

Forensic Toxicology

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Definition

- 'Toxicity'
- Adverse effect of chemical on cell

- How does poisoning take place?
 - Acute poisoning
 - Accidental / Suicidal / Homicidal
 - Chronic poisoning
 - Pollution
 - Industrial

CLASSIFICATION OF POISONS

- A. According to their effects on the body as a whole and specific organs
- B. According to their chemical composition and method of administration
- C. According to their application or use

- 1. Agricultural poisons
 - Insecticides (DDT, organophosphates)
 - Herbicides (paraquat)
 - Rodenticides (thallium)
- 2. Industrial poisons
 - Gases (carbon monoxide, cyanide)
 - Heavy metals (metals, arsenic)
 - Hydrocarbons (paraffin, benzene)
 - Caustic substances (acids, alkalis)
- 3. Household poisons
 - Medicines
 - Insecticides
 - Detergents
- 4. Poisonous plants
 - Mushrooms
- 5. Animals and insects
 - Snakes, spiders, scorpions, bees

FACTORS INFLUENCING TOXICITY

- Dose-response relationship
 - LD 50
 - Cumulative frequency distribution
 - Standard deviation
- Biological factors
 - Absorption (diffusion or active transport)
 - Accumulation / storage
 - Distribution
 - Elimination
 - Functional reserve of organ
 - Tolerance
- Chemical factors
 - Effect on specific receptor or cell (CO)
 - Biotransformation

- Route of administration
 - Skin
 - Lungs
 - Gastrointestinal
 - Parenteral
- Genetic factors
 - Congenital absence or abnormality of an enzyme (eg. malignant hyperthermia with Scoline)
 - Rate of metabolism of drugs (eg. INH)
 - Abnormal reactions (eg. porphyria)
- Miscellaneous
 - Anaphylaxis
 - Cytotoxic drugs

Problems in Toxicology

- Toxic and fatal dose
- Errors and discrepancies
- Tolerance
- Idiosyncrasy

How to make the diagnosis?

- 1. History
- 2. Symptoms
- 3. Signs
- 4. Pathological proof

Post Mortem

- Autopsy usually non-specific
- Clinical-pathological correlation
- Histology
- Laboratory analysis
 - Levels
 - Range

SPECIMENS

- Blood
- Urine
- Vitreous
- Bile
- Gastric contents
- Solid organs
- Hair and nails
 - seldom - arsenic poisoning
- Miscellaneous
 - pills, capsules, sangoma concoctions, containers

SPECIFIC POISONINGS

- Carbon monoxide
- Cyanide
- Heavy metals
- Corrosive poisons
- Organo phosphate
- Organic solvents

CARBON MONOXIDE

- Apart from alcohol and medicinal drugs, the most common cause of poisoning
- Circumstances in which it occurs:
 - petrol engines (suicides)
 - faulty gas appliances and heating systems
 - fires in confined spaces
 - industrial - steel works
- Incomplete combustion of fossile fuel in an inadequate oxygen supply

- Mechanism of death:
 - If CO displaces oxygen in a confined space e.g. inside of a motor vehicle it leads to hypoxic hypoxia
 - CO has a 300 times greater affinity for haemoglobin than oxygen, displacing oxygen from the red blood cell (anaemic hypoxia)
 - Inability of tissues to utilize available oxygen (histotoxic hypoxia)

- Post mortem findings:
 - Cherry pink coloration of the skin, especially of hypostatic areas, as well as tissues
 - Bilateral necrosis of the basal ganglia (if the acute episode is survived)
 - Toxicological confirmation depends on gaschromatographic analysis of blood: carboxy-haemoglobin saturation above 50-60% likely to be fatal

CYANIDE POISONING

- Salts of cyanide is swallowed, need to encounter water or gastric acid before liberating HCN (a gas) or cyanide acid
- Fatal dose of cyanide salt is only 150-300mg ('suicide pill')
- Circumstances surrounding fatalities:
 - Accidental during fumigation
 - Accidental in laboratories
 - Suicidal - laboratory staff, religious sects
 - Part of toxic gases during fires

- Mechanism of death:
 - cyanide is extremely poisonous - prevents uptake of oxygen by cells through inhibition of cytochrome oxidase (histotoxic hypoxia)
 - local erosive
- Post mortem findings:
 - brick-red/purplish-pink coloration of the skin, especially of hypostatic areas
 - characteristic bitter almond smell
 - oesophagus and stomach lining deep red or black, due to erosion and haemorrhage

HEAVY METALS

- Combines with mitochondrial enzymes
- Interfere with cellular respiration
- Target cell: Vascular endothelium
- GIT

ARSENIC

- Compounds poisonous
- Acute: haemorrhagic gastritis
subendocardial haemorrhage
tubular necrosis
- Chronic: Hyperkeratosis
Skin thickening
Hair loss

CORROSIVE POISONS

- Common corrosives include:
 - I. acids – it dehydrates tissue, coagulates proteins, changes Hb to hematin
 - ii. alkalis
 - iii. Miscellaneous – heavy metal salts, detergents
- Post mortem findings:
 - Erosion of the skin reflects posture of deceased during intake
 - Diffuse erosion of mucosa of upper GIT perforation with chemical peritonitis
 - Aspiration with chemical pneumonitis
 - Complications: scarring with stenosis

ORGANO-PHOSPHATE POISONING – PARATHION

- Is an agro-chemical poison (pesticide / insecticide)
- Absorbed through intact skin, orally or inhaled
- Inhibits choline esterase enzymes
- Toxic effects begin when CE-levels drop below 30%
- Large doses: death very rapid
- Smaller doses: nausea, vomiting, blurred vision, contracted pupils, hypersalivation, increased bronchial secretions, twitching and fits precede death
- Post mortem findings: non-specific apart from recovering of organophosphates from body fluids and determining of CE-levels in blood

ORGANIC SOLVENTS

- eg. benzene, toluene, petrol, buthane, etc.
- “glue-sniffing” - toluene-based adhesive
- Death may be sudden and unexpected due to the following major effects:
 - Sensitise the myocardium to catecholamines
 - Sudden arrhythmias and sudden cardiac death
 - Hypoxic hypoxia if inhaled from a plastic bag being placed over the nose and mouth
 - Cold air stimulating the hypopharyngeal neural network causing a reflex cardiac arrest
- Damage to liver, kidneys and bone marrow
- Send lungs away to laboratory

Treatment Artifact

- Activated charcoal

FIN