



**USAID**  
FROM THE AMERICAN PEOPLE

# THE EFFECTS OF METAL EXPOSURE ON HUMAN HEALTH

*Bac Ninh, January 2021*

*Disclaimer: The training program is organized and co-chair by Bac Ninh DONRE and CECOD, with financial support from USAID through Pure Earth.*

# THE EFFECTS OF METAL EXPOSURE ON HUMAN HEALTH

❖ Heavy metals are those with a density greater than  $5\text{ g / cm}^3$  (eg: Cu, Pb, Hg, Cd, As, Mn, Cr, ...). Heavy metals are toxic to the environment and organism when their content exceeds the permitted standards.

❖ The effects of heavy metal exposure depend on:

➤ Concentration - toxicity

➤ Contact time

➤ Frequency of exposure

❖ Exposure status: acute and chronic

## *Acute exposure:*

- Acute adverse effects of heavy metals are usually observed only after short term exposure to high concentrations.

- Acute heavy metal exposure can cause digestive disorders (anorexia, nausea, vomiting, abdominal pain); damage to the liver and kidneys; high blood pressure and neurological effects (fatigue, drowsiness, encephalopathy) can lead to seizures and death.

# THE EFFECTS OF METAL EXPOSURE ON HUMAN HEALTH

## *Chronic exposure:*

- Heavy metals (Cu, Pb, Hg, Cd, As, Mn, Cr, ...) are chronic or cumulative toxins.
- Chronic heavy metal exposure often causes hematological effects, such as anemia or neurological disorders, including headache, irritability, coma, convulsions, muscle weakness, ataxia, tremor and polio.
- Long-term occupational exposure to heavy metals can contribute to cancer development. The International Agency for Research on Cancer has shown that inorganic and organic heavy metal compounds can cause cancer in humans.
- Not treating heavy metal exposure in the early stages can cause long-term or permanent impairment of health, but because of the general nature of early-stage symptoms, exposure to heavy metals is often difficult to detect. Therefore, it is necessary to see a specialist thoroughly and have a blood test to know the exact results.

# THE EFFECTS OF METAL EXPOSURE ON HUMAN HEALTH

❖ Heavy metal exposure affects all subjects (adults, children, pregnant women) and affects many organs of the body, causing brain, nerve, liver, kidney, heart diseases. pulse, digestion, ...

❖ Children under 6 years old and pregnant women are most susceptible to the harmful health effects caused by heavy metals.

❖ In adults, 95% of the amount of heavy metals entering the body will be accumulated in the bones, in children only about 64% of the total amount of heavy metals will be accumulated in the bones (due to less dense bones). accumulates in the blood, brain and kidneys.

Children have 4-5 times the level of heavy metal absorption compared to adults, the half-life of heavy metals in children is also much longer than in adults, especially children under 6 years old.

❖ Iron and calcium deficient children increase the ability to absorb heavy metals.

# THE EFFECTS OF METAL EXPOSURE ON HUMAN HEALTH

❖ Heavy metal is not toxic in its free element form, but very toxic in the ionic form, because it can bind short carbon chains which are difficult to eliminate and cause poisoning. The dose of toxicity is different for each type of metal, for example:

❖ *Dose causing arsenic poisoning:* The dose causing acute poisoning: 60mg  $\text{As}_2\text{O}_3$ ; Lethal dose: 70 - 80mg  $\text{As}_2\text{O}_3$ ;

❖ *Dose causing mercury poisoning:* Acute poisoning dose, often fatal: 150-200mg; Chronic poisoning dose after a few weeks: 0.5 - 0.4mg / 24h. Lethal dose: 1 gram. Dose: 0.007 mg / 24h may cause toxicity in people who cannot tolerate it.

*Dose causing lead poisoning:* If a dose of 0.5 mg / day begins to show symptoms of poisoning, then a dose of 10mg / day of severe poisoning after a few weeks. Fatal dose: 1 gram of lead (equivalent to 5% lead acetate) absorbed into the body once.



# THE EFFECTS OF METAL EXPOSURE ON HUMAN HEALTH

- ❖ Lead (Pb): is an element with high toxicity to human health. Lead is toxic to the central nervous system, peripheral nervous system, and acts on the enzyme system containing hydrogen-containing active groups. People with lead poisoning will suffer from disorders of the hematopoietic organ (bone marrow). Depending on the degree of toxicity, abdominal pain, joint pain, nephritis, high blood pressure, brain stroke, or severe poisoning can be fatal. The outstanding feature is that after entering the body, lead is less eliminated, but accumulates over time before being toxic.
- ❖ Lead gets into people's bodies through lead-contaminated drinking water, air and food.  
Lead accumulates in bones, inhibits calcium metabolism by inhibiting vitamin D metabolism.
- ❖ The maximum permissible standard according to WHO lead concentrations in drinking water: £ 0.05 mg / ml.

# Lead exposure in children

In children, heavy metal exposure can cause:

➤ *Damage to the brain and nervous system*

- Acute encephalopathy
- Altering the function of the developing brain
- Making changes to the EEG
- Convulsions
- Cerebral palsy
- Peripheral nerve disorders
- Lack of limbs
- Dizziness



# Lead exposure in children

## ➤ *Growth and development*

- Neurodevelopmental delay
- Reduced height and growth rate
- The endocrine-thyroid system is impaired
- Osteoporosis in later years
- Weight lost

## ➤ *Cognitive development*

- Reduced IQ
- Cognitive impairment
- Slow to speak
- Difficult to study, learning results decrease
- Loss of memory and thinking ability, even at blood lead level less than 10  $\mu\text{g}$  / dL



# Relationship between lead-infected blood and IQ

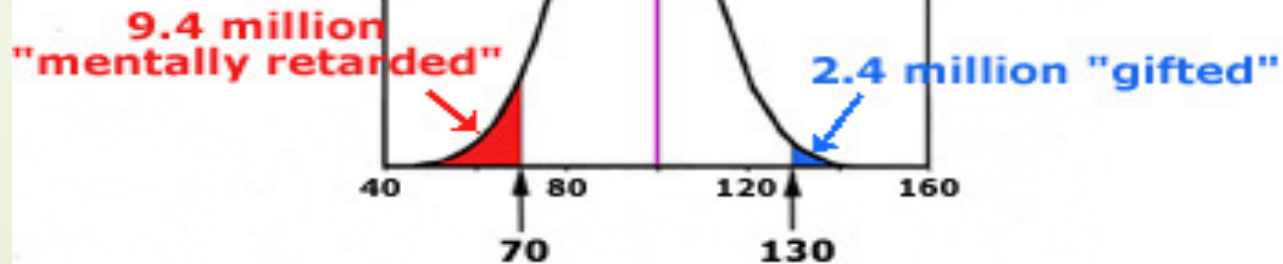
Blood Lead Levels (ug/dl)	IQ Deficits in 0-4 years old (points)	
	Lanphear	Schwartz
2	-1.87	-0.51
4	-3.74	-1.03
6	-4.83	-1.54
8	-5.61	-2.06
10	-6.21	-2.57
15	-7.31	-3.86
20	-8.08	-5.14
30	-9.18	-7.71
40	-9.96	-10.28
50	-10.56	-12.85
60	-11.05	-15.42

Average IQ = 100



57% increase

Average IQ = 95



# Lead exposure in children

## ➤ *Behavioral problems*

- Aggressive, difficult to manage
- Easily irritated, unable to control behavior
- Causing violence, violence, hostility, anti-social or illegal behavior
- Autism

## ➤ *Hearing and eyesight*

- Khiếm thính, độ nhạy thính giác giảm Hearing loss, reduced hearing sensitivity
- Degeneration of the retina, impaired vision
- Impairment of sensory function

# Lead exposure in children

## ➤ ***Movement and muscles***

- Impaired motor function
- Muscle strength and stamina are impaired
- Disabled
- Body ache

## ➤ ***Gastrointestinal system***

- Impaired vitamin D metabolism (affects mineral and calcium absorption)
- Stomached
- Anorexia
- Nausea, vomiting
- Constipation, diarrhea

# Lead exposure in children

## ➤ *Kidney and blood circulation*

- Kidney disease - acute kidney disease
- Kidney disease
- Anemia

## ➤ *Exposure to high concentrations can cause death*



A baby is being treated for lead removal



# Lead exposure in pregnant women

- ❖ In pregnant women, lead exposure can cause:
  - Miscarriage, stillbirth, and neonatal mortality
  - Reduce gestational age, premature birth
  - Reduce birth weight
  - Abnormal reproduction, disorder
  - Decreased placental function
  - Birth defects
  - Lead is carried through the placenta to the fetus from the mother
- ❖ Human placenta lead infiltration occurs very early in the 20th week of pregnancy and continues throughout pregnancy.

# Lead exposure in adults

In adults, lead exposure can cause:

## ➤ *Reproductive problems*

- Reduce libido
- Weak sperm count and quality: decrease in sperm count and increase in abnormal sperm count
- Infertility

## ➤ *Kidney*

- Kidney damage
- Death from nephritis

## *Nervous system*

- Brain disease, brain hemorrhage
- Suy giảm hệ thống thần kinh ngoại biên
- Tremor, polio

# Lead exposure in adults

## ➤ *Heart*

- Increased risk of cardiovascular disease
- Hypertension, high blood pressure
- Coronary artery disease
- Anemia, decreased hemoglobin concentration
- Increased risk of death from heart attack or stroke

## ➤ *Intellect, behavior and spirit*

- Depression
- Nervousness
- Easily irritated, agitated
- Change of personality
- Death from violence, suicide, and accident
- Decreased concentration, impaired cognition and memory

# Lead exposure in adults

## ***Digest***

- Loss of appetite
- Vomit
- Constipation, diarrhea
- Stomachache
- Anorexia, weight loss.

## ***➤ Bones, muscles and joints***

- Muscle pain, joints, gout
- Cramp
- Weak body
- Osteoporosis, increased risk of fractures.

# Lead exposure in adults

## ➤ *Feeling*

- Visual impairment
- Hearing loss

## ➤ *Other*

- Headache
- Reduce life expectancy
- Adrenal gland dysfunction
- Haggard
- Cell damage
- Increased risk of death from cancer





# References



- <http://www.who.int/ipcs/features/lead..pdf>
- <http://epa.gov/superfund/lead/health.htm>
- [http://www.who.int/ipcs/assessment/public\\_health/lead/en/](http://www.who.int/ipcs/assessment/public_health/lead/en/)
- <http://www.wcb.yk.ca/Media/documents/lead.pdf>

# The effects of mercury exposure on human health

- ❖ Mercury (Hg): toxicity depends on its chemical form. Elemental mercury is relatively inert and non-toxic. If metallic mercury is swallowed, it will be discharged without serious consequences. But mercury is volatile at room temperature, so it is toxic if inhaled. Mercury is capable of reacting with sulfur-containing amino acids, hemoglobin, albumin; Ability to bind cell membranes, alter the potassium content, change the base acid balance of tissues, and cause a shortage of energy supply to nerve cells. Children with mercury poisoning will be schizophrenic and convulsive. In water, methyl mercury is a unique form, it schizizes chromosomes and prevents cell division.

Mercury enters the environment from waste, smog of smelting factories, fluorescent lamps, thermometers, plant protection drugs, pulp ...

- ❖ The maximum permissible concentration of WHO in drinking water is 1mg / l; aquaculture water is 0.5mg / l.

# The Effects of Arsenic Exposure on Human Health

- ❖ Arsenic (As): is a metal that can exist in synthetic forms of inorganic and organic substances. In nature exists in minerals. Low concentrations stimulate growth, high concentrations are toxic to plants and animals.
- ❖ The natural sources of arsenic pollution are volcanoes and ocean dust. The artificial source of arsenic pollution is the melting process of copper, lead, zinc, steel making, burning forests, using pesticides ...
- ❖ Arsenic can cause 19 different diseases. The main effects on human health: coagulating proteins by complexing with arsenic III and destroying the phosphorus process; can cause cancer of skin, lung, bronchial, sinus tissue ...
- ❖ The WHO allowed standard for arsenic concentration in drinking water is 50mg / l.

# Effects of Cadmium exposure on human health

- ❖ Cadmium (Cd): is a metal used in the metallurgical industry, making **plastic** products; Cadmium compounds are used in the manufacture of batteries.
- ❖ The natural source of cadmium pollution is caused by volcanic dust, space dust, forest fires ... Artificial sources are from metallurgy, plating, painting, plastics industries ...
- ❖ Cadmium enters the human body through respiratory tract, food. According to many studies, smokers are at risk for cadmium infection.  
Cadmium that enters the body accumulates in the kidneys and bones; Interfering with the activity of some enzymes, causing hypertension, lung cancer, perforation of the nasal septum, disrupting kidney function, destroying bone marrow, affecting endocrinology, blood, cardiovascular.
- ❖ WHO standards for drinking water £ 0.003 mg / l.

# Effects of Chromium exposure on human health

- ❖ Chrom (Cr): exists in water with 2 forms Cr (III), Cr (VI). Cr (III) is not toxic but Cr (VI) is toxic to plants and animals. Cr (VI) causes stomach ulcers, small intestine, hepatitis, nephritis, lung cancer.
- ❖ Chromium enters water sources from the wastewater sources of electroplating, dyeing, tanning, explosives, printing, printing, etc. factories.

The WHO standard specifies the chromium content of drinking water is  $\leq 0.05 \text{ mg / l}$



# The Effects of Manganese Exposure on Human Health

- ❖ Manganese (Mn): is a trace element, needs about 30 - 50 mg / kg body weight per day. If large concentrations are toxic to the body; toxic to the protoplasm of cells, especially the impact on the central nervous system, causing damage to the kidneys, circulatory apparatus, lungs, and fatal poisoning.
- ❖ Manganese enters the water **environment** due to leaching, erosion, metallurgical industrial wastes, batteries, and chemical fertilizers.

WHO regulatory standards in drinking water are £ 0.1 mg / l.

Thank you so much!

