Lecture 9: Occupational health and safety

By

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**Workload:** any effect that at least temporarily disturbs that balance of the internal milieu, thus changing the homeostasis of the body. (originates for work capacity, accident risk…)

**Strain:** the sum of reactions to workload. (increased heart rates, core body temperature…)

**Occupational disease:** a disease contracted as a result of an exposure to risk factors arising from work activity.

**Occupational accident:** an occurrence arising out of, or in the course of work which results in:
- fatal occupational injury; or
- non-fatal occupational injury.

**Occupational injury:** death, any personal injury or disease resulting from an occupational accident.

<table>
<thead>
<tr>
<th>Work-related diseases</th>
<th>Occupational diseases</th>
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</thead>
<tbody>
<tr>
<td>Occur largely in the community</td>
<td>Occur mainly among working population</td>
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<tr>
<td>Multifactorial in origin</td>
<td>Cause is specific</td>
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<tr>
<td>Exposure to workplace may be a factor</td>
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<tr>
<td>May be notifiable and compensable</td>
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Occur largely in the community
Multifactorial in origin
Exposure to workplace may be a factor
May be notifiable and compensable

Occur mainly among working population
Cause is specific
Exposure to workplace essential
Notifiable and compensable
Work-related diseases

Occupational diseases

Partially work-related disease
- the disease has several causative factors
- work plays a partial role in the etiology, but is not the main cause
- work attributable fraction <50%

Occupational disease
- strong link to work
- attributable fraction >50%
- often only one causative factor
- delineated in legislation
## Occupational hazards to human health

<table>
<thead>
<tr>
<th>Type of hazard</th>
<th>Examples</th>
<th>Health effect</th>
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<tbody>
<tr>
<td>Physical</td>
<td>Noise</td>
<td>Noise-induced hearing loss</td>
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<tr>
<td></td>
<td>Local vibration</td>
<td>Traumatic vasospastic disease</td>
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<td></td>
<td>Various chemicals (solvents, heavy metals ..etc)</td>
<td>Intoxication</td>
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<tr>
<td></td>
<td>Bacteria</td>
<td>Fibroses</td>
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<tr>
<td></td>
<td>Fungi viruses</td>
<td>cancers</td>
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<td></td>
<td></td>
<td>Allergies</td>
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<td></td>
<td></td>
<td>Nerve system damage</td>
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<tr>
<td>Biological</td>
<td></td>
<td>Infection</td>
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<tr>
<td></td>
<td></td>
<td>allergies</td>
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<tr>
<td>ergonomic</td>
<td>Repetitive work</td>
<td>Muskuloscelent injuries</td>
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<tr>
<td></td>
<td>Work-rest schedules</td>
<td>Mental stress</td>
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<td></td>
<td></td>
<td>Lowered productivity and work quality</td>
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<tr>
<td>Psychosocial</td>
<td>Organization stress conflicts</td>
<td>Work dissatisfaction</td>
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<td></td>
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<td>Burnout</td>
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<td></td>
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<td>depression</td>
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</table>
### Occupational health vs. Environmental health

<table>
<thead>
<tr>
<th>Occupational health</th>
<th>Environmental health</th>
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</thead>
<tbody>
<tr>
<td>Hazards in workplace environment</td>
<td>Hazards in community environment</td>
</tr>
<tr>
<td>Hazards largely in air</td>
<td>Hazards largely in air, soil, water and food</td>
</tr>
<tr>
<td>Hazards are physical, chemical, biological and Psychosocial</td>
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</tr>
<tr>
<td>Route of exposure: inhalation and dermal</td>
<td>Route of exposure: ingestion, inhalation, and dermal</td>
</tr>
<tr>
<td>Exposure period: 8 hr/day for working life</td>
<td>Exposure period: lifelong</td>
</tr>
<tr>
<td>Exposed population: adults, usually healthy</td>
<td>Exposed population: children, adults, elderly and sick persons</td>
</tr>
<tr>
<td>Environmental monitoring at the workplace</td>
<td>Chemical risk factors</td>
</tr>
<tr>
<td>-----------------------------------------</td>
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<tr>
<td><strong>Volatile Organic Compounds (VOC’s) Monitor</strong></td>
<td>![Image of VOC monitor]</td>
</tr>
<tr>
<td>For dust particles</td>
<td>![Image of dust particles monitor]</td>
</tr>
<tr>
<td>For CO measurement</td>
<td>![Image of CO monitor]</td>
</tr>
</tbody>
</table>
PEL – permissible exposure limits

TLV – threshold limit value

REL – recommended exposure levels

MAC – maximum allowable concentration

(A quantity of exposure which the human body can tolerate without any temporary or lasting damage, or health risks to descendants. Applies to 8-hour working days or 40 working hours per week.)

**Ceiling limits** (C values) - Time allowed: 15 minutes one-shift maximum.

**Biological monitoring:** measured as a concentration of chemical substance that is present in body or its metabolic byproducts or through the specific changes it induces.

**Synergistic responses:** when two or more hazardous material exposures occur the resulting effect can be greater than the effect of the individual exposures. This is called a synergistic or potentiating effect.

**Example:** exposure to both alcohol and chlorinated solvents.

**Human factors that are influencing the effect of poisons:** species- sex- age- pregnancy- breastfeeding- hormone status- bodymass- nutrition- diseases- genetic factors- others
Detoxification:
Absorption
Distribution (water soluble, fat soluble chemicals)
Biotransformation
Excretion

The liver needs to work efficiently to help break down toxins.

All xenobiotics (substances that are foreign to the body or to an ecological system) are potentially dangerous if the toxin is not dealt with by the liver.

The primary way the body deals with xenobiotics is to eliminate them via the urine or bile after processing by the liver, a process called biotransformation detoxification.
What is toxic detoxication? An example:

First, methanol is slowly oxidized by alcohol dehydrogenase to yield formaldehyde.

Next, formaldehyde is oxidized by formaldehyde dehydrogenase to yield formic acid. This oxidation occurs rapidly so that little formaldehyde accumulates in the serum.

Finally, formic acid is metabolized to carbon dioxide and water, which are excreted by the kidneys and lungs.

Formaldehyde and formic acid is more toxic than methanol.

**Excretion**
Information in the genome exists in at least two forms, **genetic and epigenetic**.

The **genetic information** provides the blueprint for the manufacture of all the proteins necessary to create a living organism, whereas the **epigenetic information** provides additional instructions on how, where, and when the genetic information will be used.

**Genotoxic carcinogens**: that bind to DNA and cause mutation by cell initiation (for example: benzene, heavy metals).

**Epigenetic carcinogens**: which are not able to cause mutation and do not blind to the DNA but are able to cause cancer through promotion (for example: hormones, barbiturates).

**Development of cancer from mutation**:

1. Initiation (initiated cell)
2. Promotion
3. Progression

The initiated cell must be exposed to the promoter to complete the second phase.
Genotoxic carcinogens
Chemical capable of producing cancer by directly altering the genetic material of target cells.

**Direct carcinogens** (no metabolic activation)
- Alkylating agents

**Indirect carcinogens** (metabolic activation)
- Polycyclic aromatic hydrocarbons
- Aromatic amines
- Nitrosamines
- Natural substances: Mycotoxins
- Inorganic carcinogens: Ni, Cr, Cd, As

**Epigenetic carcinogens**

**Cytotoxic carcinogens:** Nitrillotriacetate, BHA (Butylated Hydroxyanisole), BHT (Butylated hydroxitoluene)

**Tumor promoters:** DDT, Dixin

**Hormones:** Estradiol, DES (diethylstilboestrol)

**Immunosuppressants:** Cyclosporin A

**Particulates:** Asbestos
**Arsenic**
Exposure to lower levels of arsenic and chronic exposition can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and can lead to progressive peripheral and central nervous changes, sensation of “pins and needles” in hands and feet, hyperpigmentation, hyperkeratosis, „black foot disease”. Arsenic and arsenic compounds are human carcinogens.

**Lead**
Lead can damage nervous connections and cause blood and brain disorders. Lead causes ineffective heme synthesis and subsequent microcytic anemia. Long term exposure to lead or its salts (especially soluble salts or the strong oxidant PbO₂) can cause nephropathy, and colic-like abdominal pains.

**Biological monitoring**: measuring lead level in the blood.

**Mercury**
Chronic exposure may result in tremors, impaired cognitive skills, and sleep disturbance in workers with chronic exposure to mercury vapour even at low concentrations. It affects the human brain, spinal cord, eyes, and kidneys.

**Cadmium**
Cadmium is associated with industrial processes such as metal plating and the production of nickel-cadmium batteries, pigments, plastics, and other synthetics. Chronic exposure can result in chronic obstructive lung disease, renal disease and fragile bones.
**Chromium**

Cr$^{III}$, Cr$^{VI}$ (the latter much more dangerous) Cr$^{III}$ is an essential trace mineral (glucose tolerance factor) acute poisoning (renal tubular necrosis, severe liver damage) chronic poisoning (dermatitis, skin ulcers (‘chrome holes’), ulceration of nasacal mucosa (perforation of nasal septum), airway irritation, chronic bronchitis, Cr$^{VI}$ - lung cancer

Hexavalent chromium enters the human body mainly through inhalation in the form of dust, fume or mist. They are mainly exposed to hexavalent chromium in any of the following ways:

- During the production of chemicals like chromate pigments, chromic acid.
- Working in the close proximity of chrome electroplating.
- While welding of stainless steel, chrome coated metals or chrome alloys.
- At the time of application or removal of paints with chromate content.

**Nickel**

Chronic exposition may lead to chronic rhinitis, sinusitis, perforation of nasal septum, asthma, cancers of the nasal cavities.

**Biological monitoring:** Ni-measurement in the urine
**Benzene**
It is an important industrial solvent and precursor in the production of drugs, plastics, synthetic rubber, and dyes.

**Chronic exposure:** damages the bone marrow and can cause a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and depress the immune system, increasing the chance of infection. Benzene causes leukemia. Benzene targets liver, kidney, lung, heart and the brain.

**Carbon monoxide**
Early symptoms of carbon monoxide poisoning include drowsiness and headache, followed by unconsciousness, respiratory failure, and death. Carbon monoxide binds to hemoglobin three hundred times more strongly than oxygen.