FORENSIC TOXICOLOGY

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Lecture items

• General concepts
• Classification of toxicants
• Sources and circumstances of intoxication
• Conditions of toxic action
• Ways of penetration and elimination the toxic in the body. Habituation to toxic.
Toxicology is the science that deals with:

• identification and quantitative determination of toxic substances
• study of their physico-chemical peculiarity
• mechanisms of action on the body
• consequences of toxicants action
• signs of intoxication
• isolation, treatment and antidotes used in intoxication
The origin of notion
toxic and poison

**Toxic comes from:**

→ toxikon (τοξικόν) → toxo (τόξο) = bow, arrow

→ toxikos (τοξικός) → tako (τάκο) = damage, destruction, death ...

→ yew (English or European)

“Taxus Baccata”
contains the alkaloid
taxin
Toxic is a substance which penetrate from outside the body in small quantities and under certain conditions, by its chemical and physical-chemical action cause health disorder or death.

Health disorder or death, together with the complex of symptoms and morphological changes caused by penetration of toxic in the body are known as intoxication or poisoning.
Pathophysiological classification of toxicants
(By their action on the body, organs and tissues)

<table>
<thead>
<tr>
<th>Corrosive (caustic)</th>
<th>market morphological changes, mainly local.</th>
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<tbody>
<tr>
<td>Destructive</td>
<td>severe toxic action on organs and tissues, with dystrophic and necrotic changes.</td>
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<tr>
<td>Hematic</td>
<td>cause changes in the blood components directly.</td>
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<tr>
<td>Functional</td>
<td>producing death or serious disorder without macro and microscopic morphological changes.</td>
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</table>
Sources and circumstances of intoxication
(Socio-juridical classification of intoxication)

1. Intentional or voluntary:
   • *homicides* by poisoning
   • *suicide*
   • *toxicomania* (addiction) – intentional form of periodic or chronic intoxication by repeated consumption of toxic substances
Sources and circumstances of intoxication
(Socio-juridical classification of intoxication)

2. Accidental or involuntary:

**accidental itself** - ingesting toxic as a result of carelessness, imprudence, ignorance;

**drug consumption** - errors of doctor, pharmacist, the patient himself, unlawful medicine. May be errors of prescribing or drug delivery, administration, etc..

**professional** - can be industrial, agricultural due to ignoring the work protective measures. They are usually chronic.

**food intoxication** - consumption of poisonous food or drink by their chemical or bacteriological component. This may be due to confusion of plants, mushrooms, consumption counterfeit, old, altered food or drink.
The condition and severity of poisoning depends on:

- the substance introduced into the body
- the body
- the way of administration
- toxic behavior in the body, etc.
Conditions dependent on the substance

Origin
The extraction of substances from not recommended food sources, may make them toxic origin

Oldness
The age of some substances may induce or decrease the toxic effect.
The pharmaceutical dose is the amount of substance that can produce a determined result. Distinguish therapeutic, toxic, lethal doses.

Concentration

sulphuric acid
Concentrate - aggressive corrosive
Diluted - sulfuric lemonade 0.002%; antidote in poisoning with lead and barium.
Conditions dependent on the substance

Physical state of toxic liquid solid gaseous

Most dangerous are liquids and gases which readily dissolves in the body fluids and tissues

! However, the solubility can be changed ex:

calomel (Hg2Cl2) + chloride (NaCl) → to sublimate (HgCl2)

lead salts administered with coffee → tannate of lead (PbTiO3)
Conditions dependent on the body

- age
- sex
- weight
- individual predispositions
- hypo or hypersensitivity to toxic
- habituation to toxic
Conditions dependent on the body

Age
young people and children are more susceptible to toxicants as adults
elders are susceptible to vascular, vomitive and purgative substances

Sex
women are less resistant to the toxic than men, especially pregnant women, lactating period, menstruation.
Conditions dependent on the body

Health status of the body determine:

• absorption rate
• elimination rate
• transformation of toxic in the body
• toxins tolerance, etc..

Diseases generally decrease body resistance to toxic.
Hypersensitivity or intolerance

Manifest reaction of the body to the toxic

congenital  acquired

Excessive susceptibility - idiosyncrasy
("Idios" – own and "sincrasus" - constitution).

Idiosyncratic was called the uncharacteristic response of a subject to a chemical substance that normally does not occur by the administration or its use.
Hyposensitivity or tolerance
Diminished reaction of the body to the toxic

Gained tolerance can occur to the alcohol, tobacco, opium, drugs etc..
It is considered that it is due to decrease the absorption and fixation of receptor cells, increasing the detoxification process, etc.
Habituation to toxic

Habituation to the toxic is obtained by continuous administration of low dose and gradually increased, reaching to withstand, without clinical manifestations, toxic and even fatal doses.
Ways of penetration the toxic in the body

**direct**

Direct contact with blood
- hypodermic
- intramuscular
- Intravenous ...

They are:
- more dangerous
- faster

**indirect**

Indirect contact with blood
- gastrointestinal
- respiratory
- Transcutaneous ...

They are:
- less dangerous
- slower
- widespread
Corrosive substances

Features:
Action mainly local, with effects:
irritating
sear
necrosis
fusion.
represented by
acids, bases, phenol, formalin, hydrogen peroxide, potassium permanganate, etc.
Corrosive substances

Acids

are substances which molecules, in aqueous solution, dissociates into H + ions and saline radicals.
The degree of dissociation determines the strength of the acid and toxicity.

Ways of entry:
Per os (most cases), Inhalation, Transcutaneous Transmucosal, etc..
**Acids**

**The mechanism of action**

**Hydrogen ion (H +)**
- captures the tissue water
- coagulates protein $\rightarrow$ acidic albumin
- denatures proteins

**HNO$_3$ ($> 30\%$)**
- Xantoproteic reaction: denatured proteins which contain cyclic amino acids (phenylalanine, tyrosine, tryptophan) form nitrocompounds (yellow)

**HCl, H$_2$SO$_4$**
- heat emanation $\rightarrow$ thermal action

**CH$_3$COOH**
- high resorptive properties $\rightarrow$ hemolysis
Morphological appearances

The acute period

• chemical burns (coagulative necrosis) around the mouth and on the mucosa of the digestive tract
• local inflammatory reactions.

The belated period

stomatitis
oesophagitis
gastritis
mediastinitis
peritonitis
pneumonia
dystrophic changes in the myocardium, liver, kidney
Coagulative necrosis (coagulation necrosis):

- relatively hard and dry (dehydrated)
- relatively superficial
- with rough crust on the surface
- surrounded by local inflammation
- color dark brown or brown-black
- \( (H^+ \rightarrow Hb \rightarrow \text{hematoporphyrin, methemoglobin, acidhematin} \)
<table>
<thead>
<tr>
<th>acid</th>
<th>Morphological appearance</th>
</tr>
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<tbody>
<tr>
<td>Sulphuric acid (\text{H}_2\text{SO}_4)</td>
<td>deep necrosis, brown-black</td>
</tr>
<tr>
<td>Nitric acid (\text{HNO}_3 (&gt; 30% ))</td>
<td>yellow burns</td>
</tr>
<tr>
<td>Hydrochloric acid (\text{HCl})</td>
<td>mucosa of the digestive tract get a dirty-gray color</td>
</tr>
<tr>
<td>acetic acid (\text{CH}_3\text{COOH})</td>
<td>• specific odor&lt;br&gt;• tumefaction of the mucosa of the upper segments of the digestive tract with dark-red pigment imbibition</td>
</tr>
<tr>
<td>Oxalic acid (\text{HOOC-COOH})</td>
<td>marked mucosal hyperemia with multiple small hemorrhages</td>
</tr>
<tr>
<td>Phosphoric acid (\text{H}_3\text{PO}_4)</td>
<td></td>
</tr>
</tbody>
</table>
Corrosive substances

Alkalis

are substances containing hydroxyl group (OH) and an anion of the metal. As acids, the alkali strong depends on the degree of dissociation.

Ways of entry:
Per os (most cases)
Inhalation
Transcutaneous
Transmucosal, etc..
Alkalis

Mechanism of action.

OH group tumefies, merges and dilutes the proteins → alkali-albuminates, soluble in water. Due to high solubility alkalis penetrate deep into the tissues, forming a moist necrosis (the colliquative necrosis).

Strong alkali degenerates not only soft tissue, the strong (hair, nails) is affected too.

! Heated alkali shows a greater destructive action.
Morphological appearances

The acute period
Deep colliquative necrosis:
• no demarcation zone
• marked tumefaction and edema, mucosal folds disappear
• white-grey, sometimes greenish color.

The belated period
• forming multiple ulcers sometimes perforated
• mediastinitis
• peritonitis
• pneumonia
• dystrophic changes in the internal organs
Destructive substances

substances which cause mainly destruction (dystrophic and necrotic action) on internal organs (kidney, liver, myocardium, digestive tract, brain).

representatives:

• Heavy metals
  – Mercury
  – lead

• Metalloids and their compounds
  – Arsenic
Hematic substances

Hematotropic
- Carboxyhaemoglobininic
- Methaemoglobininic

Hemolytic

Hemoagglutinative

Hematopoietic

Hemodynamics, etc.
Alcohol intoxication and his surrogates

Ethyl alcohol (C$_2$H$_5$OH)

surrogates:

Insignificant risk (alcohol-based tinctures, alcohol-based water-solutions, colognes, lotions, etc.)

Medium risk (technical liquids based on alcohol)

High risk (imminent danger) (methanol, ethylene glycol, dichloroethane)
Alcohol intoxication and his surrogates

Mechanisms of action:
CNS depression
Narcotic action (dichloroethane)
Neurovascular (methyllic alcohol)
Due to their toxic metabolites
Other action dependent impurities
Alcohol intoxication and its surrogates

Alcohol dosage:

<0.3 ‰ - no influence of alcohol (physiological)
0.3-0.5 ‰ - insignificant influence of alcohol
0.5-1.5 ‰ – easy inebriety (drunkenness)
1.5-2.5 ‰ – medium inebriety (drunkenness)
2.5-3 ‰ – severe inebriety (drunkenness)
> 3 ‰ - severe alcohol intoxication
5-6 ‰ - fatal intoxication
> 15 ‰ - sample contamination