OCCUPATIONAL HEALTH

Chemical Hazards

16 TH APRIL 2025

PROF. DR. WAQAR AL-KUBAISY

Chemical hazards

Occupational exposure to Toxic Metals

"heavy metals"

L VIII

16th April 2025

PROF DR. WAQAR AL – KUBAISY

Toxic metals,

- ✓ Toxic metals, including "heavy metals,"
- ✓ are individual metals and metal compounds
- ✓ that negatively affect people's health.
- ✓ very small amounts many of these metals are necessary to support life.
- ✓ However, in larger amounts, they become toxic.
- ✓ They may build up in biological systems and become a significant health hazard.

Most hazardous:

- Lead
- Mercury
- Arsenic
- Cadmium
- Beryllium
- Hexa -valent Chromium

Other toxic metals:

- Aluminum
- Antimony
- Cobalt
- Copper
- Iron
- Manganese
- Molybdenum
- Nickel
- Selenium
- Silver
- Tin
- Vanadium
- Zinc

LEAD POISONING

CONTENTS

- Source & Uses
- Body stores & Distribution
- Lead poisoning
- Clinical features
- Diagnosis
- Management
- Prevention

Lead exposure:

- ❑ **Lead over-exposure is**
- ❖ **one of** the **most common overexposures** found in industry and
- ❖ is a **leading cause of workplace illness**. Therefore,
- ❖ **OSHA** (***The Occupational Safety and Health Administration***) has
- ➢ **established the reduction of lead exposure to be a**
- ➢ **high strategic priority.**
- ❖ **OSHA's five year strategic plan**
- ✓ a **goal of a 15% reduction** in the average **severity** of **lead exposure or**
- ✓ **Employee blood lead levels in selected industries and workplaces.**
- ❑ **Lead poisoning** is also a **major potential public health risk**
- ❖ **In general populations,**
- ❖ **Lead poisoning** is **the leading environmentally induced**
- ❖ **illness in children.**
- ➢ **children under the age of six** are at greatest risk because
- ➢ they are undergoing **rapid neurological and physical development**

❑ lead may be **present in hazardous** concentrations in

- lead may be **present in hazardous** concentrations in
  - **food, water, and air.**
  - **Sources** include paint, urban dust, and folk remedies.

- **Lead dust or fumes are inhaled, or is ingested via contaminated hands, food, water, cigarettes or clothing**
  - **Lead entering the respiratory and digestive systems is**
    - ✓ **released to the blood and distributed throughout the body**

  - **More than 90% of the total body burden of lead is accumulated**
  - **the bones, where it is stored.**
  - **Lead in bones may be released into the blood,**
    - ➢ **re-exposing organ systems long after the original exposure.**

❑ Body Stores :

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

Mode Of Absorption :

- **Lead poisoning (Plumbism) may occur in three ways:**

(1)Inhalation:

- **Most cases of industrial lead poisoning** is due to **inhalation**
- **of fumes and dust** of lead or its compounds.

(2) ***Ingestion:***

- Poisoning 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.**

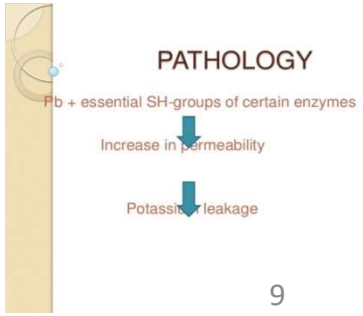
(3) *Skin :*

- Absorption through skin occurs **only in** respect of
  - ✓ **the organic compounds** of lead, especially **tetraethyl lead.**
  - ○ **Inorganic compounds are not absorbed through the skin**

Distribution in The Body:

- 90% of the ingested lead is excreted in the faeces.
  - Lead absorbed from the gut enters the circulation, and
    - 95 % 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.
- 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



characteristic finding of lead poisoning, dense metaphyseal lines.

PATHOLOGY

Pb + essential SH-groups of certain enzymes

Increase in permeability

Potassium leakage

Lead absorption

Oral:
adults absorb **10%**
children absorb **40-50%**
increased absorption if low **Fe, Ca**

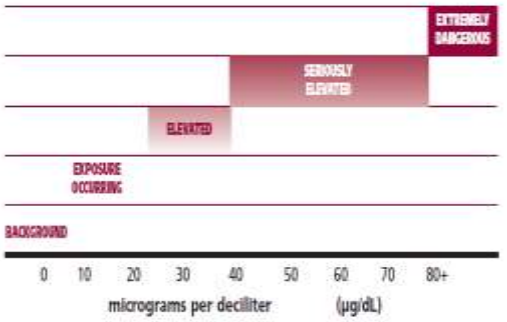
Skin:
little/no absorption

Inhalation (<1μm):
dust or lead fumes
absorb 50-70%

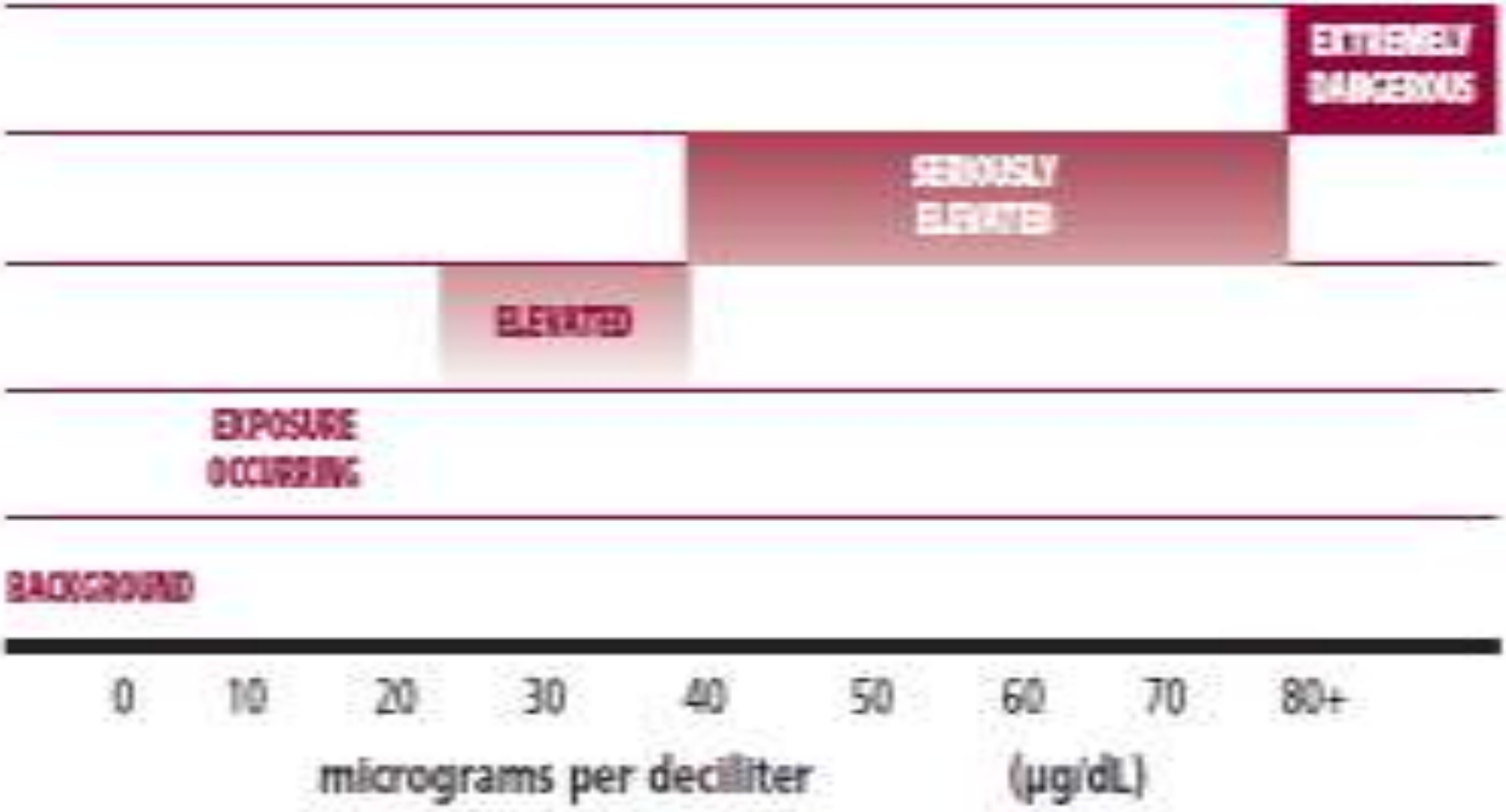
What Lead Levels Are Considered Elevated in Adults?

What Lead Levels Are Considered Elevated in Adults?

- At levels **above 80 µg/dL**, serious permanent
- ✓ health damage may occur **(extremely dangerous).**
- **Between 40 and 80 µg/dL**, **serious health damage**
- ✓ may be occurring, even if **there are no symptoms (seriously elevated)**
- ✓ **Between 25 and 40 µg/dL**, **regular exposure is occurring.**
- ✓ There is some evidence of **potential physiologic problems (elevated).**
- **Between 10 and 25 µg/dL,** lead is **building up** in the body and some **exposure is occurring.**
- ❖ **The typical level for U.S. adults is**
- ❖ **less than 10 µg/dL (mean = 3 µg/dL).**



What Lead Levels Are Considered Elevated in Adults?



SOURCE & USES

- Lead(Pb) is a heavy metal

❑ Occupational & Non-occupational sources

❑ Main source of environmental (non-occupational)source of Pb

➢ is Gasoline

➢ Also through drinking water from lead pipes,

➢ chewing lead paints on toys etc..

❑ More industrial workers are exposed to lead than to any other toxic metal.

❑ Lead is used widely in a variety of industries

➢ because of its properties:

(1) low boiling point

(2) mixes with other metals easily to form alloys سبائك

(3) easily oxidised and

(4) anticorrosive.

LEAD POISONING(PLUMBISM)

All lead compounds are toxic

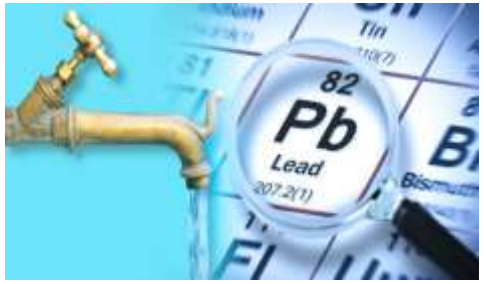
- **MOST Dangerous**
  - lead arsenate,
  - lead oxide and
  - lead carbonate;
- the least toxic is lead sulphide

Industrial Uses :

Over 200 industries are counted where lead is used

- manufacture of storage batteries
- glass manufacture;
- ship building;
- printing and potteries;
- rubber industry and
- several others

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 the case of children.

Clinical Picture :

The clinical picture of lead poisoning or **plumbism** is different in the **inorganic and organic** lead exposures.

Clinical Features

Inorganic Pb exposure:-

- Abd. Colic
- obstinate constipation
- loss of appetite
- blue lines on gums
- stippling of red cells
- anaemia
- wrist drop foot drop

Organic Pb compounds:-

(toxic **effect mainly on CNS)**

- Insomnia
- Headache
- Mental confusion
- Delirium etc..

Clinical picture

Acute lead poisoning

- (as short as days)
- loss of appetite,
- nausea,
- vomiting,
- stomach cramps,
- constipation,
- difficulty in sleeping,
- fatigue,
- moodiness,
- headache,
- joint or muscle aches,
- anemia, and
- decrease in sexuality.
- Acute health poisoning from uncontrolled occupational exposures has resulted in
- fatalities

Long term (chronic):

- as long as several years result
- in severe damage to the
- blood-forming,
- nervous,
- urinary, and
- reproductive systems.
- The frequency and severity
- of clinical symptoms increases with the concentration of lead in the blood

Key lead-induced health effects.

Neurological Effects	Gastrointestinal Effects	Reproductive Effects
♦Peripheral neuropathy	♦Nausea	♦Miscarriages/ Stillbirths
♦Fatigue/Irritability	♦Dyspepsia	
♦Impaired concentration	♦Constipation	♦Reduced sperm count & motility
♦Hearing loss	♦Colic	♦Abnormal sperm
♦Wrist/Foot drop	♦Lead line on gingival tissue	
♦Seizures		
♦Encephalopathy		

Heme Synthesis

- ♦Anemia
- ♦Erythrocyte protoporphyrin elevation

Renal Effects

- ♦Chronic nephropathy with proximal tubular damage
- ♦Hypertension

Other

- ♦Arthralgia
- ♦Myalgia


Lead poisoning
Lead buildup in the body causes serious health problems
Symptoms
- Headaches
- Irritability
- Reduced sensations
- Agressive behavior
- Difficulty sleeping
- Abdominal pain
- Poor appetite
- Constipation
- Anemia
Additional complications for children:
Lead is more harmful to children as it can affect developing nerves and brains
Loss of developmental skills
Behavior, attention problems
Hearing loss
Kidney damage
Reduced IQ
Slowed body growth
Source: MedlinePlus/Mayo Clinic
240809 AFP

DIAGNOSIS

Diagnosis of lead poisoning is based on :

- **History**
- **Clinical features** *such as loss of appetite, intestinal colic, persistent headache, weakness, abdominal cramps and constipation, joint and muscular pains, blue line on gums, anaemia,* etc.
- **Laboratory diagnosis**

a) Coproporphyrin in urine(CPU) Normal- **<150µg/L**

Measurement of CPU is a **useful screening test**.

In non-exposed persons, it is less than 150 1 µg/L

b)Amino levulinic acid in urine(ALAU)

>5mg/L it indicates clearly lead absorption.

c) **Pb in blood and urine:**

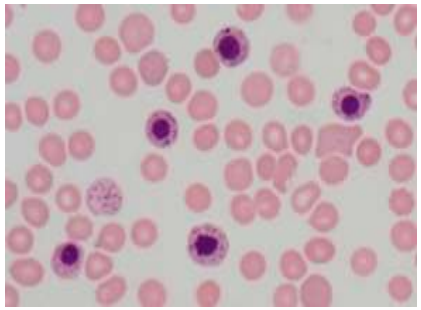
They provide **quantitative indicators** of exposure

- **In urine- >0.8mg/L** indicates **lead exposure** and **lead absorption**

In blood- >70µg/100ml Pb absorption is associated with clinical symptoms

d)Basophilic stippling of RBC: Is a sensitive parameter of the haematological response

Basophilic stippling, also known as **punctate basophilia**, is the presence of numerous basophilic granules that are dispersed through the cytoplasm of erythrocytes in a peripheral blood smear



MANAGEMENT :

❖ **The major objectives in management of lead poisoning are the**

i. **Prevention** of further **absorption,**

ii. **Removal** of lead from **soft tissues** and

iii. **Prevention of recurrence**.

➢ **Early recognition of cases will help in removing them from further exposure.**

❑ Treatment

➢ A saline purge will **remove unabsorbed** lead from the gut.

➢ Like Ca-EDTA, **it is a chelating** agent and works by **promoting lead excretion in urine**.

➢ Chelation therapy is an antidote for poisoning by mercury, arsenic, and lead.

➢ Chelating agents convert these metal

- Chelating agents convert these metal ions into a chemically and biochemically inert form that can be excreted
- **Chelating agents** are used to reduce blood and tissue levels of injurious heavy metals.
- **Chelating agents** are generally classified based upon the target heavy metal – iron, copper, mercury and lead being the major targets

What are thE Treatment Issues To Be Considered For Adults?

- When Lead Poisoning Has Been Diagnosed, The
- **First Course Of Action** Is
- To **Discontinue exposure.**

Whether discontinuation of exposure is **sufficient to treat depends on:**

- **the blood lead level,**
- **severity of clinical symptoms,**
- **biochemical and hematologic disturbances**
- **the nature and history of exposure**

All of these factors must be considered in determining the necessity for chelating therapy.

There is no exact blood lead concentration above which treatment with a chelating agent is always indicated

In most cases, however, when a **blood lead level rises** to 80 μg/dL, **chelation should be considered**, especially in the presence of more **severe signs** and symptoms

Treatment:

Chelating agents for lead poisoning:

1. EDTA - Sodium calcium edetate
2. DMSA – Dimercapto-succinic acid
3. BAL - Dimercaprol
4. Penicillamine - *no* longer recommended

EDTA -Sodium Calcium Edetate

- **IV for severe toxicity,**
- **particularly encephalopathy**
- Well tolerated,
- <1% nephrotoxicity

- **DMSA - 2,3dimercaptosuccinic acid**
- **Oral agent** of choice *for lead poisoning*
- **Given as a 19 days course**
- **Well tolerated**
- **The main problem is foul taste and**
- **smell !!**

Remember:

The exposure must first be discontinued before initiating chelation therapy.

- A single course of chelation may not sufficiently reduce blood lead levels and
- repeat courses may be required among heavily exposed individuals.

Therapeutic chelating agents have potentially adverse side effects and should be used cautiously and on an individual basis

PREVENTIVE MEASURES

The most effective way to protect workers is to minimize their exposure through:

- Engineering controls,
- Good work practices and training,
- the Use of personal protective clothing and equipment, including respirators, where required.

Engineering controls include:

1)Material substitution,
2)isolation,
3)process/equipment modification
4)local ventilation.

a)**Substitution** Pb **compounds** should be substituted by **less toxic materials**

b)**Isolation** All **processes which give rise to harmful concentration of pb dust or fumes** should **be enclosed and segregated**

c)Local exhaust ventilation There should be adequate local exhaust ventilation system To remove dust & fumes

1)**Substitution** Pb **compounds** should be substituted by **less toxic materials**

2)**Isolation** All **processes which give rise to harmful concentration of pb dust or fumes should be enclosed and segregated**

3)Local exhaust ventilation There should be adequate local exhaust ventilation system To remove dust & fumes

4)Personal protection By approved respirators

5)Good housekeeping is essential where lead dust is present.

Floors, benches, machines should be kept clean by **wet sweeping**

6)In working atmosphere Pb conc. Should be kept <2mg per 10cu.m of air which is usually **the permissible limit** or threshold value

6) **Periodic medical 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**

7)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

8)Health education Workers should be educated on the risks involved and personal protection measures

- **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**

How to reduce exposure?

- Wash hands and face before eating, drinking or smoking.
- Eat, drink and smoke only in areas free of lead dust and fumes.
- **Store food and tobacco** in clean areas.
- **Wear a clean, properly fitted respirator** in all areas that have lead dust or fumes.
- **Change into** different **clothes and shoes** before engaging in work with lead.
- **Keep street clothes** and **shoes in a clean place**.
- **Shower after working** with **lead before going home.**
- **Launder clothes separately** from other family members' clothes

I. Guidelines for the Control of Lead in the Workplace

- **First**, test each worker **before they begin** any work involving lead
- Then test that worker **every month:**
  - For the **first 3 months** of testing, and
  - **Whenever the previous blood lead level** was **greater than 25 µg/dL**
    - (If the previous blood lead level was at least 50 µg/dL,
  - a **follow-up test within 2 weeks** and **medical removal** is required) **or**
  - Whenever an **increase of at least 10 µg/dL** from the previous test is observed

II. Voluntary Guidelines for the Control of Lead in the Workplace

- ❑ After the **first three months**, continue testing **every 2 months:**
  - ➢ When the blood lead levels have **remained below 25 µg/dL for 3 months,** and
  - ➢ If an **increase less than 10 µg/dL** from the previous test is observed
- ❑ **Test every 6 months:**
  - ➢ When the blood **lead levels remain below 25 µg/dL for 6 mths,&**
  - ➢ If **an increase less than 10 µg/dL** from the previous test is observed
- ❑ Results of each test should be provided to the worker.
- ❑ Tracking the test results can help the employer and the worker identify whether blood lead levels are
  - ➢ dropping,
  - ➢ remaining stable or
  - ➢ increasing.
  - ➢ The **employer should** also **review the test results for all workers to help identify jobs where problems may be occurring**

Thank you for attention