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Forensic Toxicology- A General Introduction

**“All substances are poisons, there is none which is not a poison. The right dose differentiates a poison from a remedy.”
(Paracelsus, 1493-1541)**

What is Toxicology?



- **IMP DEFINITIONS**

- **Toxin:** A poisonous substance produced during the metabolism and growth of certain microorganisms and some higher plant and animal species
- **Dose:** 'Dose makes the poison' is a fundamental principle of toxicology, but the actual study of toxicology is much more nuanced and complex than this simple statement suggests.
- **Toxicology:** The study of the nature, effects, and detection of poisons and the treatment of poisoning.

Trivia

- [Mathieu Orfila](#) is considered to be the modern father of toxicology, having given the subject its first formal treatment in 1813 in his *Traité des poisons*, also called *Toxicologie générale*

Branches of Toxicology

- Clinical Toxicology
- Medical Toxicology
- Forensic Toxicology
- Industrial Toxicology
- Environmental Toxicology
- Biochemical and Molecular Toxicology
- Product Development Toxicology
- Regulatory Toxicology

Forensic Toxicology

- **Definition:** Forensic toxicology focuses on medical-legal aspects of chemical exposure and toxic injury.
- **A forensic toxicologist** must consider the context of an investigation, in particular any physical symptoms recorded, and any evidence collected at a crime scene that may narrow the search, such as pill bottles, powders, trace residue, and any available chemicals.
- The **primary concern** for forensic toxicology is not the legal outcome of the toxicological investigation, but rather the technology and techniques for obtaining and interpreting the results

Important Factors

- Dose makes the poison
- The concentration of the chemical
- The threshold required to exert a particular effect
- How the interaction takes place
- Which factors are of importance in each exposure scenario.

Samples to be Analyzed in Forensic Toxicology

- Urine
- Blood
- Hair sample
- Oral Fluid
- Other Body Fluids
- Other Samples

Urine

- Common among drug testing for employees and athletes.
- A urine sample is quick and easy for a live subject
- An example of this is THC, is the main psychoactive substance found in the Cannabis plant.... from cannabinoid
- For example: Marijuana use, which in heavy users can be detected in urine for up to 14 days following use.
- Note: That it can take as long as 8 hours until a given substance can be detected.

Blood

- Blood Sample: 10 cm^3 is usually sufficient to screen and confirm most common toxic substances
- A blood sample provides the toxicologist with a profile of the substance that the subject was influenced by at the time of collection; for this reason, it is the sample of choice for measuring blood alcohol content.
- BAC is most commonly used as a metric of Drunkenness for legal or medical purposes in drunk driving cases.

Hair sample

- Hair is capable of recording medium to long-term or high dosage substance abuse.
- Chemicals in the bloodstream may be transferred to the growing hair and stored in the follicle , providing a rough timeline Chronology of drug intake events.
- Head hair grows at rate of approximately 1 to 1.5 cm a month, and so cross sections from different sections of the follicle can give estimates as to when a substance was ingested.

Some Ethical Facts

- Testing for drugs in hair is not standard throughout the population. The darker and coarser the hair the more drug that will be found in the hair.
- If two people consumed the same amount of drugs, the person with the darker and coarser hair will have more drug in their hair than the lighter haired person when tested. This raises issues of possible racial bias in substance tests with hair samples

Oral fluid

- The use of oral fluid is gaining importance in forensic toxicology for showing recent drug use, e.g. in clinical settings or investigation of driving under influence of substances.
- Oral fluid is the proper term, however saliva is used commonly.
- Oral fluid is composed of many components and concentrations of drugs typically parallel to those found in blood. Sometimes referred to as ultra filtrate of blood, it is thought that drugs pass into oral fluid predominantly through a process known as passive diffusion.
- Drugs and pharmaceuticals that are highly protein bound in blood will have a lower concentration in oral fluid.

Other Body Fluids

- Other bodily fluids and organs may provide samples, particularly samples collected during an autopsy .
- A common autopsy sample is the gastric contents of the deceased, which can be useful for detecting undigested pills or liquids that were ingested prior to death.
- In highly decomposed bodies, traditional samples may no longer be available.
- The vitreous humours from the eye may be used, as the fibrous layer of the eyeball and the eye socket of the skull protects the sample from trauma and adulteration.
- Other common organs used for toxicology are the brain, liver, spleen and stomach contents.

Other

- Maggots and other organisms that may have ingested some of the subject matter may have also ingested any toxic substance within it.
- **Referred to as Entomotoxicology**
- **Entomotoxicology** is the analysis of toxins in arthropods (mainly [flies](#) and beetles) that feed on carrion. Using arthropods in a corpse or at a crime scene, investigators can determine whether toxins were present in a body at the time of death. This technique is a major advance in forensics; previously, such determinations were impossible in the case of severely decomposed bodies devoid of intoxicated tissue and bodily fluids
- More on this can be read on <http://en.wikipedia.org/wiki/Entomotoxicology>

Age Old Methods

- Mecke Reagent, and Froehde's Reagent for opiates
- Marquis Reagent and Simon's reagent for amphetamine, methamphetamine and other analogs, like MDMA,
- The Scott's test for cocaine, and
- The modified Duquenois reagent for marijuana Cannabis (drug).
- For compounds that don't have a common spot test, like benzodiazepines, another test may be used, typically mass spectroscopy, or Spectrophotometry.

Detection Of Drugs

- Detection of drugs and pharmaceuticals in biological samples is usually done by
 1. An initial screening and then a confirmation of the compound(s),
 2. Include a quantitation of the compound(s).
 3. The screening and
 4. Confirmation are usually, but not necessarily, done with different analytical methods.

Testing Times....

- The choice of method for testing is highly dependent on what kind of substance one expects to find and the material on which the testing is performed.
- Biological samples are more complex to analyze because of factors such as the matrix effect and the metabolism and conjugation of the target compounds.

Instrumentation

- **Gas chromatography** is of particular use in examining volatile organic compounds.
- **Detection of Metals:** The Reinsch test, emission spectroscopy or X-ray diffraction
- The compounds suspected of containing a metal are traditionally analyzed by the destruction of the organic matrix by chemical or thermal oxidation. This leaves the metal to be identified and quantified in the inorganic residue.

Screening Methods

- Thin-layer chromatography, Gas-liquid Chromatography and immunoassay.
- For complete legal identification, a second confirmatory test is usually also required.
- The trend today is to use liquid chromatography tandem mass spectrometry, preceded with sample workup as liquid-liquid extraction or solid phase extraction.

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If you do have any comments, suggestions, doubts, please feel free to email me at joulyn18@gmail.com

References

- Forensic Toxicology: Wikipedia
- **History of toxicology:**
http://www.eoearth.org/article/History_of_toxicology
- <http://ebook30.com/free/toxicology+notes/>
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