Poison Center & Public Health Collaborations Community of Practice (PCPH CoP)

NEWSLETTER

LETTER FROM THE EDITOR February 2024

Greetings!

This month we will feature a series of newsletters on three toxic metals: arsenic, lead, and mercury. These metals occur naturally, but past and present human activities have led to persistent environmental contamination. Exposure to these metals continues to be a public health problem because many people are still at risk and exposure can cause severe health effects.

The National Poison Data System (NPDS) captures calls that report exposure to arsenic, mercury, lead, and their various compounds. We believe there is an opportunity to increase the use of the nation's 55 poison centers (PC) and their data for monitoring, identifying, and preventing toxic metal exposures.

The present newsletter will introduce toxic metals and then focus on arsenic.

Sincerely,
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Toxic Metals

Toxic metals, commonly known as "heavy metals," refer to a group of metalloids, transition metals, and basic metals with high atomic weight, high density, and toxicity to humans and other living species. Though these metals occur naturally in the earth's crust, commercial and industrial activities of the past and present have altered their geochemical cycles and biochemical balance. This has increased their environmental levels in certain areas. These metals are nonbiodegradable, persistent in nature, and can accumulate in living organisms.[1]

> Some metals such as zinc, copper, and manganese are considered minerals. They are essential nutrients for living organisms and only become toxic at high exposure levels. In contrast, other metals such as arsenic, cadmium, chromium, lead, and mercury can be harmful to human health even at low exposure levels.[1]

Arsenic, **mercury**, and **lead** have a long history of public health significance, and the National Poison Data System (NPDS) has had substance codes to track these exposures for decades. Various agencies have made many efforts to reduce potential exposure and environmental contamination. For example, limiting the use of lead-based paint has made exposure less common today than it was in the past.[2] However, arsenic, mercury, and lead are still a public health concern in multiple locations and for specific populations in the United States.[2]

Credit: Getty Images

Arsenic

Arsenic (As) is a naturally occurring metalloid distributed throughout the Earth's crust. It can be found in water, air, and soil. Anthropogenic sources, originating from human activities including mining and fracking, using coal-fired powerplants, using arsenic-treated wood, and using arsenic-containing pesticides, have increased environmental levels of arsenic in certain locations.[3]

Forms of Arsenic
Elemental: steel gray solid material
Organic: arsenic combined with carbon
Inorganic: arsenic combined with oxygen, chlorine, and/or sulfur

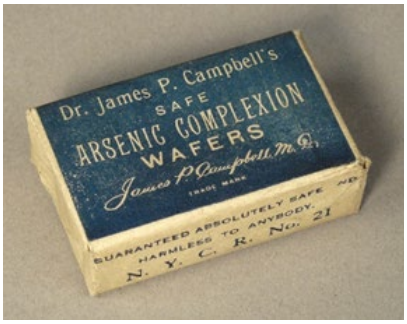
Most organic and inorganic arsenic compounds are white or colorless powders with no noticeable smell or taste. Because of these traits, most people are unaware when they are exposed through food, water, or air.[3]

Inorganic arsenic has been recognized as a human poison since ancient times. Inorganic arsenic has higher toxicity, and the health effects are more severe than with organic compounds.[4] There is little information available on the human health effects of organic exposures. However, some animal studies have identified possible health concerns from exposure to several organic arsenic derivatives widely used in agriculture.[3]

Historical use

- **Pesticides:** From the 1930s to the 1960s, inorganic arsenic compounds were used as pesticides on cotton fields and in orchards.[3] Inorganic compounds can no longer be used in agriculture. However, residues remain in the soil, and discontinued pesticides may still be found in some farms and homes.[3]
- **Pigments**: In the 19th century, inorganic forms of arsenic were used in paints and dyes for clothes, paper, and wallpaper.[5]
- **Medicine**: Arsenic has a long history of being used to treat a variety of diseases, including asthma, cholera, syphilis, psoriasis, and tuberculosis. Most arsenic-based drugs were abandoned when antibiotics were discovered in the 1940s.[6]
- **Cosmetics**: Multiple women's skincare products used to contain arsenic. Arsenic complexion wafers (photo to the right) claimed to remove facial disfigurements, including freckles, pimples, and redness.[7]

Before inorganic arsenical pesticides were banned, tobacco contained about 17 times more arsenic than present day levels.[3]



Dr. James P. Campbell's Safe Arsenic Complexion Wafers. Ca 1890

Present-day use

Since 1985, there has been no domestic production of arsenic, but the United States is a leading consumer of imported arsenic.[3]

Chromated copper arsenate (CCA) preservative: Approximately 90% of all arsenic is used as a wood preservative. CCA-treated wood is referred to as "pressure-treated."[3]

After the Environmental Protection Agency (EPA) reached an agreement with U.S. wood manufacturers, the manufacturers voluntary transitioned from CCA to other preservatives for certain residential-use wood products (e.g., play structures, picnic tables, decks) in 2003. Wood treated before 2003 can still be used, and existing structures made with CCA-treated wood were not affected. CCA-treated wood products continue to be used in industrial applications.[3]

CCA-treated wood often has a green hue.[3]
Image Credit: ATSDR

Gallium arsenide: This compound is widely used in technology and electronics. Gallium arsenide is a component in discrete microwave devices, lasers, light-emitting diodes, photoelectric chemical cells, and semiconductor devices.[3] The disposal of these electronic wastes in landfills can result in arsenic leaching into the surrounding environment.

One Canadian study found that the soil under 32 of 217 CCA-treated play structures had arsenic concentrations that exceeded the Canadian federal soil guidelines.[3]

Main sources of human exposure

Arsenic cannot be destroyed in the environment. It can only change forms.[3] While arsenic is released from natural sources such as volcanoes and the weathering of rocks and minerals, releases from anthropogenic sources far exceed natural sources. Anthropogenic releases increase the potential for water, soil, and air contamination.[3]

Arsenic has been found in 1,149 of the 1,684 current and former National Priorities List (NPL) sites.[3]

NPL sites are identified by the EPA as the most serious hazardous waste sites in the United States. These sites are targeted for long-term federal clean-up activities.

Drinking water	People are most likely to be exposed to inorganic arsenic through contaminated drinking water, especially in areas with water sources that naturally have higher levels.[5] The concentrations in water sources may be increased around former agricultural areas where arsenic was used, hazardous waste sites, factories that engage in mining, and ore smelting locations.[3] A 2017 CDC and U.S. Geological Survey study estimated that about 2.1 million people may be getting their drinking water from private wells with high concentrations of arsenic.[8] Arsenic levels tend to be higher in rural communities in the Southwest, Midwest, and Northeast.[4]
Occupational	Occupational exposures to arsenic are a significant concern in several industries. Those who work in or around nonferrous smelting, pesticide manufacturing, wood preservation, semiconductor manufacturing, glass production, electronic waste recycling, and other hazardous waste sites are at risk of exposure to high levels of arsenic through inhalation, ingestion, dermal contact, and eye contact.[3,9]  Credit: Getty Images
Soil and dust	There are natural sources of arsenic in soil. Still, past and current use of arsenic-containing pesticides, pollution from mining, smelting, and coal-fired power plants have increased levels in certain areas. Children may be exposed to contaminated soils and dust from hand-to-mouth activities while playing on and around CCA-treated wood structures.[3] Though lead arsenate pesticides were eliminated over 50 years ago, millions of acres of land are estimated to be contaminated with residues.[10] This may be a health concern in parts of the United States where land previously used as orchards has been converted into residential developments.[10]
Food	Plants, including fruits, vegetables, and grains, can absorb arsenic in the environment.[11] Absorption is more common in foods grown in areas with naturally high levels of arsenic and soils contaminated from previous arsenic pesticide use. Inorganic arsenic can be found in rice, fruit juices, and some types of seaweed. Organic arsenic compounds can be found in fish, shellfish, and marine algae. However, organic arsenic compounds generally have low toxicity.[3,5]

Health effects

Various factors, such as dose, exposure duration, exposure route, age, and diet, determine the health risk from exposure.[3] Arsenic affects physiological processes in nearly all organ systems.[3]

Acute effects: The immediate symptoms of acute arsenic poisoning include vomiting, abdominal pain, and diarrhea. These may be followed by numbness and tingling of the extremities, muscle cramping, and in extreme cases, death.[12]


Credit: Getty Images

Chronic effects: For chronic exposures, the first observable symptoms are usually in the skin, including pigmentation changes, lesions, and hyperkeratosis. Arsenic and its compounds are classified as human carcinogens, and have associations with skin, lung, and bladder cancer. Other effects include developmental effects, diabetes, and pulmonary and cardiovascular disease.[12]

Climate change: There is limited research on how climate change may affect arsenic in the environment. One study suggests that warmer temperatures may help release arsenic into groundwater. Another study suggests water level deterioration may increase the soluble arsenic contamination in groundwater.[13]

Additional Resources

Arsenic | Toxicological Profile | ATSDR

Poison Emergency?
Call 1-800-222-1222 OR
Visit POISONHELP.ORG

Announcements

The next quarterly PCPHCoP webinar will be held **April 17, 2024, from 3:00 p.m. to 4:00 p.m. Eastern Time.**

To be added to the CoP email distribution list, please request by emailing PCPHCoP@cdc.gov.

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