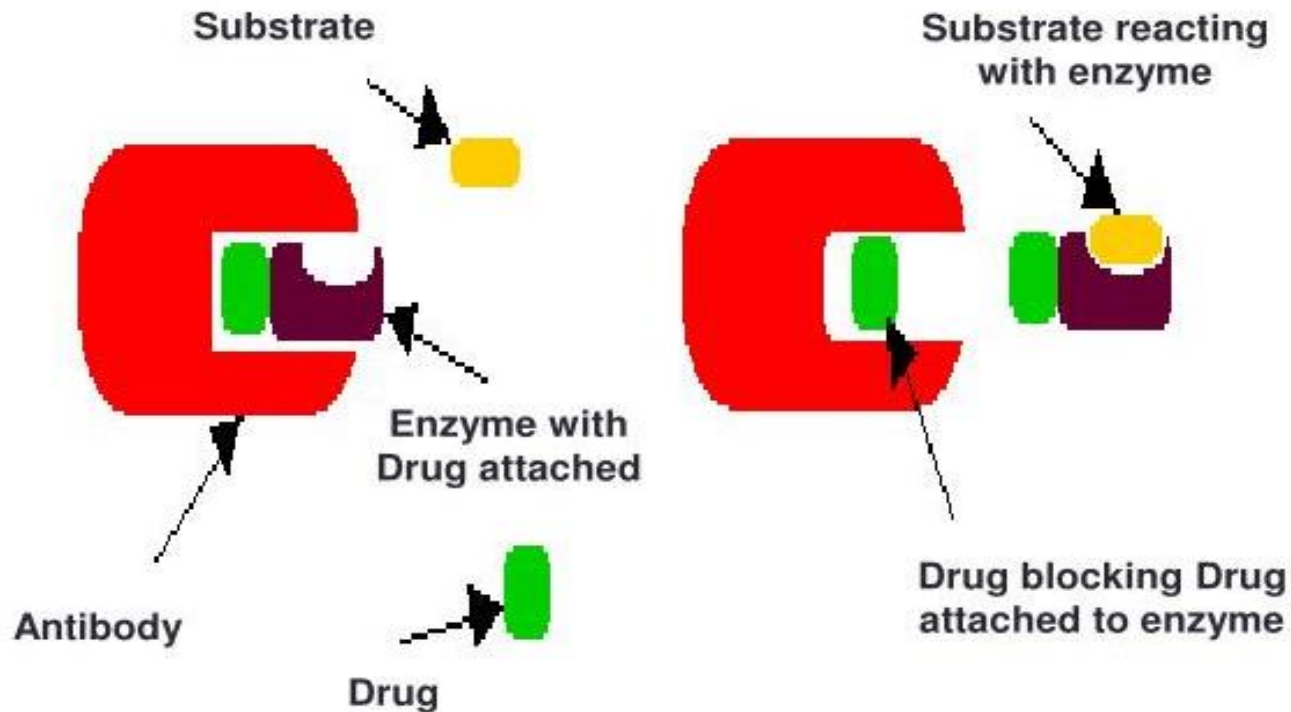


Analysis Basics

- Presumptive Testing
 - Immunoassay
 - EMIT, EIA, ELISA
 - Antibody directed to a target analyte structure
 - Antibody fixed to a solid sorbent
 - Substances with structures similar to the target analyte bind with the antibody-sorbent
 - Substances other than the target analyte may bind
 - Unbound materials and waste are washed away

Analysis Basics

- Presumptive Testing
 - Immunoassay example (homogeneous)



Analysis Basics

- Presumptive Testing
 - Immunoassay
 - Sum total of sorbent-bound substances are “quantified” relative to a single target analyte concentration
 - Substances other than the target analyte may bind
 - If response meets assigned cutoff - POS
 - If response fails to meet assigned cutoff - NEG

Analysis Basics

- Presumptive Testing
 - Immunoassay
 - Pros
 - Fast
 - Cheap
 - No expertise required (non-instrumental methods)
 - » Easy to interpret NO/YES
 - Cons
 - Class-specific only
 - Substances other than the target analyte may bind
 - » Antigen-antibody recognition is not definitive
 - Interferents

THC - Substances or Conditions which can cause false positives

Dronabinol (Marinol)

Ibuprofen (Advil, Nuprin, Motrin, Excedrin IB etc)

Ketoprofen (Orudis KT)

Kidney infection (Kidney disease, diabetes) Liver Disease

Naproxen (Aleve)

Promethazine (Phenergan, Promethegan)

Riboflavin (B2, Hempseed Oil)

<http://www.passyourdrugtest.com/false-positives.htm>

Amphetamines - Substances or Conditions which can cause false positives

Ephedrine, pseudoephedrine, propylephedrine, phenylephrine, or desoxyephedrine

(Nyquil, Contact, Sudafed, Allerest, Tavist-D, Dimetapp, etc)

Phenegan-D, Robitussin Cold and Flu, Vicks Nyquil

Over-the-counter diet aids with phenylpropanolamine (Dexatrim, Accutrim)

Over-the-counter nasal sprays (Vicks inhaler, Afrin)

Asthma medications (Marax, Bronkaid tablets, Primatine Tablets)

Prescription medications (Amfepramone, Cathne, Etafediabe, Morazone, phendimetrazine, phenmetrazine, benzphetamine, fenfluramine, dexfenfluramine, dexdenfluramine, Redux, mephentermine, Mesocarb, methoxyphenamine, phentermine, amineptine, Pholedrine, hydroymethamphetamine, Dexedrine, amifepamone, clobenzorex, fenproporex, mefenorex, fenelylline, Didrex, dextroamphetamine, methphenidate, Ritalin, pemoline, Cylert, selegiline, Deprenyl, Eldepryl, Famprofazone) Kidney infection, kidney disease, Liver disease, diabetes

<http://www.passyourdrugtest.com/false-positives.htm>

Opiates - Substances or Conditions which can cause false positives

Poppy Seeds

Tylenol with codeine

Most prescription pain medications

Cough suppressants with Dextromethorphan (DXM)

Nyquil

Kidney infection, Kidney Disease

Diabetes, Liver Disease

<http://www.passyourdrugtest.com/false-positives.htm>

Cocaine - Substances or Conditions which can cause false positives

Kidney infection (kidney disease)

Liver infection (liver disease)

Diabetes

Amoxicillin, tonic water

<http://www.passyourdrugtest.com/false-positives.htm>

Analysis Basics

- Presumptive Testing
 - Immunoassay
 - Response may be due to multiple bound substances, not a single substance
 - Could include the target analyte, could include interferents
 - Quantification is solely intended to meet a cutoff concentration for positive/negative, not to quantify a specific target

Analysis Basics

- Definitive Testing
 - Analyte resolution
 - Sample preparation
 - LLE, SPE
 - Chromatography
 - GC, LC
 - Analyte identification
 - Molecular identification
 - MS, MS/MS
 - GC/MS, LC/MS/MS

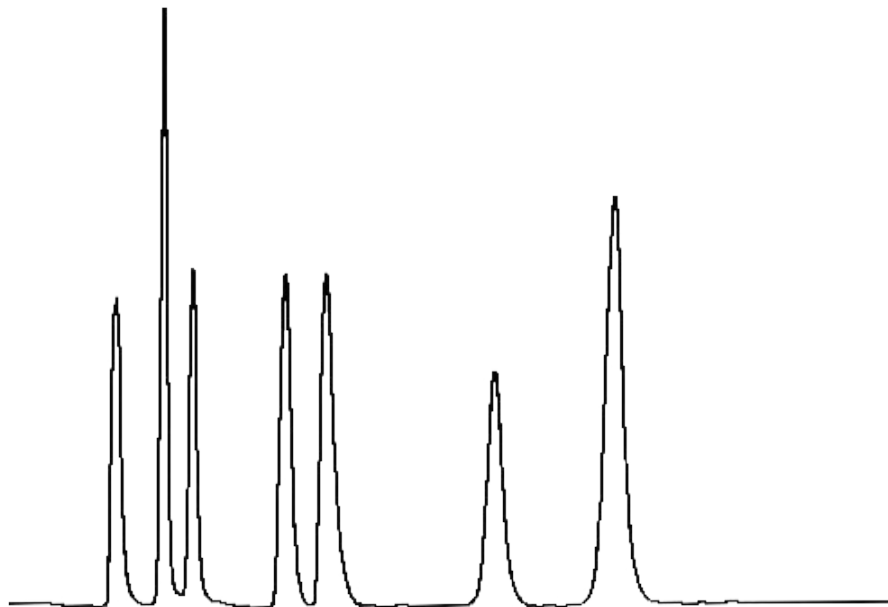
Analysis Basics

- Analyte Resolution
 - Sample preparation
 - LLE, SPE
 - Specimens extracted
 - Organic solubility
 - Ionic transformation (pH)
 - Unwanted materials discarded



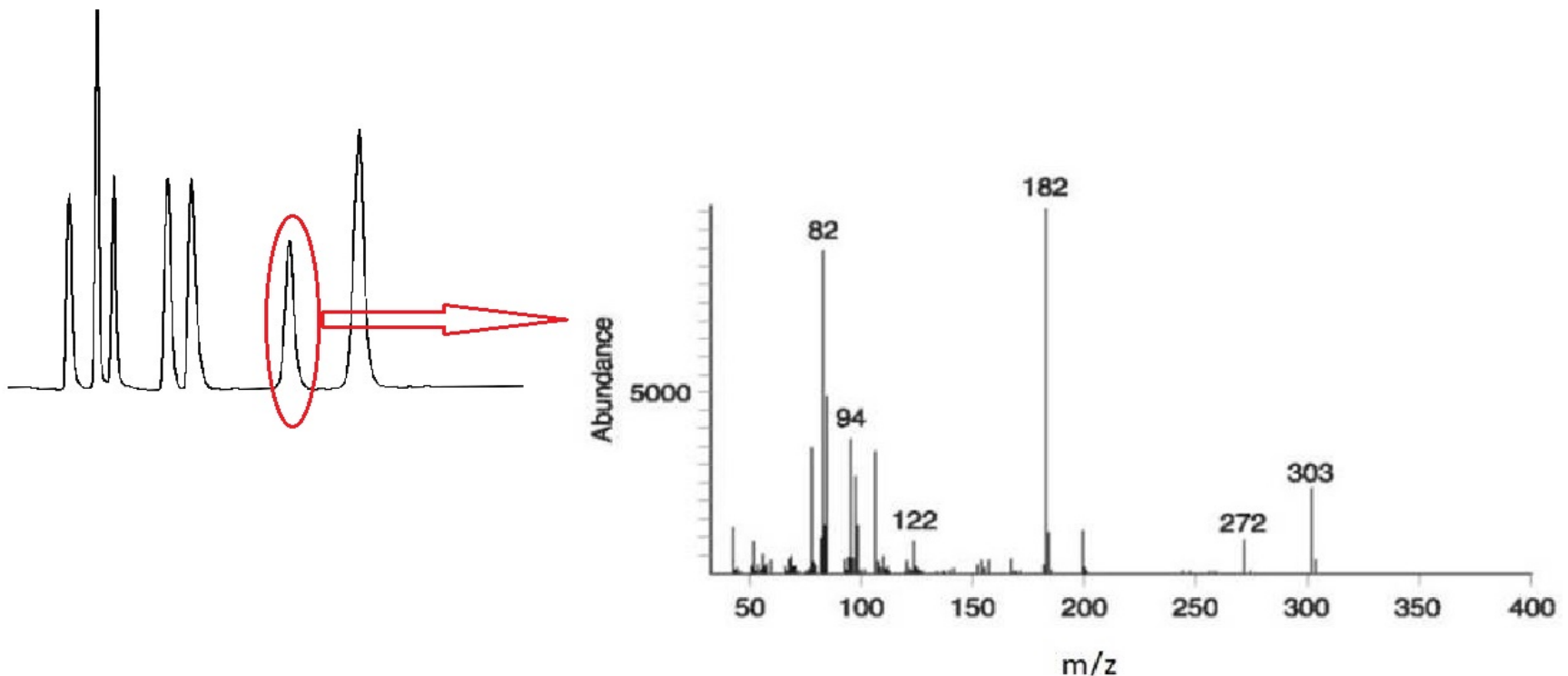
Analysis Basics

- Analyte Resolution
 - Chromatography
 - GC/MS, LC/MS
 - Separation of substance mixtures



Analysis Basics

- Analyte Identification
 - Chromatography/Mass spectrometry
 - Resolution then fragmentation then detection



Analysis Basics

- Analyte Identification
 - Mass spectrometry



Analysis Basics

- Definitive Testing
 - Pros
 - Definitive
 - Identify individual substances
 - Can be calibrated
 - Quantification
 - Controllable

Analysis Basics

- Definitive Testing
 - Cons
 - Not fast
 - Expensive \$\$\$\$
 - Labor-intensive
 - Laboratory facilities required
 - Expertise required

Drug Testing

- Purpose
 - Health
 - Performance
 - Ingestion/Exposure
- Venue
- Execution

Purpose

- Health
 - Explanation of symptoms
 - Cause of death
 - Legal considerations
 - Guide to treatment
 - Compliance with treatment program
 - Avoid adverse drug interactions
 - Successful patient outcome renders test results moot
 - False negative invokes alternate efforts
 - False positive invokes alternate efforts

Purpose

- Performance
 - Explanation of actions
 - Results used in adjudication
 - False negative is harmless to the defendant
 - Homicide victim?
 - False positive is devastating to the defendant

Purpose

- Ingestion/Exposure
 - Results used in adjudication
 - Solely to indicate exposure
 - Compliance
 - False negative is harmless to the defendant
 - False positive is devastating to the defendant

Drug Testing

- Purpose
- Venue
 - Personal
 - Diagnostic
 - Administrative
 - Evidential/Forensic
- Execution

Venue

- Personal
 - Immunoassays
 - I just have to know



ALWAYS TEST CLEAN
URINE - BLOOD - HAIR
GUARANTEED

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Venue

- Diagnostic
 - Immunoassays
 - Guide to treatment
 - Class-specific test is sufficient
 - Avoid adverse drug interactions
 - Successful patient outcome renders test results moot
 - False negative invokes alternate efforts
 - False positive invokes alternate efforts

Venue

- Diagnostic
 - Clinical laboratories
 - CLIA 88
 - Urine
 - Drugs of abuse (DAU) by immunoassay kit
 - Serum
 - Derivative of blood
 - Ethanol
 - Therapeutic drug monitoring (TDM) by clinical methods
 - » Antibiotics, anticonvulsants, anticoagulants



Venue

- Diagnostic
 - Urine drug testing
 - Immunoassays - class-specific only
 - No confirmation of positive results
 - No definitive analyte identification
 - Sufficient to guide treatment
 - Serum drug testing (derived from clotted blood)
 - Clinical method
 - No confirmation of positive results
 - No molecular identification
 - Sufficient to guide treatment

Venue

- Diagnostic
 - Serum/plasma ethanol testing
 - Serum derived from clotted blood
 - Plasma derived from unclotted blood
 - Enzyme specificity is demonstrated
 - Serum/plasma-to-blood ratio = 1.18 ± 0.04
 - Sufficient to guide treatment
 - Results may be reliable
 - Sufficient QA
 - Often used in adjudication
 - Must be rendered evidential

Venue

- Administrative
 - Non-regulated testing
 - Presumptive
 - Immunoassays
 - Hand-held devices, spot tests
 - No confirmation of positive results
 - Not evidential, sufficient for probable cause
 - Regulated testing
 - Presumptive + confirmation of positives
 - Immunoassay + GC/MS
 - Evidential

Venue

- Regulated Testing
 - Federal Drug-Free Workplace Program
 - Executive Order 12564, Sept. 15, 1986
 - Each Executive agency shall establish a program to test for the use of illegal drugs by Federal employees in sensitive positions and the Secretary shall promulgate scientific and technical guidelines for drug testing programs
 - Public Law 100-71 (July 11, 1987)
 - Intended to incorporate presumptive and confirmation testing otherwise recognized for legally acceptable toxicological testing
 - Frye, Fed. Rule 702

Venue

- Regulated Testing
 - Health and Human Services (HHS)
 - Substance Abuse and Mental Health Services Administration (SAMHSA)
 - Center for Substance Abuse Prevention
 - » Division of Workplace Programs (DWP)
 - Oversight of the program
 - Oversight of the National Laboratory Certification Program (NLCP)
 - » DOT, 19 CFR Part 40

<https://www.transportation.gov/odapc/part40>

Venue

- Regulated Testing
 - Urine presumptive testing
 - Hair
 - Alternate specimens under investigation
 - Confirmation of positive results
 - Definitive molecular identification, quantification
 - Evidential

Venue

- Regulated Testing
 - Conceived to deter illicit drug use amongst safety-sensitive federal employees
 - Intended solely to identify intentional illicit drug exposure
 - Results are NEG/POS
 - Medical Review Officer (MRO)
 - Positive laboratory finding is reported as negative if the subject has legitimate access

Venue

- Regulated Testing
 - Limited scope – popular in 1980's California
 - Marijuana metabolites
 - Δ^9 -THC-COOH, NOT Δ^9 -THC
 - Cocaine metabolites
 - Benzoyllecgonine, NOT cocaine
 - Opiates
 - Morphine, 6-MAM, codeine, hydrocodone, oxycodone
 - Phencyclidine
 - Amphetamines
 - Methamphetamine, amphetamine, MDMA, MDA

Analyte urine cutoff concentrations (ng/mL)

Δ^9 -THC-9-COOH	50/15
benzoylecgonine	300/150
morphine/codeine	2000/2000
6-monoacetylmorphine (6-MAM)	10/10
hydrocodone/hydromorphone	300/100
oxycodone/oxymorphone	100/100
phencyclidine	25/25
meth/amphetamine	250/250
MDMA/MDA	500/250

Venue

- Administrative
 - Court-ordered compliance
 - Non-regulated
 - Non-evidential
 - Regulated
 - Evidential

Venue

- Evidential/Forensic
 - Criminal investigations
 - Explanation of actions
 - Suspect
 - Victim
 - Death investigations
 - Cause
 - Manner

Venue

- Evidential/Forensic
 - [fo-ren' sik] *adj* belonging to courts of law
 - L *forensis*-forum, market place
 - Belonging to, used in, or suitable to courts of judicature, or to public discussion and debate

Merriam Webster's Dictionary

Venue

- Evidential/Forensic
 - Legal requirements
 - Relevance
 - Collection and identification
 - Preservation of evidential value
 - Competent examination
 - Analysis
 - Interpretation

Venue

- Evidential/Forensic
 - Scientific requirements
 - Quantity
 - Maintenance
 - Analysis
 - Technology/methodology
 - Reliability/precision/accuracy
 - » Standardization

Venue

- Evidential/Forensic
 - Standardization
 - Calibration
 - Standardization of process
 - Establish parameters for quantitative evaluation
 - Control
 - Verification of accuracy of process
 - Positive
 - Negative
 - Alternate substances

Venue

- Evidential/Forensic
 - Initial presumptive testing followed by confirmation of positive results
 - Definitive molecular identification
 - Quantification \pm
 - Specimens limited only by method validation
 - Analytes limited only by method validation
 - Methodology limited only by validation
 - Quantification limited only by method validation

Venue

- Evidential/Forensic
 - Laboratory results not intended to be used without interpretation
 - Interpretation requires knowledge of pharmacology and toxicology

Venue

- Evidential/Forensic
 - Admissibility rather than regulation
 - Pre-dates regulated testing standards
 - Regulated testing standards established to facilitate introduction into to legal proceedings
 - Frye v. US, 1923
 - General acceptance standard
 - Federal Rules of Evidence 702, 1973
 - Daubert v. Merrell Dow, 1993
 - Reliability AND Relevance standards

Venue

- Evidential/Forensic
 - Analyst certification
 - Forensic Specialties Accreditation Board
 - www.thefsab.org
 - Laboratory accreditation
 - ANAB (ANSI National Certification Board)
 - <https://anab.ansi.org/laboratory-accreditation>
 - Method standardization
 - AAFS/ASB
 - <https://www.asbstandardsboard.org/>

Execution

- Purpose
- Venue
- Execution
 - Analysis
 - Analytes
 - Substances detected with analysis
 - Specimens
 - Interpretation

Execution

- Analysis
 - Presumptive screening
 - Immunoassay
 - Advanced MS/TOF methods
 - Confirmation
 - GC/MS, LC/MS/MS



Execution

- Analytes
 - Selection based upon purpose and venue
 - Drugs of abuse (DAU), misuse, non-use
 - Parent drugs
 - Pharmacodynamics
 - Metabolites
 - Pharmacodynamics

Execution

- Specimens
 - Selection based on purpose and venue

Blood

Gastric contents

Serum

Hair

Plasma

Nails

Urine

Breath

Vitreous humor

Oral fluid

Bile

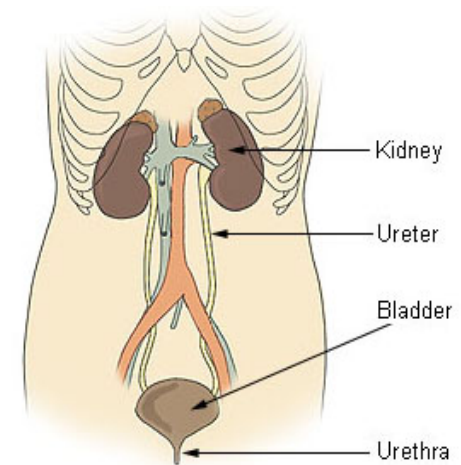
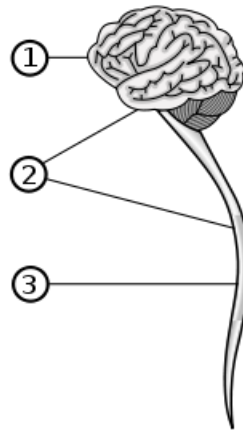
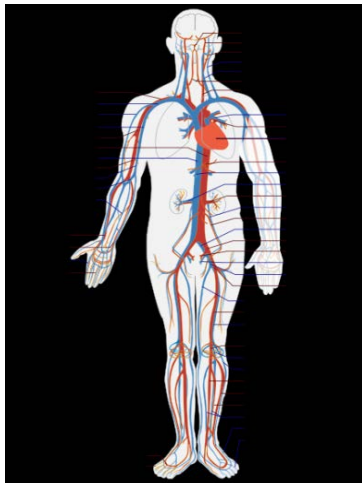
Sweat

Tissues

“Other”

Execution

- Specimens
 - Relevance
 - Does the specimen reflect a target organ?
 - Does it matter?



Execution

- Specimens
 - Relevance
 - CNS, cardiovascular, pulmonary are is the target organs for toxicity-based pharmacodynamic effects
 - CNS is the target organ for performance-based pharmacodynamic effects
 - Blood is the most documented specimen to reflect CNS

Execution

- Specimens
 - Blood
 - Circulates throughout the body
 - Reflects presence of analytes in organs based upon pharmacokinetic parameters (volume of distribution V_d)
 - Drugs in blood vs. performance
 - Presence of active analytes in blood may be used to establish impairment
 - Serum/Plasma
 - Derived from blood
 - Largely limited to ethanol

Execution

- Specimens
 - Urine
 - Excreted from the circulating body water
 - Reflects time-averaged presence of analytes in blood filtered in the kidneys
 - Analytes are detectable for longer periods in urine than in blood
 - Less invasive to collect than blood

Execution

- Specimens
 - Urine
 - Presence of analytes in urine may be used to establish consumption of the analyte or a substance giving rise to the analyte
 - Presence of analytes in urine do NOT necessarily reflect a concurrent presence in blood or organs
 - Presence of analytes in urine CANNOT be used to establish impairment
 - Concentrations are essentially uninterpretable due to variable solute composition

Execution

- Specimens

- Hair

- Limited to chronic exposure

- May provide timeline based upon position of drugs in hair (proximal vs. distal)
 - Growth ~1 cm/month (head)

- Nails

- Similar to hair
 - Slower growth



Execution

- Specimens
 - Oral fluid
 - Limited to drugs of abuse
 - May reflect blood
 - Under investigation
 - Sweat
 - Limited to drugs of abuse
 - May reflect blood
 - Under investigation

Execution

- Specimens
 - Vitreous humor
 - Limited to ethanol
 - May substitute for putrefied blood
 - Breath
 - Limited to ethanol

Interpretation

- Purpose
 - Health assessment
 - Presumptive test result is sufficient
 - Evidential test result is necessary for COD/MOD
 - Performance assessment
 - Presumptive test result is PC
 - Evidential test result is necessary
 - Ingestion/exposure assessment
 - Presumptive test result is PC
 - Evidential test result is necessary

Interpretation

- Venue
 - Personal
 - Presumptive test result is sufficient
 - Diagnostic
 - Presumptive test result is sufficient
 - Administrative
 - Presumptive test should NOT be used as evidential
 - Evidential test should be necessary
 - Evidential/Forensic
 - Name says it all

Interpretation

- Execution
 - Analysis
 - Presumptive + Confirmation = Evidence
 - Analytes
 - Class-specific for diagnostic use only
 - Individual substances necessary for evidential use
 - Specimens
 - Blood - exposure, performance
 - All others - exposure only (maybe)

Interpretation

Specimen	Exposure	Effect
Urine	Yes	No
Hair	Yes	No
Oral fluid	Yes	TBD
Sweat	Yes	TBD
Blood	Yes	Yes
Vitreous Humor	Yes	Maybe (ethanol)
Tissues	Yes	Maybe

Interpretation

- Significant Considerations
 - Pharmacological activity
 - Metabolites may/may not retain activity of parent
 - Concentration
 - Blood, vitreous humor (ethanol)
 - Generalities
 - Tolerance
 - Time relative to incident
 - Residence
 - Absorption, Distribution, Metabolism, Elimination
 - Retrograde extrapolation

Interpretation

- Drug test findings are generally an unreliable sole basis for establishing specific degrees of individual impairment.
- Drug test findings are most useful for explaining observed signs/symptoms.
 - Performance
 - Cause of death
- *Per Se* limits represent cutoff for likelihood of misadventure, not degree of impairment.

Interpretation

Testing	Reliable?	Active substance?	Relevant specimen?
Diagnostic Drugs Ethanol	No Yes*	No Yes	Urine Serum
Administrative Non-regulated Regulated	No Yes	No Yes/No	Urine Urine+
Personal	No	No	Urine
Evidential	Yes	Yes	Blood+

Interpretation

Testing	Health?	Performance?	Exposure?
Diagnostic	Yes	No	No
Drugs	Yes	Yes*	Yes
Ethanol			
Administrative	Yes	No	No
Non-regulated	Yes	No	Yes
Regulated			
Personal	caveat emptor	No	No
Evidential	Yes	Yes*	Yes