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Effect of Heavy Metal Ions in Water on Human Health

Dr. Bharti Chouhan[1], Pushpa Meena[2], Dr. Neelam Poonar[3]

Assistant Professor, Department of Zoology and Department of Botany, University of Rajasthan, Jaipur, India

Abstract: ***The provision of safe drinking water has been one of humanity's most successful public health interventions and is a defining aspect of a developed country. Metals are released into the environment by both natural and anthropogenic means, especially mining and industrial activities, and automobile exhaust, which are serious harmful to human health. Among all water contaminations, heavy metal ions, such as Pb, Cd, As and Hg, have high toxic and non-biodegradable properties, can cause severe health problems in animals and human beings. Wastewater from many industries, including chemical manufacturing, battery manufacturing industries, metallurgical, leather tanning, and mining, contain these heavy metal ions. These wastewater with heavy metal ions are discharged into natural water directly, not only threat the aquatic organisms, but may be enriched by precipitation, adsorption, and harmed human health through the food chain. The term "heavy metals" refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration (Lenntech, 2004).***

Keywords: Water quality, Environment, Heavy metals, Human health

1. Introduction

Water covers over 71% of the earth's surface and is a very important natural resource for people (National Environment Research Council, 2007). Yet; only 2.5% of the earth's water is fresh and thus suitable for consumption. Not only that, but of that 2.5%, more than two-thirds is locked away in glaciers and not particularly able to help meet the growing demands of society (Ward, 2003). It is the fundamental right of every individual to get pollution free water. Water pollution affects drinking water, rivers, lakes and oceans all over the world, which consequently harms human health and the natural environment. Water pollution include sewage and waste water, industrial waste, oil pollution, marine dumping, atmospheric deposition, radioactive waste, underground storage leakages, global warming, eutrophication etc. (Gambhir et al., 2012). With the increasing use of a variety of metals in industry and in our daily life, problems arising from toxic metal pollution of the environment have assumed serious dimensions.

Water pollution may not cause immediate effect on the health of the individual but can prove fatal in the long run. Heavy metals from industrial processes can accumulate in nearby lakes and rivers, proving harmful to the marine animals, other animals consuming this toxic water and humans using animal products. Toxins in industrial waste can cause immune suppression, reproductive failure or acute poisoning.

2. Sources and Occurrence

Heavy metals occur as natural constituents of the earth crust, and are persistent environmental contaminants since they cannot be degraded or destroyed. To a small extent, they enter the body system through food, air, and water and bio-accumulate over a period of time. (Lenntech, 2004; UNEP/GPA, 2004). Sources of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources. Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution .Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high tension lines, plastics, textiles, microelectronics, wood preservation and paper processing plants.

3. Toxic Effects

Heavy metals disrupt metabolic functions in two ways:

a) They accumulate and thereby disrupt function in vital organs and glands such as the heart, brain, kidneys, bone, liver, etc.
b) They displace the vital nutritional minerals from their original place, thereby, hindering their biological function. It is, however, impossible to live in an environment free of heavy metals. There are many ways by which these toxins can be introduced into the body such as consumption of foods, beverages, skin exposure, and the inhaled air.

1) Lead

Lead poisoning is a type of metal poisoning caused by increased levels of the heavy metallead in the body. Like most toxic heavy metals, lead interferes with a variety of body processes and is toxic to many organs and tissues, including the heart, bones, intestines, kidneys, and reproductive and nervous systems. In children, lead is most damaging.Children are growing at a very fast rate - growing bones, developing stronger muscles and creating many connections in their brain. When lead instead of essential nutrients is "available" to the body to make bones, muscle, and brain connections, permanent harm to health can occur. Lead can be harmful and be associated with:

- Learning disabilities resulting in a decreased intelligence (decreased IQ)
- Attention deficit disorder
- Behavior issues
- Nervous system damage
- Speech and language impairment
- Decreased muscle growth

- Decreased bone growth
- Kidney damage.

Lead exposure is a concern for adults, even though they have finished growing. Since an adult's body is much larger than a child's body, more lead is needed to cause injury but the harm lead can do to an adult is very serious. High levels of lead can cause:

- Increased chance of illness during pregnancy
- High blood pressure
- Digestive issues
- Nerve disorders
- Memory and concentration problems
- Muscle and joint pain.

2) Arsenic

Arsenic (As) has many applications: (a) in bronzing, hardening and improving the sphericity of shot, wood preservation, pyrotechnics, varieties of semiconductor devices solar cells, light-emitting diodes, lasers, and integrated circuits);and (b) as pesticides . In the environment

Arsenic is usually found combined with other elements as inorganic and organic forms. Inorganic arsenic is known to be more poisonous than organic one. Arsenic trioxide (As2O3) is the most common inorganic arsenical in air, while arsenates (AsO4)3- or arsenates (AsO2) occur in water, soil, or food. Arsenic concentration is high in marine food. In humans arsenic toxicity occurs due to ingestion of As containing powders or solutions accidentally, suicide, homicide, or consumption of contaminated food or drinking water. Arsenic has been reported to be associated with hypertension and serious impacts on the cardiovascular system, and even hepatic damage at high doses. It has a suppressive effect on spermatogenesis and gonadotrophin and testosterone release in rats. There is correlation between arsenic exposure and diabetes mellitus (type II). Besides, inorganic arsenic ingestion arsenic leads to various dermal effects like: hyperkeratosis, hyper pigmentation and hypo pigmentation; per orbital swelling; the occurrence of spontaneous abortion and damage of the nervous system.

3) Cadmium

Cadmium enters the environment from a variety of anthropogenic sources. Wastewater is key source of environmental cadmium contamination and diffuse pollution occurs through industrial air emissions and widespread use of fertilizers on agricultural soils. Humans are exposed to cadmium by inhalation and ingestion although the main health impacts recorded in the literature are through dietary exposure (kidney and bone damage) and inhalation from smoking tobacco and occupational exposure (lung damage). Cadmium in the environment is toxic to plants and animals and many micro-organisms. Cadmium does not degrade in the environment to less toxic products which contributes to its bioaccumulation in the kidneys and liver of vertebrates and invertebrates. However, human exposure also occurs when cadmium contaminated soils are disturbed and the dust is inhaled. Diets high in meat (especially liver and kidneys) or products from marine mammals may result in a particularly high intake of cadmium. Cadmium is not considered essential for biological function in humans. The main human organ impacted by cadmium exposure is the kidney in both the general population and the occupationally exposed. Tobacco smokers are considered to be at particular risk as are people with low iron levels. A secondary critical effect is skeletal damage as a secondary response to kidney damage or direct action on the bone cells by the cadmium.

Certain compounds of cadmium (Cd) are highly toxic to humans. Cadmium is employed in several industrial processes such as: (a) protective coatings (electroplating) for metals like iron; (b) preparation of Cd-Ni batteries, control rods and shields within nuclear reactors and television phosphors. Some compounds are used as stabilizers for PVC. For non-smoking population the major exposure pathway is through food. Cadmium is readily taken up by plants. Potential source of cadmium toxicity is the use of commercial sludge for fertilizing agricultural fields. Some root crops(carrots and parsnip) and some leafy crops (lettuce and spinach)are able to accumulate more cadmium compared toothier plant foods. Grain crops like rice and wheat can accumulate relatively high amounts of cadmium. Its absorption is increased by calcium, protein and vitamin. Internal organs of mammals such as liver and kidneys may also contain high amounts of cadmium. Cadmium is a normal constituent of tobacco, because Nicotine species is able to concentrate cadmium independent of soil-Cd content. It has been documented that Itai-itai disease was caused by large amounts of cadmium in the villages. Cadmium is a cumulative toxicant and carcinogenic that affects kidneys, generates various toxic effects in the body, disturbs bone metabolism and deforms reproductive tract as Well as endocrine system. An exposure to cadmium increases calcium excretion thus causes skeletal demineralization, probably leading to increases in bone fragility and risk of fractures. Occupational human exposure has been correlated with lung cancer. Cadmium exposure, during human pregnancy, leads to reduced birth weights and premature birth.

4) Mercury

Main effects of Mercury on Human Health and the environment effects on human health Toxicity of mercury is dependent on whether it takes the form of elemental mercury, inorganic mercury or organic mercury compounds (particularly alkyl mercury compounds such as methyl mercury and ethyl methyl salts). In terms of methyl mercury, dietary ingestion is the major source of human exposure, especially for seafood and fish. Methyl mercury is a well known potent neurotoxin which causes adverse impacts on the developing human brain. It passes readily through the placental barrier and the blood-brain barrier making any exposure during pregnancy of great concern. Inhalation of elementary mercury vapor has been observed to lead to symptoms including tremors, emotional liability, insomnia, memory loss, neuromuscular changes, and headaches as well effects on the kidney and thyroid. High exposures have led to death but the critical effects are neurotoxin and renal. Mercury is organ mercurial in the form of methyl mercury which has toxicological characteristics. Minamata disease name given after of methyl mercury in seafood in Minamata and Niigata in Japan in the 1950-1960's, caused the death of thousands of people. Tokomak *et al* .were the first to describe the symptoms of methyl mercury poisoning. Thus, the symptoms were named the

Hunter-Russell syndrome .A few studies reflect that even minor increases in methyl mercury exposures can cause harmful effects on the cardiovascular system, blisters in the upper gastrointestinal tract, vomiting, abdominal pain, constipation and gastritis. It is absorbed in the gastrointestinal track, immediately entering the blood stream. It readily passes the placental barrier affecting the developing nervous system of the fetus. Continuous exposure conditions to elemental Hg can lead to its accumulation in the thyroid. The acute exposure to elemental Hg vapors can cause "pink disease" or acrodynia.

4. Concluding Remarks

Conclusively, based on experimental studies, the advances of toxicology has improved our knowledge about human exposure to toxic elements (metals and metalloids) and their health effects, such as developmental retardation, several types of cancer, kidney damage, endocrine disruption, immunological ,neurological effects and other disorders. The ongoing research works throw more light onto new insights and bio chemical and molecular mechanisms involved in the development of pathological conditions in human.

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