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*Full Length Research Paper*

## **Toxic effects of lead in humans: an overview**

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### **Abstract**

**The paper attempts to discuss the issue of heavy metal toxicity, their sources and detoxification have been discussed. The excretory organs for heavy metals, Oral Chelation Supplements as well as the poisonous effect of lead have been observed. Sources and potential effect of lead, Carcinogenicity of Lead, signs and symptoms of lead poisoning have also been addressed. Epidemiology Studies on metallic lead workers have been reported. Conclusion and recommendations were made. Some of such recommendations is Government should review and enforce its existing regulations and by-laws on environmental pollution, and Government should encourage the use of plastic pipes for boreholes and pipe born water from dams and rivers for human consumption and irrigation purposes.**

**Keywords:** Lead, sources, poisonous effect, carcinogenic, signs and symptoms, epidemiology.

### **INTRODUCTION**

Heavy metal toxicity is a growing concern and often an unknown root cause of a number of serious health issues. A heavy metal is defined as any metallic chemical element that has a high density and is toxic, or poisonous at lower concentrations. Many heavy metals naturally exist in our surrounding ecosystems, and are generally not a problem in small concentrations. However, with industrialization, heavy metals are used in many products we use daily and have leached into our food. It is our exposure to these low to moderate amounts of metals over long periods of time that cause ill effects to our health. Heavy metals constitute a very heterogeneous group of elements widely varied in their chemical properties and biological functions. Heavy metals are kept under environmental pollutant category due to their toxic effects on plants, animals and human being.

The main problem with heavy metals in our bodies is their ability to bio-accumulate. Bio-accumulation means the metals do not leave the body by their own accord and accumulate in certain tissues. Due to bio-accumulation,

heavy metals are passed up the food chain from smaller species (fish) to humans. The main tissues targeted by heavy metals include: the liver, kidneys, bowel, brain and nervous system, spleen and eyes. Dietary intake of many heavy metals through consumption of plants has long term detrimental effects on human health (Sharma and Agrawal, 2005). The metals will not be cleared by the system unless some type of intervention is used to chelate the metals and flush them out. There are some heavy metal toxicities that are more prevalent than others, like mercury from dental fillings and lead from lead pipes and paint (Janine, 2005).

Heavy metal exposure happens over a lifetime, depending on where you live, and your exposure. Unfortunately, many infants today are born toxic with heavy metals as they pass to the baby through the placenta and breast milk. Children are especially at risk because many vaccines contain heavy metals, mainly aluminum and mercury. Thimerosal is a preservative in many childhood vaccines that is 49.5 % ethyl mercury by

weight. Toxic metals can be present in industrial, municipal, and urban runoff, which can be harmful to humans and aquatic life. Increased urbanization and industrialization are to blame for an increased level of trace metals, especially heavy metals, in our waterways. There are over 50 elements that can be classified as heavy metals, 17 of which are considered to be both very toxic and relatively accessible. Toxicity levels depend on the type of metal, its biological role, and the type of organisms that are exposed to it. The heavy metals linked most often to human poisoning are lead, mercury, arsenic and cadmium. Other heavy metals, including copper, zinc, and chromium, are actually required by the body in small amounts, but can also be toxic in larger doses.

Lead is one of the most toxic elements naturally occurring on Earth and is the 5th most utilized metal in the U.S. Human exposure to lead occurs primarily through drinking water, airborne lead-containing particulates, and lead-based paints. The primary source of lead in drinking water is from lead-based plumbing materials. The corrosion of such materials will continue to increase concentrations of lead in municipal drinking water. The EPA actually allows small amounts of lead to be present in our tap water due to this insurmountable problem. Lead from water and airborne sources have been shown to accumulate in agricultural areas leading to increased concentrations in agricultural produce and farm animals. Cigarette smoke is also a significant source of lead exposure.

High concentrations of lead can cause irreversible brain damage, seizure, coma, and death if not treated immediately. Evidence suggests that lead may cause fatigue, irritability, memory problems, reduction in sensory and motor reaction times, decision making impairment, and lapses in concentration. In adults, lead is very detrimental to the cardiovascular system. Occupationally exposed individuals tend to have higher blood pressure and are at an increased risk for cardiovascular disease, myocardial infarction, and stroke. The kidneys are targets of lead toxicity and prone to impairment at moderate to high levels of lead concentrations. Other signs/symptoms of lead toxicity include gastrointestinal disturbances, abdominal pain, cramps, constipation, anorexia and weight loss, immune suppression, and some liver impairment.

Children absorb lead much more efficiently than adults do after exposure and are susceptible to the most damaging effects of lead toxicity. Lead not only appears to affect cognitive development of young children but also other areas of neuropsychological function. Young children exposed to lead may exhibit mental retardation, learning difficulties, shortened attention spans (ADHD), increased behavioral problems (aggressive behaviors) and reduced physical growth. Lead has been determined by many health experts to be the #1 threat to developing children in our industrial societies.

Lead damages the kidneys, brain, blood (it enters the red blood cells), muscles and bones.

Symptoms of Lead toxicity may include chronic kidney disease, hypertension, encephalopathy, anaemia, gout, sterility, abortion, fatigue, irritability, ADD, hyperactivity, memory loss, decreased sensory and motor reaction times, and abdominal pain. Heavy metals are what one might call "the unknown killers" since these probably cause and aggravate most health conditions in our bodies. These tiny pieces of metals, easily embedded inside body tissues, are inside the human body as a result of the toxic environment we live in now. Dr. According to Dietrich ( ) in his article "A Comprehensive Review of Heavy Metal Detoxification and Clinical Pearls from 30 Years of Medical Practice" explained that heavy metals are neurotoxins, absorbed by nerve endings and travels inside the neuron to the cell body. The body is constantly trying to cleanse these neurotoxins through a natural body cleansing process using the available exit routes: the liver, kidney, skin and exhaled air and detox mechanisms include acetylation, sulfation, glucuronidation and oxidation. The liver is a most important organ in these body cleansing processes since most elimination products are expelled with the bile into the small intestine.

Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Heavy metals may enter the human body via food, water, air, or absorption through the skin in agriculture, manufacturing, pharmaceutical, industrial, or residential settings. Industrial exposure is common in adults. Ingestion is the most common route in children (Roberts 1999). Children may develop toxic levels from normal hand-to-mouth activity (ie, coming in contact with contaminated soil or eating objects that are not food such as dirt or paint chips) (Dupler 2001). Less common routes of exposure include a radiological procedure, inappropriate dosing or monitoring during intravenous (parenteral) nutrition, a broken thermometer (Smith 1997), or a suicide or homicide attempt (Lupton 1985). – Health Concern\*\*\* (Table 1).

## **Detoxification of Heavy Metals**

According to Janine (2005), there are four steps involved in the detoxification of heavy metals:

### **1. Diagnosis of heavy metals**

Heavy metal toxicity can be tested in one of many ways. The body does excrete small amounts of heavy metals in the hair, stool and urine. Hair analysis reveals the amount of metal being excreted and the mineral status of the patient. Certain patterns of mineral deficiencies and excesses in the hair are consistent with heavy metal

**Table 1.** Showing toxicity, food and other sources of Lead

<b>Metal</b>	<b>Toxicity</b>
Pb	Organic forms are more toxic and easily absorbed by the gastrointestinal tract
<b>Food Sources of Toxic Lead</b>	
Pb	Eggs, cocoa powder, rice, wheat, potato, calcium supplement, smoked food, wine, beer, milk, carrot, raisins
<b>Other Sources</b>	
Pb	Leaded gasoline, tire wear, lubricating oil and grease, bearing wear

Source: Varsha et al (2010)

toxicity even if the actual metals being excreted are minimal. Stool and urine samples can be taken either with a provoking agent (a chelating compound to speed up the excretion of metals), or without. Depending on a patient's complaint or disease process, testing with provocation may be risky with its own set of side effects because you are forcing the body to dump more metals all at once. For this reason, I prefer to test the stools initially without a chelating agent to see what the body is excreting on its own. After a chelation protocol, the test can be re-taken to show the change in excretion of the metals.

## 2. Remove the source of toxicity

If the source of toxicity is known, as with dental amalgams, a protocol for removal should be discussed with your dentist. I usually suggest that no more than one large amalgam be removed at one visit and visits should be spaced out by about a month. This allows the body to detoxify smaller amounts of mercury over a period of time.

However, if the source of toxicity is unknown, this is where the detective work begins. Knowledge of the sources of heavy metals may help to narrow down the field of possible exposure sites. Keep in mind that the exposure may have been years ago due to the fact that the body bio-accumulates heavy metals.

## 3. Excretory Organs for Heavy Metals

The organs of excretion need to be functioning optimally when you start to chelate or remove heavy metals from the body. The main organs of excretion for heavy metals include: liver, kidneys, lungs, bowels and skin. If these organs are not excreting efficiently during the metal detoxification process, there is a danger of becoming more toxic and experiencing more symptoms of toxicity. Thus:

### Liver

A simple way to encourage the detoxification of the liver is to squeeze fresh lemon juice (1/4 to 1/2 lemon) into

warm water and drink first thing in the morning. Herbal medicines such as Milk Thistle and Dandelion Root are commonly used for liver detoxification.

### Kidneys

To detoxify the kidneys, drink at least one litre of water per day and urinate frequently. It is important to sip small amounts of water throughout the day, rather than gulping a lot at one sitting because only 2 ounces of water can be absorbed at once. Herbal medicines such as Dandelion Leaves, Corn Silk and Horsetail cleanse the kidneys.

### Lungs

Lungs can be detoxified by deep breathing exercises. Most of us only use the top 1/3 to 1/2 of our lung capacity. It is important to use the entire lung while breathing to exchange as much stale air as possible with each breath. For this reason, exercises like yoga and Pilates are wonderful because they incorporate proper breathing and train the lungs to detoxify.

### Bowels

Bowel detoxification can be achieved with increasing the amount of fibre in the diet. There are two types of fibre, soluble and insoluble. The chart below gives examples of each. Increasing the number of bowel movements per day is imperative when detoxifying heavy metals. I usually recommend that patients aim for at least two bowel movements daily while on a heavy metal detoxification protocol.

### Skin

The skin, being the largest detoxification organ, eliminates heavy metals through perspiration. Inducing perspiration can be achieved with far infrared (FIR) saunas. FIR saunas are reported to have better detoxifying effects compared to traditional saunas and steam rooms. FIR is the same as the heat we absorb from the sun, but not the ultraviolet rays that can be damaging to the skin. It is just below red light in the electromagnetic spectrum of light and cannot be seen,

only felt as heat. FIR energy is absorbed by our bodies and penetrates into the fat and muscles of the body, not just superficially as do regular saunas. For this reason, it has a greater ability to detoxify the lymphatic system and fat cells. It is very important to shower soon after a sauna to wash away the toxins.

#### 4. Chelation

Chelation (pronounced key-layshun) means binding of a substance to the heavy metal so it can be excreted from the body. There are two types of chelation therapy, intravenous and oral. I prefer oral chelation because it is easy to administer and most of the heavy metals are excreted via the bowel. Intravenous chelation usually excretes via the kidneys.

#### Oral Chelation Supplements

##### Vitamin C

Vitamin C is a natural heavy metal chelator. It binds mercury, lead and arsenic.

##### Minerals

Minerals such as zinc, manganese, chromium and selenium are all heavy metal chelators. Selenium binds both methyl mercury and inorganic mercury, forming mercury selenide which is excreted in the stool.

##### Sodium Alginate

Derived from brown seaweed, sodium alginate (*Laminaria japonica*) binds heavy metals and radioactive elements to its own molecules. The chelated product is not broken down by saliva or bile and is readily excreted in the large intestine.

##### Chlorophyll

Chlorophyll is the element in plants that makes them green. Chlorophyll chelates heavy metals because it has a porphyrin ring which binds divalent metal ions. The middle of chlorophyll is magnesium, which is freed under acidic conditions, allowing other heavy metals to bind in its place. Chlorophyll can be taken in drop form. The standard adult dose is 5 drops a day, mixed in water. Caution: Chlorophyll can stain the teeth so be sure to dilute it in water.

#### Poisonous Effect of Lead

Lack of toxicity of lead means that there is no clearly defined symptoms, but there may be more subtle signs of poisoning, because, like radiation, lead is a cumulative

poison. Once in the body, it accumulates in bones, liver and kidneys. Even moderate levels can lead to kidney impairment and immune suppression. Obvious symptoms of lead poisoning are severe weakness, spasms in the abdominal area, and paralysis. Asymptomatic, but also dangerous is the constant presence of lead in blood. It affects the formation of hemoglobin and causes anemia. There may be disturbances of the psyche. Lead poisoning in children of lead workers: 38 in 91 children (41.8%) presented lead blood levels up to 300 ug/L and 10 with lead blood levels higher than 800 ug/L. The source of contamination was lead dust carried home on parents contaminated work clothing. Lead In humans, Long term exposure can occur acute or chronic damage to the nervous system on humans. Heavy metals can enter our bodies via food (fish, meat, and produce) and drinking water, and children can be exposed to lead through ingesting paint chips. The Environmental Protection Agency ranks lead, mercury, and cadmium as three of the top six toxins.

Leaded gasoline is responsible for the proliferation of lead across the planet, even into Greenland's ice. More than 90 percent of houses built before 1975 still have lead paint. Lead also exists in everything from plumbing to calcium supplements, hair dye, mini-blinds, and leaded crystal. Urban areas with high levels of traffic or trash incinerators, as well as areas containing battery plants or industrial facilities that burn fuel, may still have high lead levels in the air (AIM, 2009). Lead damages the kidneys, brain, blood (it enters the red blood cells), muscles and bones. Symptoms of Lead toxicity may include chronic kidney disease, hypertension, encephalopathy, anaemia, gout, sterility, abortion, fatigue, irritability, ADD, hyperactivity, memory loss, decreased sensory and motor reaction times, and abdominal pain (Janine, 2005).

#### Sources and Potential Effect of Lead

Now the main sources of lead poisoning are components of many colors used in the home, the water flowing through pipes coated with lead. It is desirable in the first place to avoid these factors. Other sources are listed below:

##### Sources:

- Emissions of aircraft engines
- Oil of lead-based paint
- car batteries
- bone meal fertilizer from
- Ceramic coating on porcelain
- cigarette smoke
- dust and particles from lead-based paints
- Insecticides
- pipes made of lead or lead-coated

**Table 2.** Types of heavy metals and their effect on human health with their permissible limits

Pollutants	Major sources	Effect on human health	Permissible level (mg/l)
Arsenic	Pesticides, fungicides, metal smelters	Bronchitis, dermatitis, poisoning	0.02
Cadmium	Welding, electroplating, pesticide fertilizer, Cd and Ni batteries, nuclear fission plant	Renal dysfunction, Lung disease, Lung cancer, Bone defects (Osteomalacia, Osteoporosis), increased blood pressure, kidney damage, bronchitis, gastrointestinal disorder, bone marrow, cancer	0.06
Lead	Paint, pesticide, smoking, automobile emission, mining, burning of coal	Mental retardation in children, developmental delay, fatal infant encephalopathy, congenital paralysis, sensor neural deafness and, acute or chronic damage to the nervous system, epilepticus, liver, kidney, gastrointestinal damage	0.1
Manganese	Welding, fuel addition, ferromanganese production	Inhalation or contact causes damage to central nervous system	0.26
Mercury	Pesticides, batteries, paper industry	Tremors, gingivitis, minor psychological changes, acrodynia characterized by pink hands and feet, spontaneous abortion, damage to nervous system, protoplasm Poisoning	0.01
Zinc	Refineries, brass manufacture, metal Plating, plumbing	Zinc fumes have corrosive effect on skin, cause damage to nervous membrane	15
Chromium	Mines, mineral sources	Damage to the nervous system, fatigue, irritability	0.05
Copper	Mining, pesticide production, chemical industry, metal piping	Anemia, liver and kidney damage, stomach and intestinal irritation	0.1

Source: Reena et al (2011)

- The process of lead ore from motor fuel with a high content of lead (exhaust)
- vegetables grown near highways

#### Potential Effects:

- Cramping abdominal pain;
- Anemia;
- Arthritis;
- Violations of brain activity;
- Irritability;
- Overvoltage;
- Effect on the formation of hemoglobin;
- Impaired fertility in women;
- Violations of growth and development of infants;
- Effects on the synthesis of vitamin D, leading to calcium deficiency;
- Kidney disease;
- Liver damage;
- mental illness;
- Loss of appetite;
- Neurological disorders;
- Paralysis;
- weakening of the immuneeneral weakness

#### Carcinogenicity of Lead

There is limited evidence in humans for the carcinogenicity of inorganic lead compounds. There is sufficient evidence in experimental animals for the carcinogenicity of inorganic lead compounds. There is sufficient evidence in experimental animals for the carcinogenicity of lead acetate, lead subacetate, lead

chromate, and lead phosphate. There is inadequate evidence in experimental animals for the carcinogenicity of lead oxide and lead arsenate. There is inadequate evidence in experimental animals for the carcinogenicity of lead powder. Overall evaluation Inorganic lead compounds are probably carcinogenic to humans.

#### Signs and Symptoms

Lead metal foreign bodies in eye or orbit in humans have been considered to cause little reaction and rarely any toxic effect. Clinical experiences with various intraocular foreign bodies presented in detail with histological studies indicated that lead metallic foreign bodies caused minimal inflammatory reaction, mainly mechanical injury. In another report it was concluded that lead fragments in patients were well tolerated in the eye and in the orbit and that they should not be removed unless they were in the anterior chamber. A case is described in which a small lead shot was allowed to remain in the vitreous, the vision returned to normal as blood in the vitreous absorbed or settled in the course of a year ... In one case, which appears to have been quite exceptional, a patient with a lead shot behind one globe had impaired vision in that eye. This was assumed to be due to a toxic effect of lead. A significant improvement of vision was reported when systemic and topical treatment with 2,3-dimercaptopropansulfonate sodium was started 5 yr after the injury.

#### Epidemiology Studies

One of 2 epidemiological studies on metallic lead workers showed no excess of cancer deaths. The other showed a

slight (although significant) excess of deaths due to cancers of digestive system and resp system among smelter workers but not among workers in lead-acid battery factory Table 2 above.

## RECOMMENDATIONS

Since heavy metal toxicity is a growing concern and often an unknown root cause of a number of serious health issues. Similarly, heavy metal exposure happens over a lifetime, depending on where you live, and your exposure. Unfortunately, many infants today are born toxic with heavy metals as they pass to the baby through the placenta and breast milk. Thus, there is the need for government to enforce environmental pollution control measures for safety of food being consumed by the increasing population and for sustainable national development, the following recommendations can be looked into:

1. Government should review and enforce its existing regulations and by-laws on environmental pollution
2. Government should enforce industries to establish treatment plants for their effluents and such plants should be changed with time to conform with new technology in other to sustain treatment effectiveness
3. Health Officials should embark on regular supervision of industries as well as work places and homes to enforce strict adherence to the use of treatment plants by industries and dump sites by work places and households, respectively.
4. Industries should be compelled to publish the levels of heavy metals in their finished consumable products.
5. Government should encourage tertiary and research institutions by way of funding to embark on regular monitoring of industrial effluents in other to ascertain the level of compliance to the use of treatment plants
6. Individuals and indeed consumers of finished products should be encouraged to avoid purchase and consumption of products which do not bear or carry levels of heavy metals contents.
7. The National Agency for Food and Drug Administration Commission (NAFDAC) and Standard Organization of Nigeria (SON) and other relevant Agencies should be well funded to up-date their research laboratories in order to meet the present day challenges.
8. Government should encourage the use of plastic pipes for boreholes and pipe born water from dams and rivers for human consumption and irrigation purposes.

## CONCLUSION

Heavy metal toxicity is a growing concern and often an unknown root cause of a number of serious health issues. As such, there is the need for an urgent control measures to reduce if not eradicate the continuous pollution of the environment with heavy metals. The source, its potential toxic effect of lead, signs and symptoms, its carcinogenic effect as well as epidemiological studies have been discussed. Recommendations and conclusion were made.

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