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Spotlight Air Environmental
SAE Public Health Researcher

Heavy Metals Toxicity

General notes*

These short articles we post on our website regarding public health issues are designed to be brief and easily understandable while providing useful information. To this end, the present posting on the topic of heavy metal toxicity aims to provide a brief, preliminary, and general introduction to the topic without focusing on particular heavy metals. The list of toxic heavy metals usually includes arsenic (As), mercury (Hg), cadmium (Cd), lead (Pb) aluminum (Al), chromium (Cr), and zinc (Zn). The notes provided below are intended to introduce some of the topics, themes, and concepts that are basic to, and recurrent in, discussions of heavy metal pollution and toxicity. These notes will serve as background information in future postings when we discuss the heavy metals individually in more detail focusing on two or three of the heavy metals at a time, highlighting the specific kind of harmful effect of each on human health.

1. General Characteristics of Heavy Metals

The toxic metals are considered "heavy" because they share a level of density that it is at least 5 times higher than that of water. They are nondegradable, which means that they cannot be broken down or eliminated. Thus, they have permanent presence in the environment in some form. Heavy metals are often divided into essential and non-essential. The essential heavy metals, which are needed in small or "trace" amounts for biological functioning, include chromium, iron, copper, zinc, and manganese. However, it is important to note the essential heavy metals can become toxic when they accumulate in the body beyond trace levels. This is particularly true of chromium, some forms of which can become a carcinogen. The non-essential heavy metals with no known biological function, including arsenic (As), lead (Pb), cadmium (Cd), mercury (Hg), and aluminum (Al), can by extremely toxic even in trace amounts.

2. The Sources of Toxic Heavy Metals in the Environment

The sources of heavy metals pollution in the environment are commonly said to be either *natural* or *anthropogenic*. The term natural refers to the crust of the earth which consists of 5% sedimentary and 95% igneous rocks. Natural forces such as weathering, volcanic eruptions and leaching are said to cause the release of heavy metals from the rocks to become pollutants of soils, water bodies, and the air. However, it has also been observed that the contribution of natural sources to the pollution and toxicity of the environment is relatively modest. The sources of most of the pollution and toxicity in water, soils, and air are anthropogenic, which is another way of saying that they are produced by human activities such as mining, the burning of fossil fuels, smelting, foundries, power plants that use coal, the production and applications of chemical fertilizers, pharmaceuticals, municipal and domestic waste disposals, etc. The list is

long and has been constantly expanding with increasing urbanization and industrialization. Global worming and climate change also have their contributions in worsening the problem of toxicity of heavy metals.

3. Pathways of Exposure

Exposure of humans to toxic heavy metals can happen in one or a combination of three ways: ingestion of contaminated food, water, or, in some cases, even contaminated soil; inhalation or breathing of polluted dust particles in the air, or dermal absorption. Dermal absorption as pathway to exposure to toxic heavy metals is particularly significant in relation to workers in industries that produce chemicals, dyes and paints. As we shall see in future postings, what pathway, or combination of pathways, will be primarily operative in a particular case depends on the nature and behavior of the specific heavy metal.

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Jonova, Claudia, et al, "Heavy Metals: Toxicity and Human Health Effects"
(See: (https://pubmed.ncbi.nlm.nih.gov/39567405/)

Tchounwou, Paul B., et al, "Heavy Metals Toxicity and the Environment"
(See: https://pmc.ncbi.nlm.nih.gov/articles/PMC4144270/pdf/nihms414261.pdf)