

OCCUPATIONAL HEALTH

Chemical hazards

Occupational exposure to Toxic Metals

"heavy metals"

LIX

28th April 2025

PROF DR. WAQAR AL – KUBAISY

28/4/2025



MERCURY POISONING

28TH APRIL 2025



Iraq mercury contaminated seed grain - CP



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

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and

(affect health human)

where it poses a risk to humans

Cont. Mercury Poisoning

Most of seafood contaminated
it

❖ 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 **organic 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



☐ 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.

That's why you should know type?

Depend on type.

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 ^{heavier than} 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**.
in high concentration

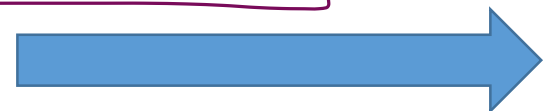
❑ **Organic compounds** are further divided between

❖ **alkyl** (carbon-chain) and *More Dangerous Aryl*

❖ **aryl** (aromatic ring) groups.

• Although all mercury compounds **are toxic**,

• the **small-chain alkyl compounds** are the **most hazardous**



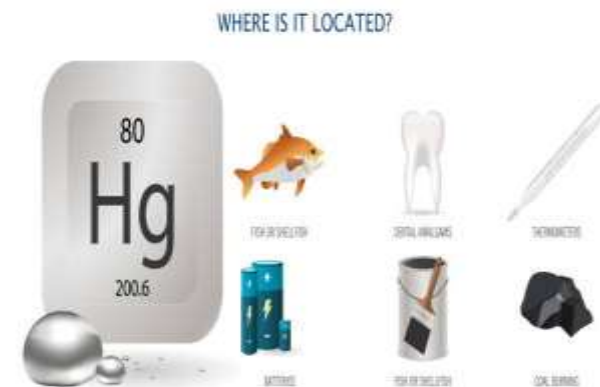
Occupational Safety & Health Cont. Mercury Poisoning

- ❑ 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 *(CFLS)*
- ❖ 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.



☐ Following ingestion,

@elementary
H/L/L

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

minamata disease

in Japan
eating Sea food

☐ 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

Inhalation route

Cont. ...Mercury poisoning result from

Higher Absorption



- ❑ 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:

I. Short Term exposure

II. long Term exposure

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:

- Nervous,
- Digestive
- Respiratory systems, and
- the kidneys.

❑ In most cases, exposure occurred when mercury was heated

[high concentration cause heating]

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.
 Handwritten: No A/C
- ❖ 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 *micrograms*

❖ 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

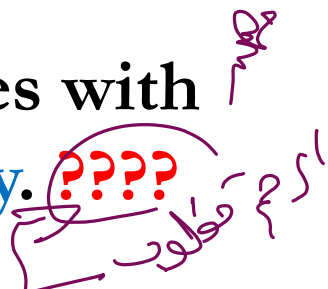
Health Effects


- ❑ 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 occurred 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

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- 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 division

- ❑ 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 pregnancies¹ 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

WHO, 2002

no indication

❑ 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**



❑ 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:**

First line prevention

- ❖ **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. *vaporated* *عنه ما يتبخر*
- ❖ 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)

Which of the following is the most common cause of mercury poisoning?

- A) Inhalation of mercury vapor**
- B) Consumption of contaminated seafood**
- C) Skin contact with mercury**
- D) Injection of mercury compounds**

Answer: B) Consumption of contaminated seafood

What is a major environmental source of increased mercury levels due to industrialization?

- A) Plastic production**
- B) Coal burning**
- C) Oil drilling**
- D) Automobile emissions**

Answer: B) Coal burning

Which group is especially vulnerable to the effects of mercury poisoning?

- A) Elderly individuals**
- B) Athletes**
- C) Children and unborn babies**
- D) Healthcare workers**

Answer: C) Children and unborn babies

Organic mercury compounds are characterized by mercury binding to which types of chemical groups?

- A) Oxygen and nitrogen groups**
- B) Carbon chains or aromatic rings**
- C) Sulfur and chlorine groups**
- D) Phosphate groups**

Answer: B) Carbon chains or aromatic rings