Forensic Medicine and Toxicology - Topic 13 - Toxicology

Definitions, History and Mechanisms

Essential Terms

- **Toxicology** is the study of harmful effects of substances and the conditions under which those effects occur.
- **Clinical toxicology** concerns recognition and treatment of toxic exposures, while **forensic toxicology** applies toxicological evidence to legal questions.
- A **poison** is a substance that can harm the body through its chemical action under the particular conditions of exposure.
- Toxicity depends on the substance, dose, route, duration, formulation and the exposed person's susceptibility.
- A medicine can become toxic, while the mere detection of a chemical does not prove that it caused illness or death.

Historical Development

- Early toxicology developed from observations of poisonous plants, animals, medicines and environmental exposures.
- Paracelsus emphasised the relationship between dose and toxicity.
- **Mathieu Orfila** helped establish systematic experimental and forensic toxicology in the nineteenth century.
- Modern toxicology combines analytical chemistry, pharmacology, clinical medicine and exposure assessment.

Toxicokinetics and Toxicodynamics

Absorption, Distribution and Elimination

- **Toxicokinetics** describes absorption, distribution, metabolism and elimination of a toxic substance.
    - Delayed-release formulations, slowed gastric emptying and large exposures can prolong absorption.
    - Protein binding, tissue distribution and renal or hepatic disease can alter the measured concentration and duration of toxicity.

Toxic Mechanisms and Classification

- **Toxicodynamics** describes how the substance or its metabolites disrupt receptors, enzymes, membranes or other cellular processes.
- Some substances are more harmful after metabolism, as occurs when methanol forms toxic acidic metabolites.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

- Repeated exposure may cause cumulative injury even when each individual exposure produces few immediate symptoms.
- Classify poisons by their source, target organ, chemical group, mechanism or clinical syndrome according to the question being answered.

Classification of Poisons

1. By Source

- Poisons may be natural substances from plants, animals or microbes, or manufactured chemicals and medicines.
- The origin does not determine safety; a natural substance can be highly toxic.

2. By Major Action

- Corrosives damage tissue locally, while systemic poisons act after absorption.
- Neurotoxic, cardiotoxic, hepatotoxic and nephrotoxic groups describe their main organ effects.
- One poison may belong to several groups because it injures more than one organ.

3. By Exposure Pattern

- Acute poisoning follows a substantial exposure over a short period.
- Chronic poisoning follows repeated or sustained exposure and may present as gradual organ dysfunction.
- Accidental, occupational, therapeutic-error and intentional exposures describe circumstances rather than biological mechanisms.

Factors that Modify Toxicity

1. Properties of the Substance

- Dose, concentration, solubility, particle size and formulation influence the amount that reaches the tissues.
- A corrosive may cause severe local injury even when systemic absorption is limited.

2. Route and Duration

- Inhaled or injected substances can act rapidly, while skin or gastrointestinal absorption may be prolonged.
- A sustained-release preparation can delay the peak concentration and require longer observation.

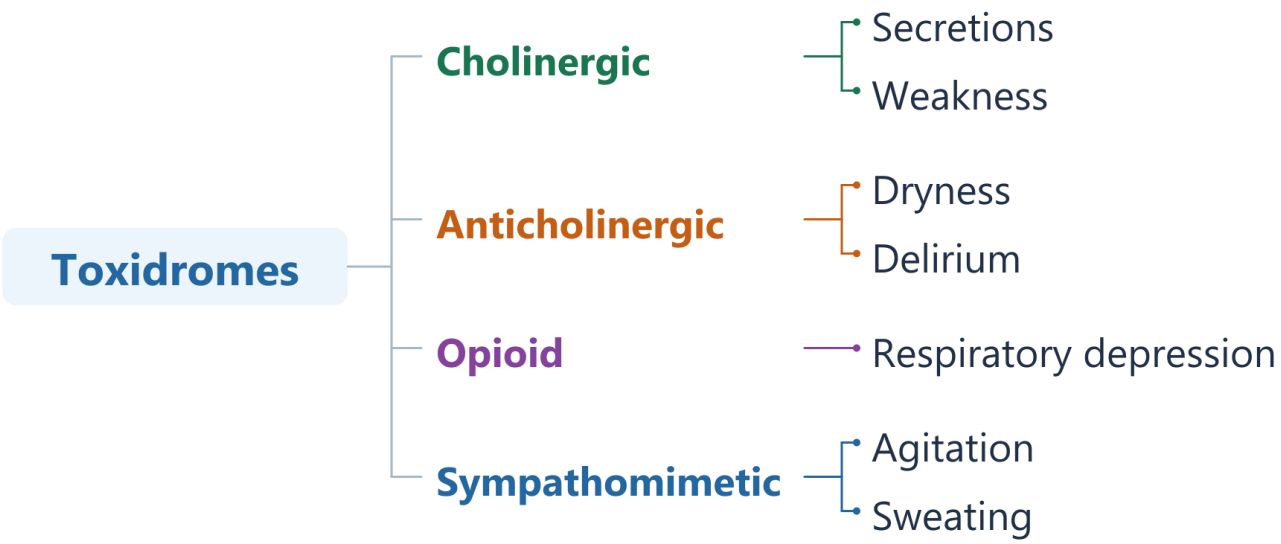
3. Host Factors

- Age, body size, pregnancy, nutritional status and renal or hepatic function influence risk.
- Tolerance may reduce some visible effects without preventing all organ toxicity.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

- Drug interactions can alter metabolism or add to respiratory, cardiac or neurological depression.

Recognising a Poisoned Patient



History and Examination

Exposure History

- Ask what was taken or encountered, when it happened, the possible quantity, route, formulation and any co-exposures.
- Use containers, prescriptions, witness accounts and workplace information to support the history without delaying treatment.

Examination and Toxidrome Recognition

- Assess airway, breathing, circulation, consciousness, temperature, pupils, skin moisture, secretions and neuromuscular findings.
- Look for trauma, hypoglycaemia, infection and other conditions that may mimic or coexist with poisoning.
- A **toxidrome** is a pattern of findings that suggests a mechanism, not a definitive identification of one poison.

Hippus or Pupillary Unrest

- **Hippus** is a spontaneous, rhythmic or irregular alternation of pupillary constriction and dilatation, which can be observed even under steady illumination.
- Small fluctuations may occur normally and can vary with autonomic activity, attention and physiological state.
- Hippus alone does not identify a particular poison or establish poisoning.
    - Interpret it with pupil size and reactivity, consciousness, other clinical signs and the exposure history.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

Evidence of Poisoning in the Living and the Dead

Clinical Clues

- A sudden unusual illness after a shared meal, medicine or workplace exposure may suggest poisoning, especially when several people are affected.
- A container, smell, stain or plant fragment is an investigative clue and requires safe identification.

Autopsy and Analytical Evidence

- At autopsy, examine the mouth, gastrointestinal tract and organs for local injury, aspiration, oedema or organ damage.
- Many lethal poisons produce no distinctive gross lesion, so a negative gross examination does not exclude poisoning.
- Collect specimens before preservative contamination and interpret analytical detection with concentration, sampling time and the clinical course.
- A positive toxicology result establishes exposure within analytical limits, whereas a cause-of-death opinion also requires a plausible fatal mechanism.

Major Toxidromes

1. Cholinergic Pattern

- Excess acetylcholine can cause secretions, sweating, diarrhoea, bronchospasm, bradycardia, small pupils, fasciculations and weakness.
  - Organophosphates and carbamates are important causes, but not every patient shows every feature.

2. Anticholinergic Pattern

- Antimuscarinic toxicity can cause dry skin and mouth, dilated pupils, urinary retention, tachycardia, hyperthermia and delirium.
  - Datura and several medicines can cause this pattern.

3. Sympathomimetic Pattern

- Stimulant toxicity can cause agitation, dilated pupils, sweating, hypertension, tachycardia, hyperthermia and seizures.
  - Sweating often helps distinguish this pattern from anticholinergic toxicity, although mixed exposures can blur the distinction.

4. Opioid and Sedative Patterns

- Opioid poisoning commonly produces reduced consciousness, slow breathing and small pupils, although pupil size is not a reliable exclusion test.
- Sedative poisoning may produce reduced consciousness, ataxia and impaired breathing, especially with other depressants.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

Speedball and Mixed Stimulant–Opioid Toxicity

- **Speedball** traditionally refers to the combination of cocaine and heroin, and the term is also used more broadly for a stimulant–opioid combination.
- The stimulant and depressant effects **do not cancel each other out**.

Clinical and Toxicological Importance

- The opioid component can depress consciousness and breathing.
- The stimulant component can cause agitation, hypertension, tachycardia, hyperthermia, seizures or cardiac ischaemia.
- Mixed toxicity can produce an incomplete or changing toxidrome, so neither agitation nor pupil size reliably excludes an opioid contribution.
- Respiratory failure and cardiovascular complications can coexist and cause death.

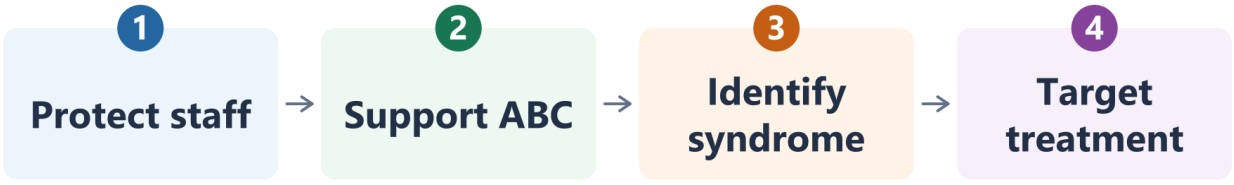
Assessment and Management Principles

- Prioritise airway and ventilation, and monitor consciousness, temperature, blood pressure and cardiac rhythm.
- Give naloxone when opioid-related respiratory depression is suspected, while continuing ventilatory support as required.
- Naloxone reverses the opioid component but does not treat cocaine-related seizures, hyperthermia or cardiovascular toxicity.
- Continue observation and treat the remaining abnormalities with appropriate emergency and toxicology support.

Medico-legal Interpretation

- Consider exposure to more than one drug and interpret toxicology with the clinical course, scene evidence and autopsy findings.
- Detection of cocaine and an opioid supports combined exposure but does not establish that their combined use was intentional.

Initial Treatment and Investigations



Stabilization and Bedside Tests

Immediate Clinical Priorities

- Protect rescuers from contaminated clothing, vapour or vomitus before beginning care in a hazardous exposure.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

FREE PREVIEW

Click here to visit our website

MBBS PREMIUM NOTES

Complete MBBS notes for every subject and year are available only in the FirstHope app.

Scan or click here

Click here to get the app >

Available on Google Play

Browse MBBS notes by year

firsthope.co.in/mbbs

Click here to explore MBBS >

Scan or click here

FirstHope Medical on Instagram

@firsthope.medical

Click here to follow

App and notes help

Find answers about access and downloads

Click here for help

YEAR 1 / YEAR 2 / YEAR 3 / YEAR 4