TOXICANTS OF PUBLIC HEALTH HAZARD

B-Industrial toxicants (toxic metals)

Industrial chemicals causing diseases have existed ever since man began manufacturing on a large scale & during the industrial revolution occupational diseases became common. Many of the chemicals used in industry are chemically reactive molecules & are likely to interact with biological systems & cause damage in some cases at the site of exposure. Exposure is most commonly via skin &lungs. There are now many thousands of chemical substances used in industry ranging from metals & inorganic compounds which risk people who work with it.

Heavy metal poisoning

Some metals such as iron are essential for life, while others such as lead are present in all organisms but serve no useful biologic purpose. Some of the oldest diseases of humans can be traced to heavy metal poisoning associated with metal mining, refining and use. Heavy metals are found everywhere: including in food, air, water...Cadmium is everywhere contaminant that is presents in many feed and feed ingredients, in particular minerals and forages grown near smelting and mining areas. Arsenic and mercury are heavy metals which are widespread in the environment and which can be found in many feeds, in particular in feeds of marine origin.

Lead poisoning

Lead poisoning is one of the oldest occupational and environmental diseases in the world.

Lead continues to have widespread commercial application (like ingested lead paints, battery, and lead pipes , plastic etc…).

Lead serves no useful purpose in the human body. Lead is slowly but consistently absorbed via the respiratory and gastrointestinal tracts.

Inorganic lead is poorly absorbed through the skin Absorption via the GIT varies with the nature of the lead compound, but in general, adults absorb about10% of the ingested amount while young children absorb closer to50%. The daily lead consumption is about 300µg. It is unsafe if consumed at a concentration greater than 0.5 mg/day for 3 months or more. Once absorbed from the respiratory or GIT, lead is bound to erythrocytes and widely distributed initially to soft tissues, then to the sub periosteal surface of bone and bone matrix. It has a half-life of 2-3weeks in blood and 15 years in bone. More than 90% of the lead that is eliminated appears in the urine.

Lead exerts multi systemic toxic effects through at least three mechanisms by;

- Inhibiting enzyme activity (e. g Interference with enzymes responsible for heme synthesis)
- Interfering with the action of essential cations, particularly calcium, iron, and zinc.
- Altering the structure of cell membranes and receptors (e.g attachment of lead to RBC membranes→ increased fragility and decreased survival time due to interference of sodium-potassium pump).

The sign and symptoms of lead poisoning may include anorexia apathy, behavioral changes, persistent vomiting, convulsions (acute poisoning) & ataxia, wrist & ankle drop, chronic nephritis (chronic poisoning).

Laboratory findings

A. Complete blood count

B) Serum Lead level

C) Erythrocyte Protoporphyrin (EPP) :EPP often referred free erythrocyte Protoporphyrin (FEP). Protoporphyrin accumulates as a result of the lead inhibition of the enzyme ferro chelases, which binds to porphyrin, forming hemoglobin. EPP is regarded as the foremost test for chronic lead poisoning.

Management OR treatment

-Chelating agents (Antidotes) E.g. dimercaprol, CaNa2-EDTA

-Saline purgative

-d-pencilliamine (pb excretion in urin)

Nicotine

Widely available in tobacco products and in certain pesticides, nicotine has diverse pharmacological actions and may be the source of consider able toxicity. These toxic effects range from acute poisoning

to more chronic effects. Nicotine exerts its effects by binding to a subset of cholinergic receptors, the nicotinic receptors. These receptors are located in ganglia, at the neuromuscular junction, and also within the CNS, where the psycho active and addictive properties most likely reside.

The complications of smoking include cardiovascular disease, cancers (especially malignancies of the lung and upper airway), chronic pulmonary disease, and attention deficit disorders in children of women who smoke during pregnancy. Nicotine may be a factor in some of these problems. For example, an increased propensity for platelets to aggregate is seen in smokers, and this platelet abnormality correlates with the level of nicotine. Nicotine also places an increased burden on the heart through its acceleration of heart rate and blood pressure, suggesting that nicotine may play a role in the onset of myocardial ischemia.

TOXICITY OF HOUSE HOLD PRODUCT

- MEDICAL TOXICANTS

Drugs are biologically active molecules used in the treatment, prevention & diagnosis of disease. However, drugs have made & will continue to make a major contribution to human health, we must accept the risks attached to these benefit.

The basic mechanisms for the toxicities arising from drugs are

- Direct& predictable toxic effects due to over doses

- Toxic effects occurring after repeated therapeutic doses

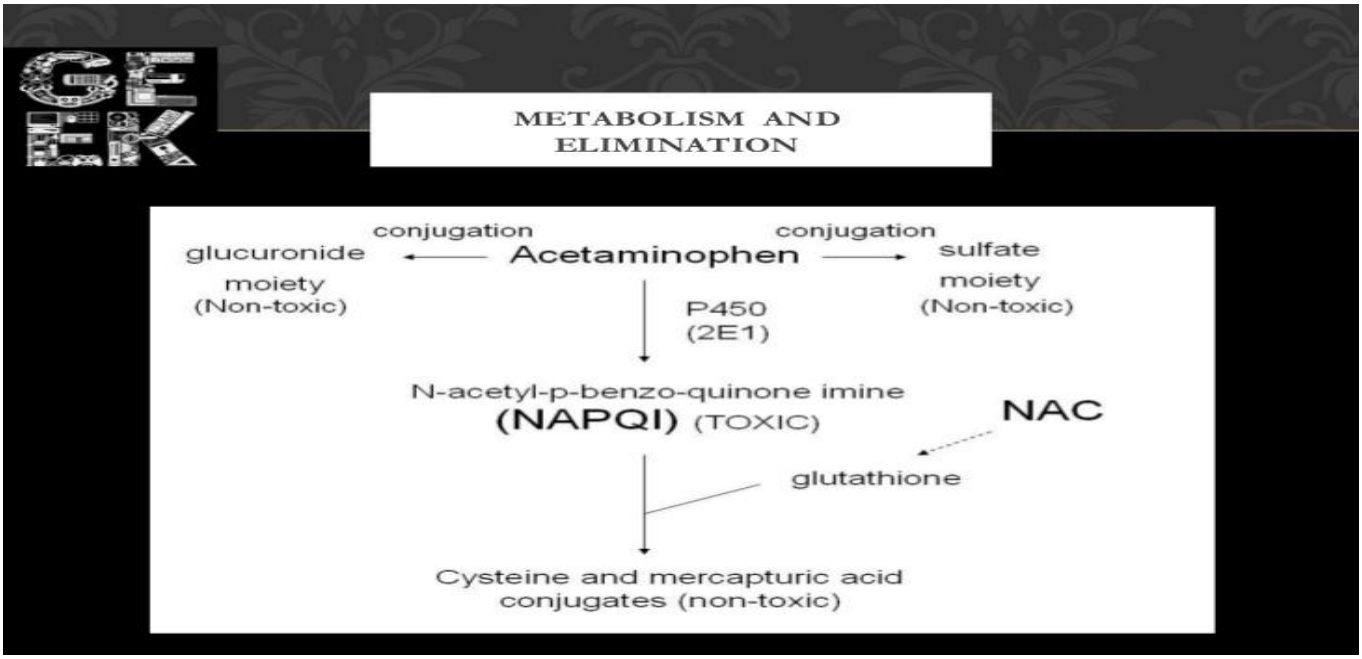
- Direct but unpredictable toxic effects occurring after single therapeutic doses

- Toxic effects due to another drug or substance interfering with the disposition or pharmacological response.

1. Acetaminophen (Paracetamol**)**

Acetaminophen is analgesics for mild &moderate pain which is very safe provided only the normal therapeutic dose. Acetaminophen is one of the drugs most commonly involved in suicide and accidental

poisoning. Initial symptoms after an overdose are mild and non-specific, often resulting in delayed arrival for medical care or a missed diagnosis. Acute ingestion of more than 150-200mg/kg (children) or 7gm (adults) is considered potentially toxic. Paracetamol is metabolized mainly by conjugation & minor proportion metabolized by oxidation which produces toxic products which detoxified normally. However, overdoses change the metabolic scheme giving a rise in toxic metabolite which react with liver proteins & cause tissue damage (leading to hepatic toxicity). Initially, the victim is asymptomatic or has mild GI distressed (nausea, vomiting) which is followed by evidence of liver injury.



2. Aspirin (salicylate)

Acetylsalicylic acid, commonly known as aspirin, is still one of the most widely used minor analgesics. Salicylates, however still accounts for numerous suicidal and accidental poisonings. Salicylate Poisoning can also result from chronic over medication; this occurs most commonly in elderly victims using salicylates for chronic pain because of impaired biotransformation, excretion & others. Salicylic acid is then metabolized by conjugation. The first sign of salicylate toxicity is often hyperventilation and respiratory alkalosis due to medullary stimulation. Metabolic acidosis follows due to accumulation of intracellular lactate as well as excretion of bicarbonate by the kidney to compensate for respiratory alkalosis.

3- Barbiturates

Barbiturates belong to a class of sedative-hypnotic drugs with abuse potential & a recognized withdrawal syndrome. Toxic manifestations of barbiturates vary with the amount of ingestion, type of

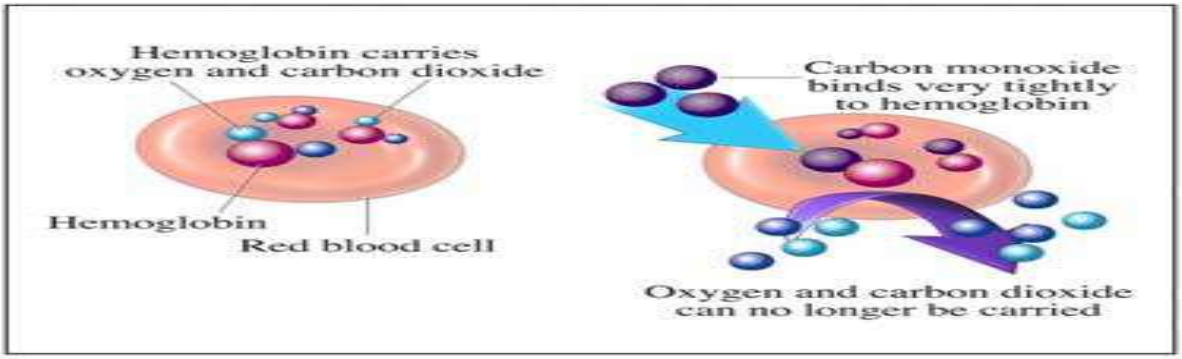
drug and time elapsed since ingestion. Lower doses of short acting barbiturates (E.g. pentobarbital) than the long acting barbiturates (e.g. Phenobarbital) generally cause toxicity, but fatalities are more common with the latter. Mild in toxic action resembles that of alcohol intoxication. Moderate intoxication is characterized by greater depression of mental status and severe intoxication causes coma.

Environmental toxicants

Exposure of biological systems to chemicals may occur through environmental pollution of the atmosphere, water or soil. This results from industrial, agricultural & other human activities. Food born toxins derived from different microbes also can contribute in causing environmental intoxication. The atmosphere may be polluted by gases such as carbon monoxide & particulates.

a) Carbon monoxide (CO) poisoning:

Carbon monoxide is a colorless, odorless gas and lighter than air ,that is everywhere because it is produced by the incomplete combustion of carbon compounds. The possibility of carbon monoxide poisoning is obvious for the victim of fire and smoke inhalation; but accidental and suicidal exposures are also common. The gas is readily absorbed across the alveolus and CO combines 200-250 times greater affinity for hemoglobin than oxygen and producing carboxyhemglobin(COHb). This displacement of oxygen from hemoglobin leads to a decrease in oxygen transport and causes tissue hypoxia. Elimination of carbon monoxide is predominantly through respiration; only about 1% is metabolized to carbon dioxide. Victims with mild to moderate CO poisoning often of headache, dizziness and nausea and vomiting. Severe poisoning may result in chest pain, dyspnea, cherry red skin ,syncope, seizures and coma.



Treatment : 1-Imm. removal from the contaminated environment 2-supplemment 100% O2

3-Hyperbaric Oxygen (HbO) therapy

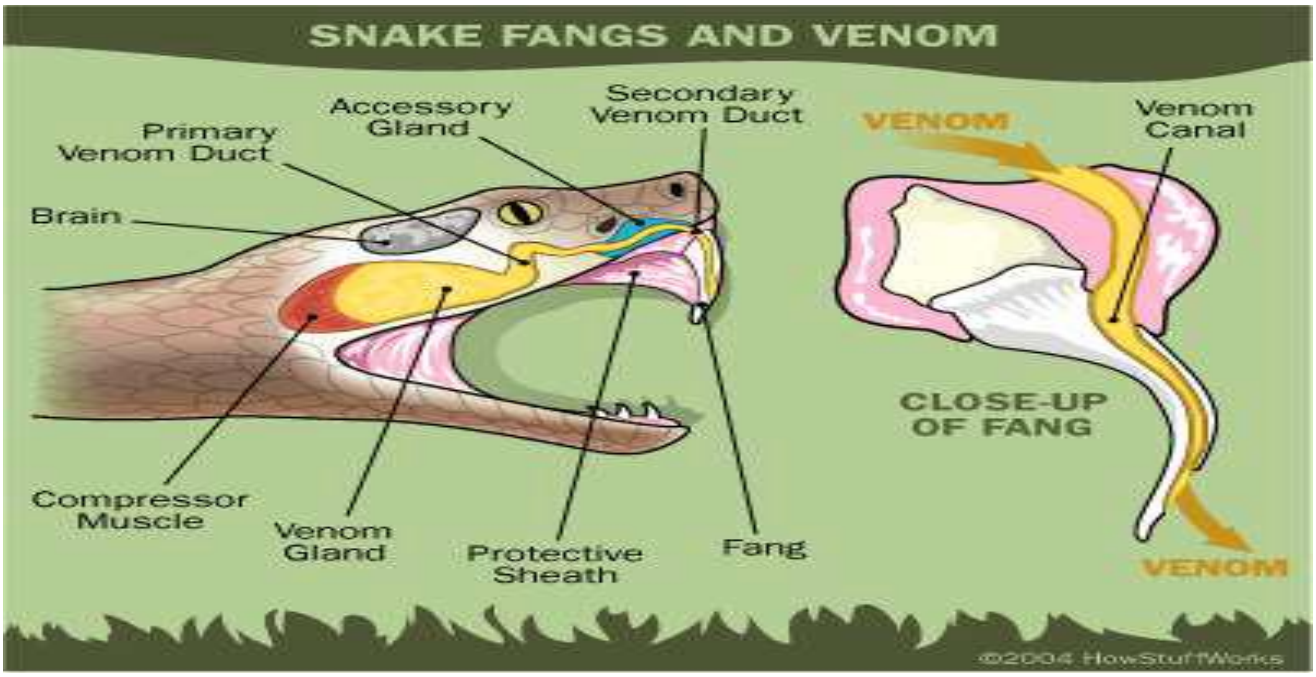
NATURAL TOXIN

a. Animal toxins

Animal toxins comprise a diverse range of structures & modes of action. A simple & well known example is formic acid which is found in ants. Animal toxins are often mixtures of complex proteins. Most of us suffer from animal toxins at some time in our lives. However, in some countries death & illness due to animal poisons represents a significant proportion of cases.

*Snake venom

Snake bite is one of the most common forms of poisoning by natural toxins world wide. The snake venom is a complex mixture of compounds. The enzymatic components of snake venom like proteolytic enzyme , acetylcholinestrase, phosphodiestrase ,anticoagulents and etc…. cause local and sometimes systemic effects, and the non-enzymatic components provide lethality. Absorption of snake venom is variable but most rapid through the blood vessels. Distribution depends on protein binding, membrane permeability and pH. The kidney excretes venom. Clinical presentations of snakebite may be obvious, but not always. It can cause local pain, gradual swelling, bleeding from bite site, nausea, vomiting, diarrhea, hemolytic anemia, hemorrhage, respiratory failure, paralysis or muscle stiffness and shock. **Poisonous snakes**: in india 200 species of snakes. Only 52 are poisonous causes neurotoxic ,hemotoxic ,cardiotoxic and myotoxic



Treatment-

- Immobilize the bitten extremity , do not attempt to suck out poison , Remove any constricting clothing.

-Tie a piece of cloth or a Tourniquet tightly to prevent the venous blood return

- wash the wound by warm water ,potassium permanganate added if available

- Incision and suction on the bite site and Cleaning the bitten area by consult surgeon (in hospital)

- Broad spectrum antibiotic

-antivenin is administrated IV

-if breathing fails do artificial respiration

b) Plant toxins: Many species of plants contain toxic chemicals. There are many well known plant toxins ranging from the irritant formic acid found in nettles to more poisonous compounds such as atropine (atropa belladonna). The concentration of toxic chemicals is variable among the same species & different species. **Major toxic effects are on the skin (e. g allergic dermatitis), GIT (e. g gastroenteritis), cardiovascular (e .g arrhythmia)**

1-Oleander
2-Manchineel
3-Deadly Nightshade (Atropa Belladonna)
4-Castor Beans
5-Water Hemlock (Cicuta)
6-English Yew
7-Rhubarb
8-Daphne
9-Dumb Cane
10-Jimson Weed (Datura Stramonium)

Mycotoxins

Mycotoxins are structurally diverse secondary metabolites of fungi that grow on feed. This class of chemicals comprises **such toxins as aflatoxin, ochratoxin, and the trichothecenes, notably T-2 toxinand deoxynivalenol (vomitoxin).** As a class, these toxins can produce cellular depletion in lymphoid organs, alterations in T- and B-lymphocyte function, suppression of antibody responses. T-2 toxin has also been implicated as a developmental immunotoxicant, targeting fetal lymphocyte progenitors leading the thymic atrophy often observed with these mycotoxins .For ochratoxin, at least, the dose, the route of administration, and the species appear to be critical factors in results obtained in immunotoxicity studies. In addition, in vitro experiments demonstrated that aflatoxin B1 required metabolic bioactivation in order to produce suppression of antibody responses and of mitogen-induced

lympho proliferation . Studies in laboratory animals have also shown increased risk to secondary infection after aflatoxin B1 treatment.For the extensively studied trichothecenes, the mechanism of immune impairment is related in part to inhibition of protein synthesis.

Mycotoxin Effects on Animals

- Feed refusal
- Impaired animal health, resulting in reduced production of eggs, milk, weight gain, etc.
- Metabolites are passed through the milk in cheese, dry milk, and yogurt.

Disease and Death in animals

Biotoxins (Natural toxicants)

Are substances which are both toxic and have a biological origin. They come in many forms and can be produced by nearly every type of living organism: there are **mycotoxins** (made by fungi), **zootoxins**(made by animals) and **phytotoxins** (made by plants).

Many biotoxins can be further classified into what kind of effects they have on the body. Some of these groups include the following:

- **necrotoxins**, substances that cause tissue destruction via cell death and are carried in the bloodstream.
- **neurotoxins**, substances that affect the nervous system.
- **haemotoxins**, substances that are carried in the bloodstream and target red blood cells.
- **cyanotoxins**, produced by cyanobacteria. Also known as Cyanophyta, is a phylum of bacteria that obtain their energy through photosynthesis.
- **cytotoxins**, substances toxic at the level of the cell (kills individual cells).
- mycotoxins, produced by fungi.
- apitoxin, honey bee venom, injected via the sting.

Biotoxins that are a threat to human health (and often animals too) are classified as **biological hazards**. These hazards are often labeled with the well know **'Biohazard'**symbol, so that those who might handle the substance, or come into contact with it, will know that it poses a threat and that the correct precautions must be taken.

There are four levels of biohazard (the **Biosafety Levels**), which can be seen most clearly by looking at the categorisation of the CDC (the Centers for Disease Control and Prevention, USA):

BIOSAFETY LEVEL ONE

- Minimum risk, which involves the least amount of protection – such as the wearing of gloves and a mask. Decontamination procedures for this level are similar to normal hygiene routines: washing hands with soap, disinfect surfaces and autoclave cultures not needed anymore. This level includes bacteria and viruses such as the chicken pox virus (varicella) and Escherichia coli.

BIOSAFETY LEVEL TWO

- Microorganisms that will cause mild disease only, or cannot be contracted easily via the air. For some organisms, special facilities and procedures must be used to make sure that there is not a public outbreak of disease. This includes diseases such as salmonella, influenza.

BIOSAFETY LEVEL THREE

- Microorganisms that can cause severe and possibly fatal disease. However, these organisms don't make the top level as there will be vaccines in existence to protect against them. Diseases in this level include tuberculosis, Plasmodium falciparum (causes malaria) and anthrax.

BIOSAFETY LEVEL FOUR

- These microorganisms can, again, cause severe or fatal diseases – but in this case, treatments or vaccines are not available. These must be dealt with extreme care: the lab must be protected by special entrance and exit procedures including showers, vacuum rooms and UV rooms to make sure that no traces of biohazardous chemicals leave the area, Hazard suits must be worn at all times and an oxygen supply into the designated lab area must be maintained. Diseases included in this final level include smallpox and Ebola