

OCCUPATIONAL HEALTH

Chemical hazards

Occupational exposure to Toxic Metals

"heavy metals"

LIX

28th April 2025

PROF DR. WAQAR AL – KUBAISY





Iraq mercury contaminated seed grain - CP

MERCURY POISONING

28TH APRIL 2025



MERCURY POISONING

☐ Mercury

- ❖ is a naturally occurring metal, that is in many products everyday, although in **tiny amounts**
- ❖ Small amounts of mercury are present in everyday foods and products, which may not affect our health.
- ☐ **Mercury** itself is naturally occurring,
 - ❖ but the amounts in the environment have been on the rise from **industrialization**
 - ❖ It is often a **by-product** of industrial processes, such as burning coal for power.
- ☐ **Mercury** is a liquid at room temperature and
 - ❖ **readily vaporizes** into the air around it.
 - ❖ Vaporized mercury can make its way into the **rain, soil,** and **water** and

Cont. Mercury Poisoning

❖ where it **poses a risk** to humans. plants, animals, like fish

❑ Consuming foods with mercury is the **most common cause of this type of poisoning.**



❖ The most common cause of **mercury poisoning** is from **consuming** too much **methyl mercury** or **organic mercury** which is linked to eating seafood.

❖ **Children** and unborn babies are the **most vulnerable** to the effects of mercury poisoning

❑ **Ingesting or coming** into **contact** with too much mercury can cause **poisonous**

❑ Mercury is a **type of toxic metal** that comes in different forms within the environment



Cont. ...Mercury Poisoning

- **Mercury and its compounds** exist in **three** general forms:
 - I. **Elemental** (or metallic).
 - II. **Inorganic**: Mercury can combine with other elements (mainly **chlorine, sulfur, and oxygen**) to form **Inorganic Mercury compounds**.
 - III. **Organic**: Mercury may combine with **carbon or carbon-containing** substances to make **Organic Mercury compounds**.

- The difference lies in how it is
 - ✓ **Absorbed**, the
 - ✓ **Clinical signs** and **symptoms**, and
 - ✓ **Response to treatment** modalities.

Elemental mercury



Cont. Mercury Poisoning

Mercury exist in 3 forms

Elemental (or metallic).

Inorganic:

Organic:

❑ **Elemental mercury** is a **heavy liquid**.

- **13.6 times** the weight of water
- Occurs naturally in **soil** and in the **atmosphere** from volcanic emissions الانبعاثات البركانية
- **Evaporates** at room temperature
- The vapor **evaporates** from the liquid and
- **Evaporation** occurs more **rapidly** when the liquid is **heated**.

❑ **Organic compounds** are further divided between

- ❖ **alkyl** (carbon-chain) and
- ❖ **aryl** (aromatic ring) groups.

- Although all mercury compounds **are toxic**,
- the **small-chain alkyl compounds** are the **most hazardous**



Cont. Mercury Poisoning

- ❑ Mercury compounds vary in toxicity, so
- ❑ OSHA provides standards for each.
- ❑ It is important to clarify which category a compound belongs to

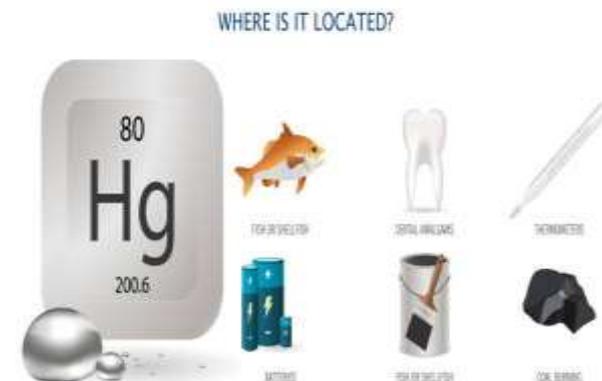
• **before** comparing it with a standard or determining its relative toxicity.

❑ Uses and occupations at risk

- ❖ Mercury is used mainly for the electrolytic production of
 - **chlorine gas and caustic soda** الصودا الكاوية, from brine (**chlor-alkali industry**).
- ✓ **Batteries** , and **electrical switches**

❑ Also mercury compounds are used in:

- **pigments;**
- **as a catalyst explosives**
- **pharmaceuticals**
- **chemical applications**



❑ Mercury is commonly found in **thermometers, manometers, barometers, gauges** المقاييس, **valves, switches, batteries, and high-intensity discharge (HID) lamps.**



❑ Also used in **amalgams for dentistry,**

❑ **preservatives, heat transfer technology, and lubricating oils**



❑ Mercury compounds used as a **seed disinfectant**, on food crops, As a **biocide**، مبيد بيولوجي،



❑ **in paints** and in **paint formulations,**

❑ as a **coating for mirrors,** for the

❑ **manufacture of certain types of glass,**

❑ as a **fungicide in paper** (has been discontinued or banned).



Workers at Risk of being exposed to Mercury:

Some examples

- ❖ Workers in facilities where electrical equipment is manufactured
- ❖ Workers in fluorescent light bulb (CFL) recycling facilities
- ❖ Workers in facilities where automotive parts are manufactured
- ❖ Workers in chemical processing plants that use mercury
- ❖ Workers in medical, dental, or other health services who work with equipment that contains mercury
- ❖ **Dentists** and their **assistants** when breathing in mercury vapour released from amalgam fillings



Mercury poisoning can result from

- I. vapour inhalation,
- II. ingestion,
- III. injection,
- IV. absorption through the skin.



minamata disease

Following ingestion,

- Elemental mercury is **poorly** absorbed and
- **most of it** is **excreted in the feces.**

absorbed through the skin

- Elemental mercury liquid and vapor can be
- **absorbed** through the **skin** in small amounts.
- Elemental mercury is **transferred to the developing child** in a pregnant women

Cont. ...Mercury poisoning result from



- ❑ Inhalation route gives higher exposure
- ❑ The vapor is well absorbed following inhalation.
- ❖ it accumulates in the **kidney** and the **brain**.
- ❑ **Very toxic** to the **nervous** system, also to **kidneys**

- ❑ Elemental mercury is **excreted** from the body **slowly**.
- It has an **elimination half-life** of 40-60 days.

- ✓ **Most elemental** mercury is **excreted** in **exhaled air**,
- ✓ **Small amounts** in the **feces and urine**
- ✓ **Very small amounts** can be eliminated in **sweat, saliva and milk**.

❑ Health Effects:

1. Short Term Exposure

- Harmful effects are **rarely** seen any more because of strict controls used in workplaces where mercury exposure might occur.
- Historically,

❑ Short-term exposure to **high concentrations** of mercury **vapor** caused **harmful effects** on the:

- i. Nervous,
- ii. Digestive
- iii. Respiratory systems, and
- iv. the kidneys.

❑ In most cases, exposure occurred when mercury was **heated**

I. Short Term exposure

II. long Term exposure

II. long term exposure

- ❑ It is caused by **inhalation exposure**.
- ❑ Mercury **liquid** and **vapor** are absorbed **through the skin** in **small amounts** and this can contribute to the overall exposure.
- ❖ Effects following absorption **through the skin** are expected to be **similar** to those reported **for long-term inhalation** exposure.
- ❑ **Mercury levels in urine** are often used as a **general indicator** of how **much exposure** to mercury has occurred.
- ❖ As a result, **urine mercury levels rather than airborne levels** are provided in some of the reports which compare mercury exposures **to specific health effects**.

❖ Urine mercury levels are reported in **microgram /gr of creatinine**

❑ The **relationship** between **airborne mercury levels** and **urine mercury levels** is complicated and depends on many factors, including other sources of mercury exposure & individual differences

❑ Several studies indicate that an

❑ **airborne** exposure of **0.025 mg/m³** compares to approximately **37 micrograms of mercury/gr of creatinine in urine**

❑ **Permissible Exposure Limits**

•0.01=14.8

•0.04=59.2

The Occupational Safety and Health Administration (OSHA) standard for

❖ **Organo alkyl mercury** compound is **0.01 mg /cubic meter** of air for TWA8 (TWA8). 8-hour total weight average

❖ with a ceiling level of **0.04 mg/cubic meter** of air for TWA8

Urine mercury levels are reported in **microgr/gr of creatinine** Cont.

□ Urine mercury levels in adults **without occupational exposure are** typically **less than 3** micrograms/gram of creatinine.

❖ Urinary mercury levels **below 35** micgr/gram of **creatinine** are considered to reflect relatively **low mercury exposure**;

❖ **35 to 50** micrograms/gram of **creatinine** reflects **moderate** exposure;

❖ **50 to 100** micrograms/gram of **creatinine** reflects **moderately high** exposure

•0.01=14.8
•0.04=59.2

❖ **above 100** micrograms/gram of **creatinine** reflects **high exposure**.

•0.01=14.8



❑ Urine mercury levels are reported in **micrograms/gram of creatinine** (a component of the urine).

Urinary mercury levels	Level of mercury exposure
less than 3 micrograms/gram of creatinine	adults without occupational exposure
below 35 micrograms/gram of creatinine	low mercury exposure
35 to 50 micrograms/gram of creatinine	moderate exposure;
50 to 100 micrograms/gram of creatinine	moderately high exposure
above 100 micrograms/gram of creatinine	high exposure

Health Effects

- ❑ Initial **exposure to** high concentrations of mercury vapor **produces** symptoms similar to "**metal fume fever**" including fatigue, fever, chills, nausea, headache, muscle joint pains and lack of appetite in
- ❖ addition **metallic taste** in the mouth may also be reported,
- ❑ **Respiratory system effects** include cough, shortness of breath, tightness and burning pains in the chest and lung inflammation
- ❑ Occupational exposure to **1-44 mg/m³** of mercury vapor **for 4 to 8 hours** cause chest pain, cough, coughing up blood, impaired lung function and inflammation of the lungs.
- In some cases, **pulmonary edema** may occur potentially life threatening
- ❑ Exposure **to high**, but unspecified, concentrations of mercury vapor
- ❖ will **cause death** due to respiratory failure.
- ❖ **All of the reported deaths** resulted from inhaling mercury vapors formed upon heating mercury

28/4/2025

- nervous,
- digestive and
- respiratory systems,
- the kidneys

2. Harmful nervous system effects:

- ❖ Effects on muscle coordination,
 - ❖ mood, behavior,
 - ❖ memory,
 - ❖ feeling ,and nerve conduction
- ❑ **These effects** are often observed in employees with moderately high or **high exposure to mercury**. ????
- ❖ **Tremors** (initially affecting the hands and sometimes spreading to other parts of the body),
 - ❖ **Emotional Instability** (including irritability, excessive shyness, a loss of confidence and nervousness),
 - ❖ **Sleeplessness**, Memory loss, Muscle weakness, Headaches slow reflexes and a loss of feeling or numbness.

- ❖ **Damage** to the **nerves** of the **arms and legs (poly-neuropathy)** has been reported in employees **with high exposures.???**
- ❖ **Reduced sensation** and **strength** in the arms and legs, muscle cramps and **decreased nerve conduction** have been observed.
- ☐ Employees with episodes of **very high exposure** appear to be more at risk of developing these effects

☐ Pathogenesis of Mercury Neurotoxicity

- ❖ • Selectively accumulates in **hippocampus**, basal ganglia, **cerebral cortex**
- ❖ • **Prevents** presynaptic serotonin release and **inhibits** serotonin transport; causes **calcium disruptions**
- ❖ • Causes **demyelinating neuropathy**
- ❖ • Causes abnormal neuronal cyto architecture; disrupts neuronal migration, microtubules, and cell

- ❑ Kidney injury is common following exposure to
 - high concentrations of mercury. Effects range from
 - ✓ increased protein in the urine to kidney failure.
- ❑ Exposure to high concentrations of mercury has also
 - ✓ caused increased blood pressure and heart rate.

- ❑ Effect when come in contact with skin:
 - ❖ Elemental mercury is not known to directly irritate the skin.
 - ❖ However, an allergic skin reaction may develop following contact with mercury.
 - ❖ Elemental mercury liquid and vapor can be absorbed through the skin and may contribute to the overall absorption and toxicity

□ Pregnancy – the risky group

first term pregnancies in the mercury exposed group

- Spontaneous abortion Stillbirth
- Congenital malformations (spina bifida and intra-atrial defect

□ Diagnosing mercury poisoning

- Physical exam and
- blood and
- urine test



- ❖ **Blood mercury** is only useful **within 3 days** of exposure and
- ❖ it is **more reliable** in methyl mercury (high concentrations in RBCs)
- ❖ A **24-hour urine** specimen is a good indicator **for inorganic mercury poisoning**
- ❖ **Hair mercury** level has **no role** in acute Hg toxicity

☐ Mercury Poisoning Treatment

- There's **no cure for mercury poisoning**.
 - **Neurological** effects from mercury toxicity **are** often **permanent**
 - When **detected early**, mercury poisoning **can be halted**.
-
- ☐ The best way **is to stop exposure** to the metal.
 - ❖ *Eat a lot of mercury-containing seafood, stop immediately.*
 - ❖ If toxicity is **linked to workplace**,
 - **Remove** from the area to prevent further effects of poisoning²².
 - ❖ If mercury levels reach a certain point **start chelation therapy**.
 - *Chelating agents are: drugs that remove the metal from organs and help body dispose of them.*

☐ In inhalational mercury

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❑ In inhalational mercury

- ❖ No role of inducing emesis
- ❖ **Oral steroid is a common practice but without substantial evidence**
- ❑ Most inhalational form are self limited
- ❖ If mercury levels reach a certain point **start chelation therapy.**
- ❑ **Hemodialysis** is used in **severe** cases of **toxicity** when renal function has declined

❑ Control hazardous conditions

- Mercury is a **VERY TOXIC** liquid.
- It is also **CORROSIVE** to many metals.
- also forms amalgams with some metals, like gold jewelry.



❑ Controlling mercury exposure is best accomplished through:



- ❖ **substituting** with a non-toxic chemical, *depending on the application. If not.*
- ❖ **engineering,**
- ❖ **administrative,**
- ❖ **personal protective equipment (PPE)**

Engineering methods include:

- ❖ **Mechanical ventilation (dilution and local exhaust),**
- ❖ **Process or personnel enclosure,** *control of process conditions, and process modification*
- ❖ **Stringent صارم control measures (closed handling system) or**
- ❖ **isolation** may be necessary.
- ❖ **Use a corrosion-resistant local exhaust ventilation system**
- ❖ **separate from other exhaust** ventilation systems
- ❖ **Cleaning of contaminated exhaust air before release to the outdoors may be necessary**

Personal protective measures include:

- Have appropriate PPE**
- ❖ **Approved respiratory protection. If respiratory protection is required,**

institute a **complete respiratory** including

- institute a **complete respiratory protection** program including
 - ❖ **selection**, fit testing, training, maintenance and inspection.
 - ❖ **A face shield** may also **be necessary** to protect eye and face.
 - ❖ Chemical protective **gloves**, coveralls, boots, and/or other chemical protective clothing are required **to protect skin**.
 - ❖ A chemical protective **full-body encapsulating suit** and respiratory protection may be required in some operations
 - ❖ **Remove contaminated** clothing immediately and *put in a closed container*.
 - ❖ **Discard** or launder before re-wearing.
 - ❖ Inform laundry personnel of contaminant's hazards.
- Do not eat, drink**, or smoke in work areas.
- Wash hands thoroughly after handling this material.
- Maintain good housekeeping

Handling recommendations for the industrial use of mercury.

- ❖ **Before handling**, it is important that:
 - **Engineering Controls** are **operating** and
 - PPE requirements and **personal hygiene measures** are being followed.
 - **People working with** this chemical should be **properly trained** regarding its hazards and its safe use.
 - **Unprotected persons** **should avoid** all contact with this chemical
 - including contaminated equipment
- ❖ **Use the type of container** recommended by the manufacturer
 - **Inspect containers** for leaks before handling
 - **Immediately report** leaks, spills or ventilation failures.
 - **Never return contaminated material** to its original container
 - **Secondary protective containers** **must be used** when this material is being carried.



Handling recommendations for the industrial use of mercury Cont. ...



- **Label containers.** Avoid damaging containers.
- **Keep containers tightly closed** when not in use.
- ❖ Assume that empty containers contain residues which are hazardous
- Avoid generating **vapors or mists.**
- **Do not heat mercury** in other than a closed system.
- ❖ Good housekeeping is very important
- **Do not use on porous work surfaces** (e.g. wood).
- ✓ **Use work surfaces which can be easily decontaminated**

Thank you ...



**Thank
you**

28/4/2025



Any questions?
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BIOLOGICAL HAZARD

(Biohazards)