

Environmental Health Fact Sheet

Cadmium

What is cadmium?

- Cadmium is a rare but widely dispersed element found naturally in the environment.

Are there commercial uses for cadmium?

- Cadmium is used in metal plating, producing pigments, nickel cadmium batteries, as stabilizers in plastics, and in nuclear reactors.

Is cadmium present in the environment?

- Cadmium is mined and then released into the environment mainly through the air during smelting.
- Once in the environment, cadmium moves easily through the soil.
- Certain plants, such as tobacco, rice, other cereal grains, potatoes, and other vegetables, take up cadmium from the soil.

How are people exposed to cadmium?

- Cigarette smokers are exposed to cadmium through inhalation of tobacco smoke. A cigarette contains approximately 2.0 micrograms (μg) of cadmium.
- Oral ingestion is the major route of exposure for the non-smokers. The average Pennsylvanian is exposed to low levels of cadmium in their diet. Typical dietary intake is about 30 micrograms per day ($\mu\text{g}/\text{day}$).
- Inhalation can occur in workplace settings where cadmium is present and proper industrial hygiene does not occur.

What happens to cadmium once in the body?

- 50% of the cadmium inhaled by a smoker is absorbed from the lungs into the bloodstream.
- Most orally ingested cadmium passes through the gastrointestinal tract and only about 6% is absorbed. Cadmium absorption may increase in persons who are iron deficient and during pregnancy.
- Cadmium in water is more easily absorbed than cadmium in food (5% in water versus 2.5% in food).
- Negligible amounts (about 0.5%) of cadmium are absorbed through the skin.

- Once absorbed, cadmium is transported throughout the body in blood bound to a protein called metallothionein.
- The greatest concentration of cadmium in the body is found in the liver and kidneys.
- Absorbed cadmium is eliminated from the body primarily in urine. It is slowly excreted and therefore accumulation in the body can be significant.
- Due to its slow excretion, cadmium accumulates in the body over a lifetime.
- In general, cadmium concentration in blood reflects recent exposure and cadmium concentration in urine reflects total body burden.
- When kidney damage from cadmium occurs, the excretion rate increases sharply, and urinary cadmium levels no longer reflect body burden.

How harmful is exposure to cadmium?

- Cadmium is primarily toxic to the lungs and kidneys, with secondary effects on the skeletal system.
- Chronic exposure to cadmium through inhalation may result in impairment of lung function. Inhalation can also result in acute liver and kidney damage.
- Chronic cadmium exposure has been reported to cause mild anemia, to affect the sense of smell, and yellow the teeth.
- Cadmium exposure may cause kidney dysfunction.
- Background exposures in water and air are not a health concern. Background dietary exposures are also not believed to cause adverse effects. However, lifetime exposure to high levels of cadmium in foods can lead to a serious kidney and bone disorder called "Itai-Itai" disease.
- Symptoms and signs of Itai-Itai disease include severe bone loss and kidney dysfunction.

Can exposure to cadmium cause cancer?

- EPA classifies cadmium as a probable human carcinogen.
- International Agency for Research on Cancer (IARC) classifies cadmium as a known human carcinogen.
- The U.S. Department of Health and Human Services (DHHS) classifies cadmium and cadmium compounds as known human carcinogens.

Are some people at greater risk of harm from cadmium than others?

- People who smoke cigarettes; are malnourished (lacking adequate iron intake); and who are occupationally exposed to cadmium (jewelry making or paint manufacture)

are at increased risk of harm compared to those who have not been exposed to cadmium.

Are there medical tests to show whether I've been exposed to cadmium?

Tests that should be performed in the case of acute cadmium ingestion:

- Liver and kidney functions – to check for liver or kidney damage
- Blood chemistry

Tests that should be performed if acute cadmium inhalation exposure is suspected:

- Chest X-ray
- Measurement of oxygen saturation
- Liver and kidney functions
- Cadmium blood and urine levels

Evaluation of people with known or suspected chronic cadmium exposure should focus on the kidneys. Initial tests should include:

- Kidney function
- Cadmium in blood and urine
- Blood chemistry
- Urinary protein

Evaluation for chronic cadmium exposure may also include:

- Urinary metallothionein and β_2 – microglobulin excretion can be correlated with long – term cadmium exposure.
- The best screening and diagnostic test for chronic cadmium exposure is a 24-hour urinary cadmium level.

Treatment and Preventive Measures

There is no effective antidote or treatment for acute cadmium exposure and toxicity. Supportive measures to treat symptoms include supplementation with calcium and vitamin D if bone disease is present. Chelation therapy has no role in cases of cadmium poisoning.

Prevention of further exposure is the most important step in the management of people with symptoms suggestive of cadmium exposure. To prevent or minimize further exposures:

- Stop smoking.

- Maintain adequate iron intake in the diet.
- Practice good occupational hygiene if involved in work with cadmium or in hobbies involving cadmium exposure such as jewelry making or paints using cadmium.

How do I interpret the results of my clinical tests?

Your physician or health practitioner is responsible to interpret the results of your clinical tests and make the appropriate diagnosis of your condition. However, in general, the following guidelines are useful for the interpretation of clinical laboratory results:

- Non-smokers have very low levels of urinary cadmium. The average cadmium level is 0.08 µg/gm creatinine. Levels increase with age to 0.26 µg/gm creatinine.
- Kidney dysfunction is unlikely when urinary cadmium levels are less than 10 µg/gm creatinine.
- Elevated blood cadmium levels confirm recent acute exposure but do not correlate with body burden or clinical outcome, and should not be used to determine the need for treatment.
- Blood cadmium levels of healthy nonexposed, nonsmokers is approximately 0.4 µg/L.
- Blood cadmium levels of occupationally exposed persons may be higher than the general population. OSHA considers a whole blood level of 5 µg/L or higher to be hazardous.
- Hair cadmium levels are not reliable either as predictors of toxicity or as indicators of occupational exposure.
- Increased medical monitoring and exposure review is required if urine cadmium is greater than 3 µg/gm creatinine, or whole blood cadmium if greater than 5 µg/L or urine β₂ microglobulin is greater than 300 µg/gm creatinine.
- Removal from exposure is required if the urine cadmium is greater than 15 µg/gm creatinine or whole blood cadmium is greater than 15 µg/L or urine β₂ microglobulin is greater than 1,500 µg/gm creatinine.

Has the federal government made recommendations to protect human health?

The U.S. Occupational Safety Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH) have established workplace levels to protect the health of people occupationally exposed to cadmium. The OSHA and NIOSH limits are:

- OSHA: The Permissible Exposure Limit – Time Weighted Average (PEL) is 5 micrograms per cubic meter (µg/m³) of air.
- OSHA requires medical examination and biological monitoring for workers exposed to cadmium for 30 or more days a year at levels equal to 2.5 µg/m³ or greater in air to prevent cadmium induced disease.

- NIOSH: The Immediately Dangerous to Life and Health level (IDLH) is 9 milligrams (9000 µg) per cubic meter (mg/m³) of air.

The U.S. Federal Drug Administration (FDA) and the U.S. Environmental Protection Agency (EPA) have set exposure standards and the U.S. Agency for Toxic Substance and Disease Registry (ATSDR) has established an exposure guideline to protect the general public from excess cadmium exposure from various sources.

- FDA: The maximum limit of cadmium in bottled water allowed by law should not exceed 5 micrograms per liter (µg/L).
- EPA: The Maximum Contaminant Level (MCL) in drinking water is 5 µg/L. The MCL is the maximum allowable amount of a contaminant in drinking water which is delivered to the consumer. The MCL is an enforceable standard.
- ATSDR: The chronic oral Minimal Risk Level (MRL) is 0.0001 milligrams per kilogram per day (mg/kg/day) of cadmium based on its kidney effects. The MRL is a guideline stating how much cadmium can be taken in without risk of adverse health effects.

What methods are available to remove cadmium water?

- Cation exchange units, reverse osmosis, or distillation all remove cadmium from drinking water.

What methods do not remove cadmium in drinking water?

- Boiling water does not remove cadmium and is not a treatment alternative. As evaporation occurs during boiling, it increases cadmium concentration in the remaining water.
- Chemical disinfection, such as chlorination, also does not remove cadmium from water.

Where can I get more information?

For emergency situations involving chemical exposures and possible human health effects call:

- The Philadelphia Poison Control Center, Philadelphia, PA; or the Pittsburgh Poisoning Control Center, Pittsburgh, PA. All poison control centers can be reached at telephone number (800) 222-1222.

For non – emergency situations regarding the need for additional information contact:

- The Pennsylvania Department of Health, Division of Environmental Health Epidemiology, P.O. Box 90, Harrisburg, Pennsylvania, 17108. Telephone number: 717-787-1708.

References

Agency for Toxic Substances and Disease Registry (ATSDR). Case Study in Environmental Medicine: Cadmium Toxicity. Atlanta: US Department of Health and Human Services; May 12, 2008.

National Toxicology Program. (2004) Report on Carcinogens, Eleventh edition. Carcinogen profiles 2004. Research Triangle Park, North Carolina: US Department of Health and Human Services, Public Health Service, National Toxicology Program.

Agency for Toxic Substances and Disease Registry (ATSDR). ToxFAQs: Cadmium. Atlanta: US Department of Health and Human Services; September 2008.

Content last modified on 02/08/10