CHEMICAL HAZARDS

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LEARNING OBJECTIVES

By the end of this lecture the students of 4th year MBBS will be able to:

- Enumerate chemical hazards (inorganic dust diseases, organic dust diseases, metals & chemicals)
- Discuss its ill effects on health
- Discuss preventive measures

Who is the Father of Occupational Medicine?

A. Dr. William Rush Dunton

B. Bernardino Ramazzini

C. Alice Hamilton

D. Paracelsus

E. Percivall Pott

BERNARDINI

RAMAZZINI,

Carpenſis Philoſophi ac Medici,

OLIM IN MUTINENSI ACADEMIA

Primi Profeſſoris, poſtremò in Patavino Lyceo Practicæ Medicinæ Profeſſoris Primarii

OPERA OMNIA,

MEDICA & PHYSIOLOGICA.

Acceſſit

VITA AUTORIS A BARTHOL. RAMAZZINO

Med. Doct. ejus ex Fratre NEPOTE ſcripta,

CUM FIGURIS, & INDICIBUS NECESSARIIS.

DE
MORBIS
ARTIFICUM
BERNARDINI RAMAZZINI
IN PATAVINO GYMNASIO
PRACTICÆ MEDICINÆ PROFESSORIS
PRIMARII
DIATRIBA
MUTINÆ OLIM EDITA.
Nunc accedit supplementum ejusdem
argumenti,
AC DISSERTATIO
DE
SACRARUM VIRGINUM
VALETUDINE TUENDA.

PATAVII. M.DCC.XIII.
Per Jo: Baptistam Conzattum.
SUPER. PERM. AC PRIVIL.

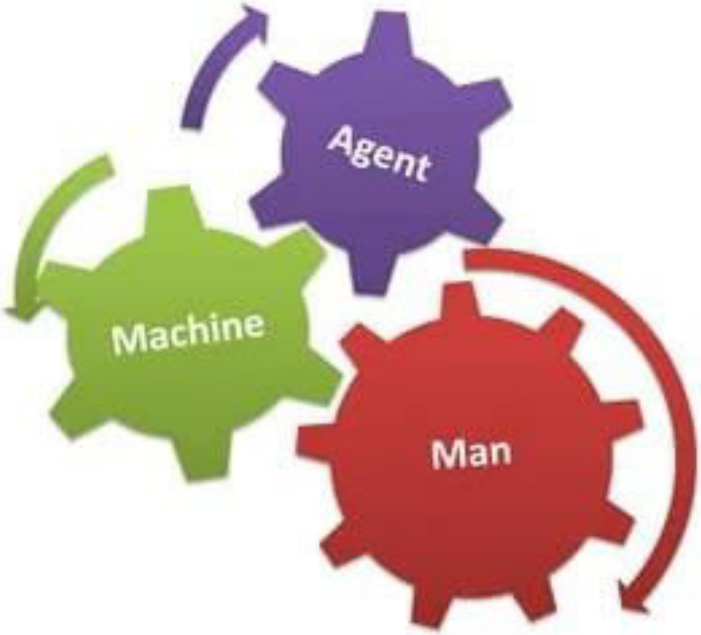
Occupational Health

- *Aim* at the promotion and maintenance of the highest degree of **physical, mental and social well being** of workers in all occupations
- *Prevention* amongst workers of **departures from health** caused by their working conditions
- *Protection* of workers in their **employment from risks** resulting from factors adverse to health

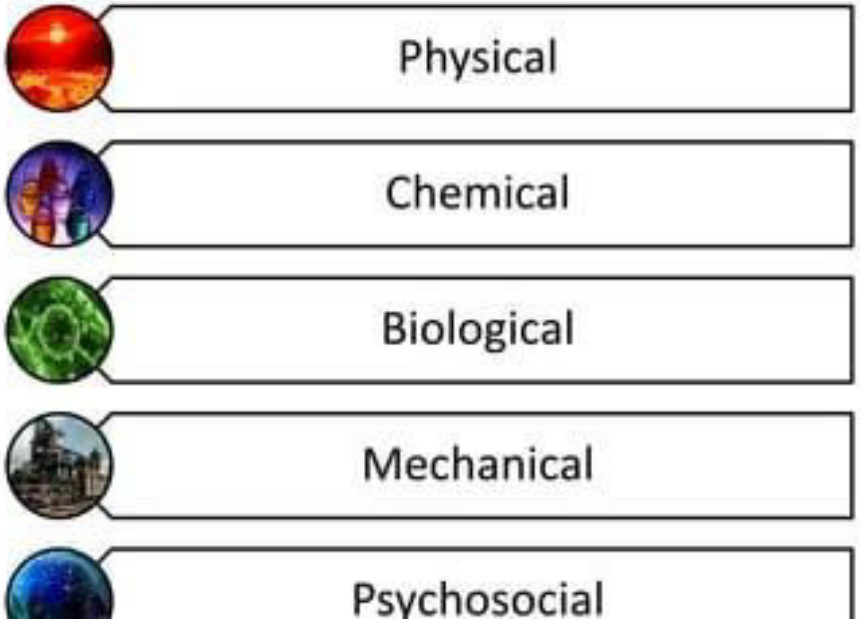
Occupational Health

- *Placing and maintenance of the worker* in an occupational environment **adapted to his physiological and psychological equipment**
- The adaptation of work to man and of each man to his job
- **Ergonomics** is now a well recognized discipline and constitutes an integral part of any advanced occupational health service. The term "ergonomics" is derived from the Greek ergon, meaning work and nomos, meaning law. It simply means: **"fitting the job to the worker"**

Occupational Environment



Occupational Hazards



CHEMICAL HAZARDS

Chemical hazards

- Acts in three ways
  - **Local action**
  - **Inhalation**
  - **Ingestion**
- Illness depends on the duration of exposure, quantity of exposure and individual susceptibility.

Chemical hazards

- **Local action :**
  - Cause dermatitis
  - Eczema
  - Ulcer
  - Cancer

- **TNT and Aniline** absorbed through skin and cause systemic effects.

Chemical hazards

- **Inhalation :**
- Dusts ranging from 0.1 – 150 microns
- > 10 microns settle down in the air
- < 5 microns directly inhaled to lungs – respirable dust.
- Dusts : organic / inorganic
  soluble / insoluble

Chemical hazards

- **Inorganic dusts** : silica, mica, coal, asbestos dust.
- **Organic dusts** : cotton and jute

- **Soluble** : dissolves and enters in to systemic circulation and then eliminated by body metabolism.
- **Insoluble** : remains permanently in the lungs.

Commonest diseases caused by dusts are **silicosis, asbestosis and anthracosis**.

Chemical hazards

- **Gases:** commonest hazard in industries
- **Simple** : oxygen and hydrogen.
- **Asphyxiating gases** : carbon monoxide, sulphur dioxide, cyanide, and chloride.
- **Anesthetic gases**: chloroform, ether, trichloroethylene.

Chemical hazards

- Some **metals and their compounds** enter as dust or fumes

- Toxicity by lead, antimony, arsenic, beryllium, cadmium, manganese, mercury, cobalt, phosphorus, chromium, zinc and others are some of the metals inhaled through dusts.

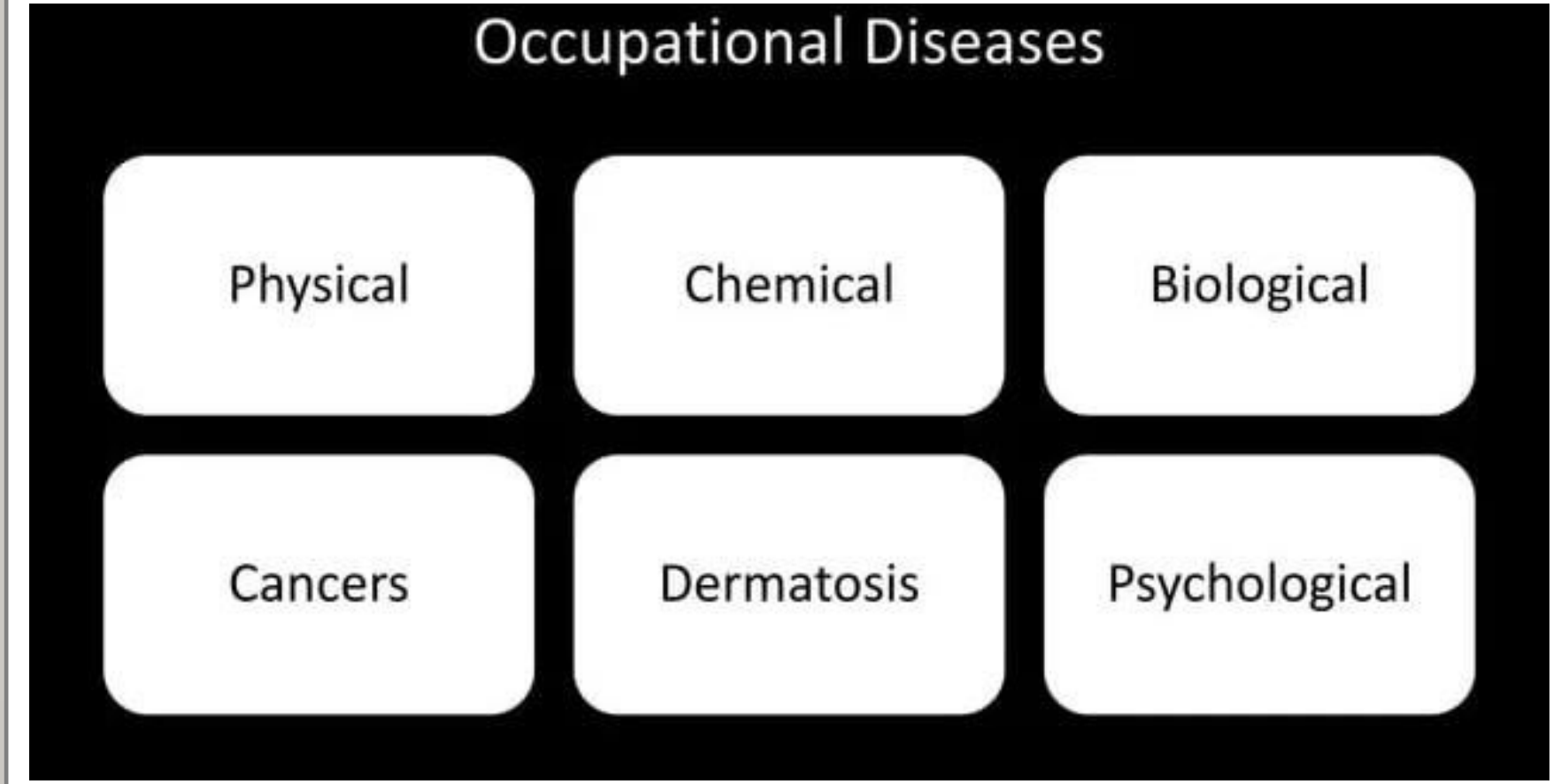
Chemicals Hazards

- **Ingestion:**
- Commonest chemical agents are lead, arsenic, zinc chromium and phosphorus.
- Swallowed as minute amounts through contaminated food and cigarettes.
- Small proportion may reach blood circulation.

Define Occupational Diseases

- An "occupational disease" is any disease contracted primarily as a result of an exposure to risk factors arising from work activity.
- "Work-related diseases" have multiple causes, where factors in the work environment may play a role, together with other risk factors, in the development of such diseases

Classification of Occupational Diseases


Occupational Diseases
Physical
Chemical
Biological
Cancers
Dermatosis
Psychological

Occupational diseases

I. Disease due to physical agents	
Heat	Heat hyperpyrexia, heat exhaustion, heat syncope, heat cramps, burns & prickly heat
Cold	Trench foot, frost bite, chilblains
Light	Occupational cataract, miner's nystagmus
Pressure	Caisson disease, air embolism, blast
Noise	Occupational deafness
Radiation	Cancer, leukemia, aplastic anemia, pancytopenia

Occupational diseases

I. Disease due to physical agents	
Mechanical factors	Injuries & accidents
Electricity	Burns
II. Diseases due to chemical agents	
1. Gases	CO2, CO, HCN, CS2, NH3, N2, H2S, HCL, SO2

Occupational diseases

II. Diseases due to chemical agents				
2.	Dusts (Pneumoconiosis)			
	a)	Inorganic dusts		
		I	Coal dust	Anthracosis
		II	Silica	Silicosis
		III	Asbestosis	Asbestosis, cancer lung
		IV	Iron	Siderosis

Occupational diseases

II. Diseases due to chemical agents				
2.	Dusts (Pneumoconiosis)			
	b)	Organic (vegetable dusts)		
		I	Cane fiber	Bagassosis
		II	Cotton dust	Byssinosis
		III	Tobacco	Tobacossis
		IV	Hay or grain dust	Farmers' lung

Occupational diseases

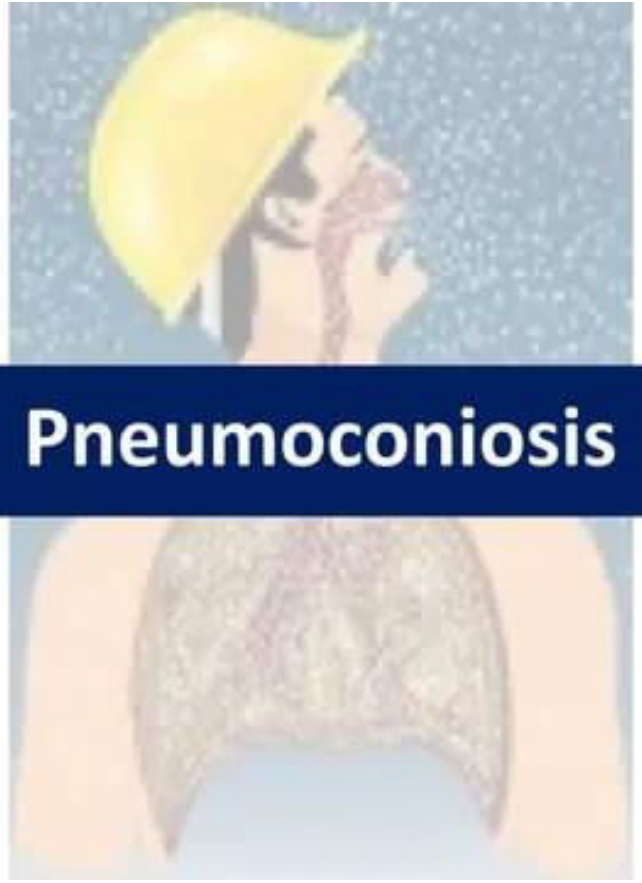
II. Diseases due to chemical agents	
3. Metal & components	Toxic hazards from Lead, mercury, Cd, Mg, Be arsenic, chromium
4. Chemicals	Acids, Alkalis, pesticides, etc
5. Solvents	Carbon bisulphide, benzene, chloroform, trichloroethylene, etc

Occupational diseases

III. Disease due to biological agents
Brucellosis, leptospirosis, anthrax, actinomycosis, hydatidosis, psittacosis, tetanus, encephalitis, fungal infections
IV. Occupational cancers
Cancer of skin, lungs & bladder

Occupational diseases

V. Occupational dermatosis
Dermatitis , eczema
VI. Disease of psychological origin
Industrial neurosis, hypertension, peptic ulcer



Pneumoconiosis

Pneumoconiosis

- The Pneumoconiosis are a group of conditions resulting from the deposition of **mineral dust in the lung** and the subsequent lung tissue reaction to dust.
- Dust within the size of **0.5 – 3 micron**, is a health hazard, which after a vulnerable period of exposure, may reduce working capacity of the man due to lung fibrosis and other complications.

Pneumoconiosis

- The hazardous effects of dust on the lungs depends upon a number of factors such as

1. Chemical composition
2. Fineness
3. Concentration of dust in the air
4. Period of exposure
5. Health status of the person exposed

In addition to the toxic effect of the dust, the **super-imposition of infection like TB** may also influence the pattern of pneumoconiosis

Types of pneumoconiosis

1. Silicosis
2. Anthracosis
3. Byssinosis
4. Bagassosis
5. Asbestosis
6. Farmer's lung

Silicosis

Silicosis

- Among the occupational diseases, silicosis is the major cause of permanent disability and mortality.
- It is caused by inhalation of dust containing free silica/ silicon dioxide.
- The particles are ingested by the phagocytes which accumulate and block the lymph channels.
- Pathologically, silicosis is characterized by a dense "nodular fibrosis, the nodules ranging from 3 to 4 mm in diameter.

Silicosis: Workers at risk

Occupation	Exposure hazard
Sandblaster	Shipbuilding and iron-working
Miner/ tunneler	Underground miners are at risk during roof bolting, shot firing and drilling; surface coal mine drillers are at high risk
Miller	Finely milled silica for fillers and abrasives; "silica flour workers"
Pottery worker	Crushing flint and fetting are major exposures
Glassmaker	Sand used for polishing and enameling
Foundry worker	Silica is essential during mould making; exposure is during fitting
Quarry worker	Slate, sandstone, granite
Abrasives worker	Finely ground particles

Silicosis: signs / symptoms & investigation

- Insidious onset, Irritant cough, dyspnea on exertion and chest pain.
- Impairment of total lung capacity (TLC)
- Mild restrictive ventilatory defect and decreased lung compliance.
- X-ray shows “snow-storm” appearance in lung field.
- Typical & atypical mycobacterial infections
- Tuberculin- positive persons with silicosis have 30 folds greater risk for developing TB (surveillance & treated)

Silicosis: management

- No effective treatment
- Continued exposure should be avoided – Dust control measures : substitution, complete enclosure, isolation, hydro blasting, good house-keeping, personal protective measures and regular physical examination of workers
- Frequent monitoring of dust level for safe working environment.
- Reduction of exposure to quartz above the threshold limit value would reduce the silicosis attack

Anthracosis

Anthracosis

- Coal workers pneumoconiosis is the term used to describe parenchymal lung disease caused by the inhalation of coal dust.
- Miners who work at the coal face in underground mining and drilling in surface mines are at greater risk.

Anthracosis: symptoms, signs & investigation

- Cough with sputum production, often as a result of chronic bronchitis
- **PMF** invariably leads to respiratory insufficiency and death
- X-ray: shows small rounded opacities in the lung parenchyma(often upper lobe), complicated anthracosis / PMF is diagnosed when large opacities are present.
- Caplan's syndrome – rounded dense opacity.
- PFT- complicated disease will show restrictive or mixed pattern.

Anthracosis: Management

- Prevention primarily depends on effective control of exposure to coal mine dust(proper ventilation, use of water spray dust suppression and enclosure of mining operation).
- Removal of miners with early detection of CWP
- Coal worker pneumoconiosis has been declared a notifiable disease in the Indian Mine Act of 1952 and also compensable in the Workmen's compensation

Byssinosis

Byssinosis

- Byssinosis is due to inhalation of cotton fiber dust over long period of time.
- Chronic cough, progressive dyspnoea and end up in chronic bronchitis and emphysema.
- India has a textile industry employing nearly 30% of factory workers.
- Incidence is 7-8%

Bagassosis

Bagassosis

- It is caused by inhalation of bagasse/ sugar cane dust.
- The sugarcane fiber which until recently went to waste is now utilized in the manufacture of paper, cardbroad and rayon.
- It is due to thermophilic actinomycete (thermoactinomyces sacchari).
- It causes breathlessness, cough, haemoptysis and slight fever.

Bagassosis

- Skiagram may show mottling in lungs.
- PFT- impairment.
- If treated early, there is resolution of the acute inflammatory condition of the lung.
- If left untreated – diffuse fibrosis, emphysema and bronchiectasis.

Bagassosis: Preventive measures

- Dust control: wet process, enclosed apparatus and exhaust ventilation
- Personal protection: mask, respirators with mechanical filters or oxygen or air supply
- Medical control: initial medical examination and periodical medical check-ups
- Bagasse control: by keeping moisture content above 20% and spraying the bagasse with 2% propionic acid.

Asbestosis

Asbestosis

- Asbestos is the commercial name given to certain types of fibrous materials, they are silicates of varying composition; combined with magnesium, iron, calcium, sodium and aluminium.
- Serpentine/chrysolite(90%) and amphibole variety.
- Fibers are usually from 20- 500μ in length and 0.5- 50μ in diameter.
- It is used in the manufacture of asbestos cement, fire- proof textiles, roof tiling, brake lining, gaskets, paint, etc
- It is mined in AP, Bihar, Jharkhand, Karnataka and Rajasthan- but most of it is imported

Asbestosis

- Asbestosis refers to the diffuse interstitial pulmonary fibrosis caused by inhalation of asbestos fiber(insoluble).
- It causes pulmonary fibrosis, leads to respiratory insufficiency and death; Ca of bronchus(smoking); mesothelioma of pleura or peritonium; and Ca of GIT.
- More than 5 to 10 years of exposure.
- Fibrosis is diffuse in character, and basal in location.

Asbestosis: signs, symptoms & investigation

- Progressive dyspnea and non productive cough
- Decreased breadth sounds
- Sputum shows "asbestos bodies" which are asbestos fibres
- In advanced stage – clubbing, cardiac distress and cyanosis seen
- X-ray – ground-glass appearance (small, regular/ linear opacity), B/L pleural thickening.

Asbestosis: Preventive measures

1. Use of safer type of asbestos. (chrysolite and amosite)
2. Substitution of other insulants: glass fiber, mineral wool, calcium silicate, plastic foams, etc.
3. Rigorous dust control.
4. Periodic examination of workers; biological monitoring(clinical, X-ray, lung function, scanning of fibers with electron microscopic).
5. Continuing research

Farmer’s lung

Farmer's lung

- It is due to inhalation of mouldy hay / grain dust.
- In grain dust / hay with a moisture content of over 30%bacteria and fungi grow rapidly, causing a rise of temperature to 40 to 50 degree C.
- **Micropolyspora faeni** is the main cause.
- Repeated attacks cause pulmonary fibrosis and inevitable pulmonary damage and corpulmonale.

Lead poisoning

Lead use – reasons

- Low boiling point
- Mixes with other metals easily to form alloys
- Easily oxidised
- Anticorrosive.
- All lead compounds are toxic - lead arsenate, lead oxide and lead carbonate are the most dangerous; lead sulphide is the least toxic.

Industrial uses

- Over 200 industries are counted where lead is used
- Manufacture of storage batteries
- Glass manufacture
- Ship building
- Printing and potteries
- Rubber industry

Non-occupational sources

- The greatest source of environmental (non-occupational) lead is gasoline.
- Thousands of tons of lead every year is exhausted from automobiles.
- Lead is one of the few trace metals that is abundantly present in the environment.
- Lead exposure may also occur through drinking water from lead pipes; chewing lead paint on window sills or toys in case of children.

Mode of absorption of Lead

- **Inhalation:** Most cases of industrial lead poisoning is due to inhalation of fumes and dust of lead or its compounds.
- **Ingestion: P**oisoning by ingestion is of less common occurrence. Small quantities of lead trapped in the upper respiratory tract may be ingested. Lead may also be ingested in food or drink through contaminated hands.
- **Skin:** absorption through skin occurs only in respect of the organic compounds of lead, especially tetraethyl lead. Inorganic compounds are not absorbed through the skin.

Body stores of Lead

- The body store of lead in the average adult population is about 150 to 400 mg and blood level averages about 25µg/100 ml.
- An increase to 70µg/100 ml blood is generally associated with clinical symptoms. Normal adults ingest about 0.2 to 0.3 mg of lead per day largely from food and beverages

Distribution in the body

- 90% of the ingested lead is excreted in the faeces.
- Lead absorbed from the gut enters the circulation, and 95 per cent enters the erythrocytes.
- It is then transported to the liver and kidneys and finally transported to the bones where it is laid down with other minerals.
- Although bone lead is thought to be 'metabolically inactive', it may be released to the soft tissues again under conditions of bone resorption.

Distribution in the body

- Lead probably exerts its toxic action by combining with essential SH-groups of certain enzymes, for example some of those involved in prophyrin synthesis and carbohydrate metabolism.
- Lead has an effect on membrane permeability and potassium leakage has been demonstrated from erythrocytes exposed to lead.

Clinical picture of lead poisoning

- The clinical picture of lead poisoning or plumbism is different in the inorganic and organic lead exposures.
- The toxic effects of ***inorganic*** lead exposure are abdominal colic, obstinate constipation, loss of appetite, blue-line on the gums, stippling of red cells, anaemia, wrist drop and foot drop.
- The toxic effects of ***organic*** lead compounds are mostly on the central nervous system - insomnia, headache, mental confusion, delirium, etc.

Diagnosis of lead poisoning

- **History**: History of lead exposure
- **Clinical features**: Loss of appetite, intestinal colic, persistent headache, weakness, abdominal cramps and constipation, joint and muscular pains, blue line on gums, anaemia, etc
- **Laboratory tests**: Coproporphyrin in urine *(CPU) :* measurement of CPU is a useful screening test. In non-exposed persons, it is less than 150 microgram/litre.
- Amino levulinic acid in urine (ALAU) : If it exceeds 5 mg/ litre, it indicates clearly lead absorption

Diagnosis of lead poisoning

- **Laboratory tests**:
- *Lead* in *blood and urine :* Measurement of lead in blood or urine requires refined laboratory techniques. They provide quantitative indicators of exposure. Lead in urine of over 0.8 mg/litre (normal is 0.2 to 0.8 mg) indicates lead exposure and lead absorption. A blood level of 70µg/100 ml is associated with clinical symptoms.
- *Basophilic stipling of RBC :* Is a sensitive parameter of the haematological response.

Preventive measures for lead poisoning

1. **Substitution:** That is, where possible lead compounds should be substituted by less toxic materials.
2. **Isolation:** All processes which give rise to harmful concentration of lead dust or fumes should be enclosed and segregated.
3. **Local exhaust ventilation:** There should be adequate local exhaust ventilation system to remove fumes and dust promptly
4. **Personal protection:** Workers should be protected by approved respirators.

Preventive measures for lead poisoning

5. **Good house-keeping:** Good house-keeping is essential where lead dust is present. Floors, benches, machines should be kept clean by wet sweeping.

6. **Working atmosphere:** Lead concentration in the working atmosphere should be kept below 2.0 mg per 10 cu. metres of air, which is usually the permissible limit or threshold value.

Preventive measures for lead poisoning

7. **Periodic examination of workers:** All workers must be given periodical medical examination. Laboratory determination of urinary lead, blood lead, red cell count, haemoglobin estimation and coproporphyrin test of urine should be done periodically. Estimation of basophilic stippling may also be done.

An Expert Committee of the WHO states that in the case of exposure to lead, it is not only the average level of lead in the blood that is important, but also the number of subjects whose blood level exceeds a certain value (e .g. , 70µg/ml or whose ALA in the urine exceeds 10 mg/litre)

Preventive measures for lead poisoning

8. **Personal hygiene:** Hand- washing before eating is an important measure of personal hygiene. There should be adequate washing facilities in industry. Prohibition on taking food in work places is essential.

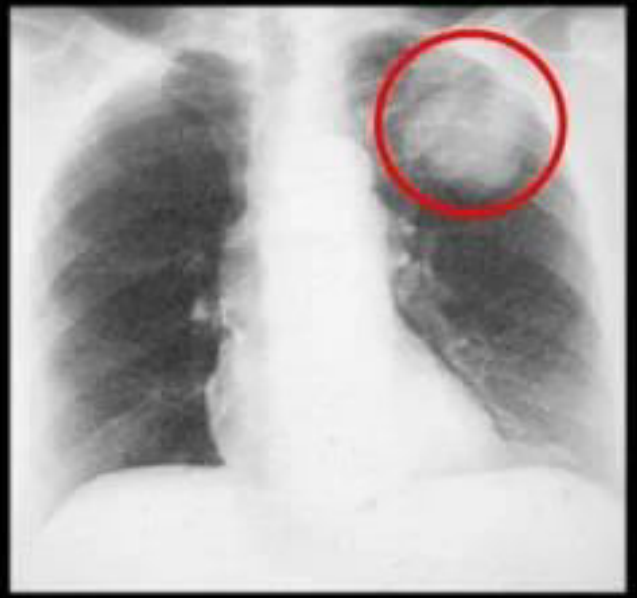
9. **Health education:** Workers should be educated on the risks involved and personal protection measures.

Management of lead poisoning

- Prevention of further absorption, the removal of lead from soft tissues and prevention of recurrence.
- Early recognition of cases will help in removing them from further exposure.
- A saline purge will remove unabsorbed lead from the gut. The use of d-penicillamine has been reported to be effective. Like Ca- EDTA, it is a chelating agent and works by promoting lead excretion in urine.
- Lead poisoning is a notifiable and compensable disease in India since 1924.

Occupational Cancers

Occupational Cancers



Occupational Cancers

- The sites of the body most commonly involved/affected are:
  - Skin
  - Lungs
  - Bladder
  - Blood forming organs

Occupational Cancers

- Exposures at the workplace or in occupation
- Physical agent (such as ionizing radiation or a fibre asbestos)
- Biological agent (such as hepatitis B virus)
- Common occupational carcinogens include Benzidine, 2 - naphylamine, Arsenic, Beryllium, Cadmium, Chromium, Nickel, Asbestos, Silica, Talc containing asbestiform fibres, etc.

Occupational Cancers

- Skin Cancer
  - In Chimney sweeper
  - Caused by coal tar, dyes, x-Rays.
- Lung Cancer
  - Common in gas industry
  - Asbestos industry & mining
  - Tobacco smoking
  - Air pollution

Occupational Cancers

- Cancer bladder
  - Common in aniline dye industry, rubber industry electric cable industry.
- Leukemia
  - Caused by exposure to benzol, X-Rays & radio –active substances.

Characteristics of occupational cancer

- They appear after prolonged exposure
- The period between exposure and development of the disease may be as long as 10 to 25 years,
- The disease may develop even after the cessation of exposure

Characteristics of occupational cancer

- The average age incidence is earlier than that for cancer in general
- The localization of the tumours is remarkably constant in any one occupation

Personal hygiene is very important in the prevention of occupational cancer

Control of Industrial Cancer

1. Elimination or control of industrial carcinogens.
2. Technical measures like exclusion of the carcinogen from the industry, well-designed building or machinery, closed system of production, etc.,
3. Medical examinations
4. Notification
5. Licensing of establishments
6. Personal hygiene measures
7. Education of workers and management
8. Research

Occupational Dermatitis

Occupational Diseases: Dermatitis

Occupational dermatitis

- Big health problem in many industries.
- The causes may be;
- Physical - heat, cold, moisture, friction, pressure, X-rays and other rays;
- Chemical - acids, alkalies, dyes, solvents, grease, tar, pitch, chlorinated phenols etc.
- Biological - living agents such as viruses, bacteria, fungi and other parasites; Plant products - leaves, vegetables, fruits, flowers, vegetable dust, etc.

Dermatitis-producing agents

- **Primary irritants** (e.g. acids, alkalies, dyes, solvents, etc.) cause dermatitis in workers exposed in sufficient concentration and for a long enough period of time.
- **Sensitizing substances:** On the other hand, allergic dermatitis occurs only in small percentage of cases, due to sensitization of the skin.

Prevention of Occupational dermatitis

- Largely preventable if proper control measures are adopted

1. **Pre-selection:** The workers should be medically examined before employment, and those with an established or suspected dermatitis or who have a known pre- disposition to skin disease should be kept away from jobs involving a skin hazard.

Prevention of Occupational dermatitis

2. **Protection:** The worker should be given adequate protection against direct contact by protective clothing, long leather gloves, aprons and boots. The protective clothing should be frequently washed and kept in good order. There are also, what are known as barrier creams which must be used regularly and correctly. There is no barrier cream so far invented which will prevent dermatitis in all occupations.

Prevention of Occupational dermatitis

3. **Personal hygiene:** There should be available a plentiful supply of warm water, soap and towels. The worker should be encouraged and educated to make frequent use of these facilities. Adequate washing facilities in industry are a statutory obligation under the Factories Act.

4. **Periodic inspection:** There should be a periodic medical check-up of all workers for early detection and treatment of occupational dermatitis. If necessary, the affected worker may have to be transferred to a job not exposing him to risk. The worker should be educated to report any skin irritation, no matter how mild or insignificant.

Preventive measures of radiation hazards

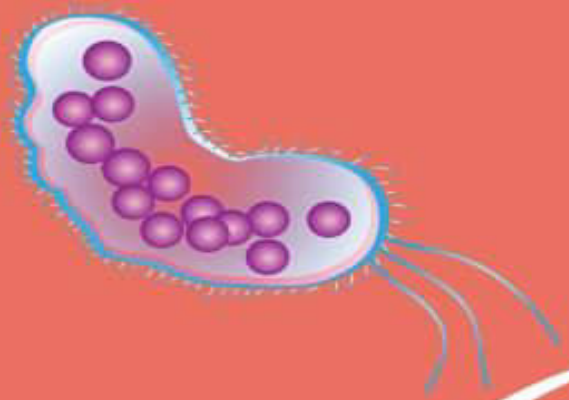
1. Inhalation, swallowing or direct contact with the skin should be avoided.
2. In case of X-rays, shielding should be used of such thickness and of such material as to reduce the exposure below allowable exposures.
3. The employees should be monitored at intervals not exceeding 6 months by use of the film badge or pocket electrometer devices.
4. Suitable protective clothing to prevent contact with harmful material should be used.

Preventive measures of radiation hazards

5. Adequate ventilation of work-place is necessary to prevent inhalation of harmful gases and dusts.
6. Replacement and periodic examination of workers should be done every 2 months. If harmful effects are found, the employees should be transferred to work not involving exposure to radiation
7. Pregnant women should not be allowed to work in places where there is continuous exposure.

Biological Hazards

Microbes



Animals

Plants

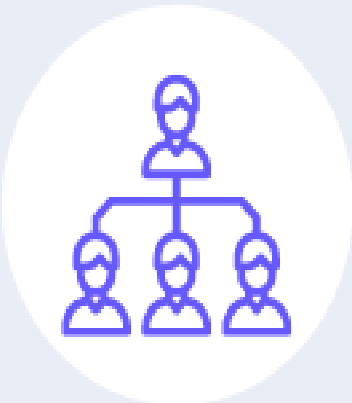
Genetically modified agents

Types of Biological Hazards

- Biological hazards can be put into different categories. The most common biological hazards include:
- **Bacteria** – microscopic organisms that live in soil, water, organic matter or the bodies of animals.
- **Viruses** – a group of pathogens that consist mostly of nucleic acids and that lack cellular structure. Viruses are totally dependent on their hosts for replication.
- **Fungal infections** can affect anyone, and they can appear on several parts of the body.
- Fungal infections can be contagious. They can spread from one person to another. In some cases, you can also catch disease-causing fungi from infected animals

Examples of Psychosocial Hazards in the Workplace

Work relationships



Job insecurity and organizational changes

Work demands

Traumatic events

Psychological Hazards in the Workplace

ENVIRONMENTAL

Poor Lighting

Poor Air Quality

Noise

PERSONAL

Substance Abuse

Mental Illness

Age Related Changes

Work/Life Conflict

Examples of Physical Hazards

1

Slips, Trips, and Falls

2

Exposure to Harmful Substances

3

Confined Spaces

4

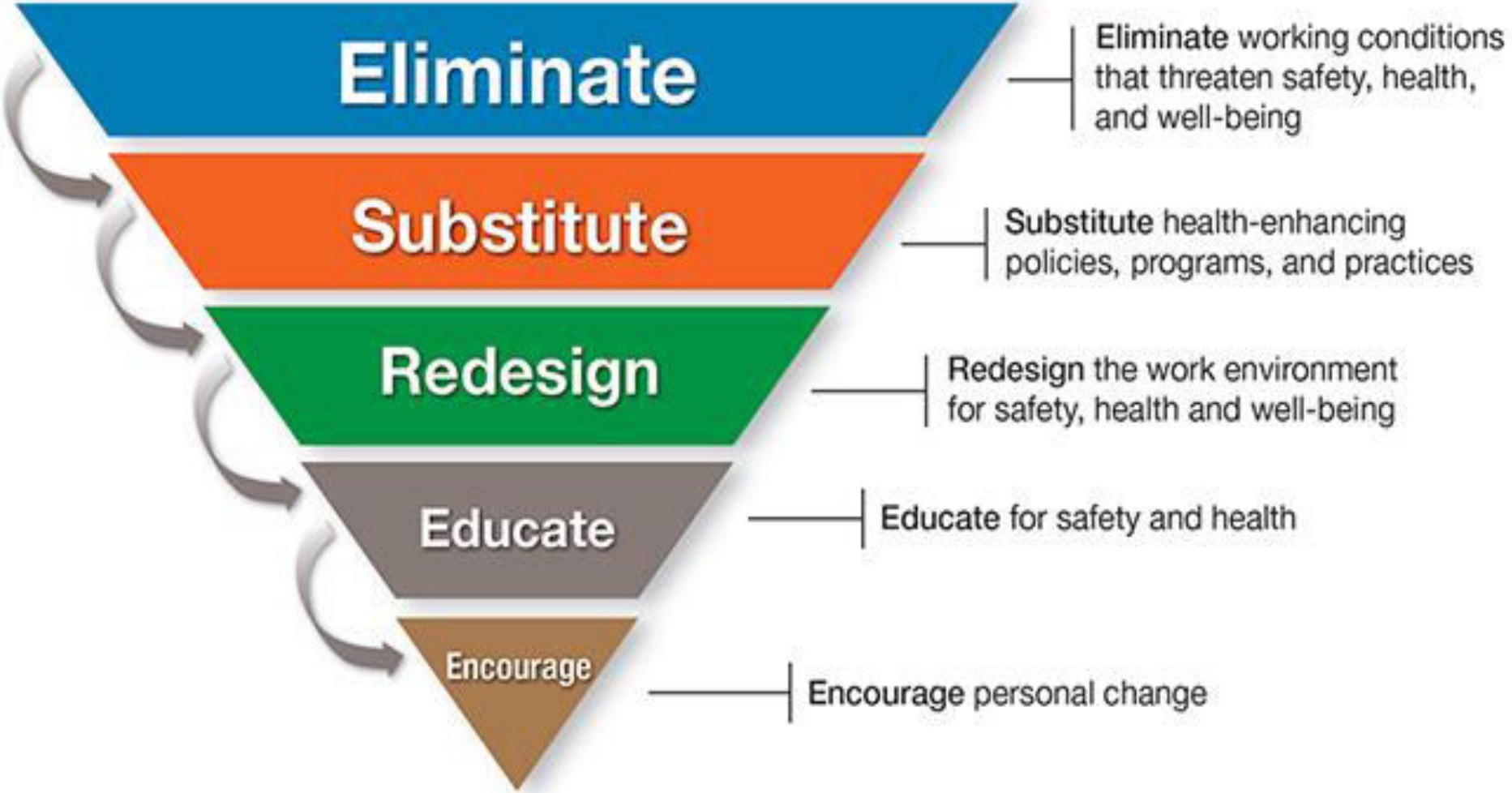
Electricity

5

Extreme Temperatures

6

Toxic Materials


Eliminate
Eliminate working conditions that threaten safety, health, and well-being
Substitute
Substitute health-enhancing policies, programs, and practices
Redesign
Redesign the work environment for safety, health and well-being
Educate
Educate for safety and health
Encourage
Encourage personal change


Thank you ....
19-May-20
Occupational Diseases