



HEAVY METAL MEDIATED HUMAN HEALTH RISK

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Abstract: In reality, heavy metals are natural constituents of the earth's crust, but irrational human intervention have affected their geochemical cycles and natural balance, leading to problems. Heavy metal related health issues need special attention, as these can reach humans through multiple pathways, and can act as systemic toxicants. Many of these are reported to cause chronic illnesses. Creating public awareness and implementing remedial action programmes may help in this regard.

Index words: Heavy metals, human health, toxicity

1.Introduction

Heavy metals belong to an ill-defined subset of elements that exhibit metallic properties which include the transition metals, some metalloids, lanthanides, and actinides (Singh et al. 2011). These have widespread environmental distribution and originate from natural and anthropogenic sources, and are common environmental pollutants in many parts of the world (Jan et al. 2015). Heavy metals such as arsenic, mercury, lead and cadmium are reported to be toxic even at low concentrations (Duruibe et al. 2007). World Health Organization (WHO, 2013) considers these three as the top three among the ten chemicals of major public health concern. Islam et al. (2015) found dietary intake and food chain pathways as major sources of toxic heavy metal accumulation in humans. Schwalfenberg et al. (2013) found the presence of unsafe levels of lead in 70-80 % of tea samples they tested. This is a real threat to consumer safety. Likewise, Sathyamoorthy et al. (2016) report high levels of arsenic, lead and mercury in soil, fodder and cattle meat in a study from Tamilnadu. Urbanisation and industrialization in watershed areas can increase heavy metal contamination in waterbodies. Yahaya et al. (2010) analysed arsenic and lead in roadside soil in Nigeria. Electronic waste dumping is one of the major causes for heavy metal pollution especially that of lead, copper and nickel leading to health problems in many nations (Singla et al. 2017).

2.Examples of some heavy metals

2 (a). Arsenic: The valence state of arsenic is reported as one of the reasons for its behaviour and toxicity (Jain and Ali, 2000). Arsenic contamination has been reported by many. For example, rice in Bangladesh by Williams et al. (2005) and in West Bengal, India, by Roychowdhury et al. (2002) and Bhattacharya et al. (2010). Roychowdhury et al. (2003) has reported arsenic levels in drinking water from West Bengal, India, to be many times higher than WHO standards.

2 (b). Lead: Lead causes extensive environmental contamination and health problems worldwide. Khairiah et al. (2012) report that lead in paddy soils come mainly from anthropogenic sources such as fertilizers, automobile exhausts, industrial effluents and the like. Lead acetate is common in hair dyes (Eagle et al. 2014). Iwegbue et al. (2015) analysed lead in skin lightening creams, which when applied to large areas of the skin for prolonged time, can penetrate and reach the internal organs. Heavy metals including lead are reported in fishes from Gulf of Khambat, Gujarat, India (Deb et al. 2015). Lead cause oxidative stress in organisms as per a study on major Indian carps by Das et al. (2017).

2 (c). Mercury: In spite of its potential risks, mercury is still used in a number of products and processes all over the world owing to its special properties. The electrical industry, healthcare facilities including dentistry, numerous industrial processes including the production of chlorine and caustic soda, in nuclear reactors, as an antifungal agent for wood processing, in paints, as a solvent for reactive and precious metal, as a preservative of pharmaceutical products and in energy saving fluorescent light bulbs (Hailemariam and Bolger, 2014), and as skin lightening agents in cosmetics (Hamann et al. 2014). Mercury is added either intentionally or unintentionally to cosmetics (Siti Zulaikha et al. 2015).

2 (d). Cadmium: Cadmium compounds are used in re-chargeable nickel-cadmium batteries. Cigarette smoking is a major source of cadmium exposure, but in non-smokers, food is the most important source of cadmium exposure (Liu et al. 2013). Cadmium emissions have increased, mainly because cadmium-containing products are rarely re-cycled, but dumped together with household waste (Jarup, 2003).

2 (e). Chromium: Chromium is present in rocks, soil, animals and plants and in water sediments. They can occur as divalent, tetravalent, pentavalent and hexavalent states (Jaishankar et al. 2014).

2 (f). Barium: Drinking water and food expose humans to barium but no conclusive evidence of human disease is established (Calabrese et al. 1985). According to these authors, acute ingestion of barium may produce a stimulant effect on all muscles, including the smooth muscles of the heart and gastrointestinal tract.

2 (g). Cobalt: Cobalt is a relatively rare element. The two valance states are cobaltous (II) and cobaltic (III) (Barceloux and Barceloux, 1999). Cobalt is an essential human nutrient, as it is an integral part of vitamin B₁₂. (Calabrese et al. 1985). It has a role in blood pressure regulation and proper thyroid function. Excessive ingestion of cobalt may lead to congestive heart failure, polycythaemia and anaemia.

2 (h). Cesium: Cesium is a soft, gold-coloured metal. It is quickly attacked by air and reacts explosively in water. The most common use for cesium compounds is that these are used as a drilling fluid, to make special optical glass, as a catalyst promoter, in vacuum tubes and in radiation monitoring equipment. It is used in the 'cesium clock' which is a vital part of the internet and mobile phone networks, as well as Global Positioning System (GPS) satellites. Cesium has no known biological role (Jan et al. 2015).

2 (i). Selenium: Selenium (Se) is an essential trace element found in humans, which has antimutagenic roles and protects DNA and other cellular components from oxidative damage. It can also counteract the negative effects of heavy metals such as mercury. But, at high concentrations, a condition called selenosis (Martin and Griswold, 2009) can result. Major signs of selenosis are hair loss, nail brittleness, and neurological abnormalities. Long-term exposure can cause respiratory problems. Selenium is rich in cereals, meat, and seafood, but less in fruits and vegetables. It may act as a carcinogen and may enhance the toxicity imposed by heavy metals such as lead (Jan et al. 2015).

3. Risk to human health

Heavy metal toxicity can cause many types of chronic diseases. The symptoms may be of various kinds, such as muscle and joint pains, gastro intestinal problems, vision problems, susceptibility to fungal infections, genotoxicity, cancers and in some instances even mental disorders (Marg, 2011). Heavy metals are considered as systemic toxicants (Jan et al. 2015). Many studies have been done in this regard in different parts of the world. Reports on arsenic (Huang et al. 2009) and lead (Wasowicz et al. 2001) are available in plenty.

Acute and chronic exposures to arsenic can cause dermal problems, respiratory, pulmonary, cardiovascular, gastrointestinal, haematological, hepatic, renal, neurological, developmental, reproductive, immunologic, genotoxic, mutagenic, and carcinogenic effects (Mandal and Suzuki, 2002). It can also enter food chains, causing problems. Inorganic arsenic is reported as a human carcinogen. Weathering of rocks converts arsenic sulphides to arsenic trioxide, which enters the arsenic cycle as dust or by dissolution in rain, rivers, or groundwater. Therefore, groundwater contamination by arsenic is a serious threat in many nations as contaminated drinking water paves its way to chronic exposure which can affect almost all the systems of the body (Huang et al. 2009). Lead affects multiple body systems, including the neurological, haematological, gastrointestinal, cardiovascular and renal systems (WHO, 2010). Lead in the body is distributed to the brain, liver, kidney and bones. It is stored in the teeth and bones, where it accumulates over time. Children are the most vulnerable to the neurotoxic effects of lead at even very low levels of exposure.

Mercury is one of the most common contaminants which is a major hazard threatening human health globally (Pack et al. 2014). It is third (after arsenic and lead) on the list of hazardous substances prepared by the US Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry of the US Department of Health and Human Services (Wang, 2012). Mercury can disrupt many cellular processes like inhibition of peptide-elongation step of protein synthesis and interferes with lipids, myelin, and mitochondrial DNA synthesis (Rani et al. 2011). Mercury in all forms affect cellular function by altering the tertiary and quaternary structure of proteins and by binding with sulfhydryl and selenohydryl groups. It can impair function of any organ, or any subcellular structure (Bernhoft, 2012). Not only brain, but also peripheral nerve function, renal function, immune function, endocrine and muscle function, may be affected. With massive acute exposure to mercury vapour, respiratory failure and Central Nervous System symptoms such as tremor or erethism can occur. Human exposure to methylmercury (MeHg) can cause neurotoxicity, teratogenicity, nephrotoxicity, cardiotoxicity, and immuno- toxicity (Ni et al. 2012).

Adverse health effects of cadmium exposure are primarily kidney damage, bone effects and fractures, various types of cancers, low birth weight, and behaviour and learning problems (Liu et al. 2013). Murphy et al. (2016) suspect occupational exposure to cadmium in male Italian steel plant workers to cause rheumatoid arthritis. Exposure to chromium compounds can result in the formation of ulcers. Ulcers on the nasal septum are very common in the case of chromate workers. Chromate compounds can induce DNA damage (Jaishankar et al. 2014). Hexavalent form is more toxic than trivalent form and is a known human carcinogen. Large amounts of intake of Barium can raise blood pressure, make changes in heart rhythm, and causes paralysis and even death (Martin and Griswold, 2009). Cobalt and Cesium are not reported to cause much health issues. Excess of Selenium can cause symptoms such as depression, nervousness, dermatitis, garlic odour of the breath, gastrointestinal disturbances, and excessive tooth decay (Calabrese et al. 1985). If unrecognized or improperly treated, heavy metal related health problems may lead to conditions increasing the morbidity and mortality rate, according to Jan et al. (2015).

4. Conclusion

Chemicals, whether of natural origin or produced by human activities, people get exposed to them through occupational, consumer, or other environmental exposure. Since heavy metal contaminants are common in the air, water, and food, consumer safety and public health issues must be taken care of. One should understand that heavy metals are natural constituents of the earth's crust, and

that indiscriminate use and unethical human intervention have made their geochemical cycles shatter, leading to problems. Awareness to public regarding contamination sources and health risk factors must be ensured.

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