The ToxGuide™ is developed to be used as a pocket guide. Tear off at perforation and fold along lines.

Sources of Exposure

General Populations

- The general population may be exposed to cadmium daily through food, cigarette smoke drinking water, and air.
- Cadmium is introduced to the food chain through agricultural soils, which may naturally contain cadmium, or from anthropogenic sources, from cadmium-plated utensils and galvanized equipment used in food processing and preparation; enamel and pottery glazes with cadmium-based pigments; and stabilizers used in food contact plastics.
- The highest levels of cadmium in food are typically found in leafy vegetables, such as lettuce and spinach, potatoes, grains, peanuts, and organ meats such as liver and kidney.
- Cadmium levels are expected to be low in drinking water and ambient air except in the vicinity of cadmium-emitting industries or incinerators.

Occupational Populations

- Occupational exposure to cadmium primarily occurs in operations involving heating cadmium-containing products.
- Occupations with the highest potential for exposure include: alloy production, battery production, pigment production and use, plastics production, and smelting and refining.

Toxicokinetics and Normal Human Levels

Toxicokinetics

- Cadmium is not well absorbed; approximately 25, 1–10, or <1% of a dose is absorbed following inhalation, oral, or dermal exposure, respectively.
- Several factors affect cadmium absorption. Cadmium aerosols with small particle sizes, such as found in cigarette smoke, is more absorbed than larger particle sizes. The body stores of iron influences cadmium absorption through the gastrointestinal tract; individuals with low iron body burdens will absorb more cadmium.
- Regardless of the exposure route, cadmium is widely distributed in the body with the highest levels found in the liver and kidneys.
- Absorbed cadmium is excreted very slowly, with urinary and fecal excretion being approximately equal.
- The half-time for cadmium in the whole body in humans is >26 years.

Normal Human Levels

- The geometric blood level of cadmium in the general population (≥1 year of age) is 0.315 µg/L.
- The geometric urine level of cadmium in the general population (≥6 years of age) is 0.193 µg/g creatinine (0.185 µg/L).

Biomarkers/Environmental Levels

Biomarkers

- Cadmium levels in blood, urine, feces, liver, kidney, hair, and other tissues have been used as biomarkers of exposure. Blood and urine cadmium levels are the most commonly used biomarkers of exposure.
- Blood cadmium levels are indicative of recent exposure rather than whole-body burdens.
- Urine cadmium levels primarily reflect total body burden. A biokinetic model can estimate intake based on urinary levels.

Environmental Levels

Air

- Cadmium levels in ambient air range from 0.1 to 5 ng/m^3 in rural areas, 2–15 ng/m^3 in urban areas, and 15–150 ng/m^3 in industrialized areas.

Sediment and Soil

- Cadmium concentrations in soil not contaminated by anthropogenic sources range from 0.06 to 1.1 mg/kg.
- Topsoil concentrations are often twice as high as subsoil levels.
- Average cadmium concentration in agricultural soils is 0.27 mg/kg.

Water

- The average level of cadmium in ocean water is between <5 and 110 ng/L.
- EPA requires water suppliers to limit the cadmium concentration in water to <5 µg/L.

ToxGuide™ for Cadmium

Cd

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U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
www.atsdr.cdc.gov

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ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

Cadmium is a Metal

- Cadmium occurs in the earth's crust and is commonly associated with zinc, lead, and copper ores.
- It is a natural constituent of ocean water.
- Cadmium is refined and consumed for use in batteries, pigments, coatings and platings, stabilizers for plastics, and nonferrous alloys, and photovoltaic devices.

Routes of Exposure

- Inhalation – Predominant route of exposure for smoking general population and occupational population.
- Oral – Predominant route of exposure for the nonsmoking general population.
- Dermal – Minor route of exposure for the general population.

Cadmium in the Environment

- Cadmium is released into the atmosphere via natural and anthropogenic sources; emissions from anthropogenic sources exceed those of natural origin by an order of magnitude.
- Major industrial sources of cadmium emissions include zinc, lead, copper, and cadmium smelting operations, coal and oil-fired boiler, phosphate fertilizer manufacture, and municipal and sewage sludge incinerators.
- Phosphate fertilizers are a major source of cadmium input to agricultural soil.
- Tobacco leaves naturally accumulate large amounts of cadmium.
- Cadmium bioaccumulates at all levels of the food chain.

Relevance to Public Health (Health Effects)

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- An MRL of $3x10^{-5}$ mg Cd/m^3 has been derived for acute-duration inhalation exposure to cadmium (≤14 days).
- No intermediate-duration inhalation MRL was derived for cadmium.
- An MRL of $1x10^{-5}$ mg Cd/m^3 has been derived for chronic-duration inhalation exposure to cadmium (≥1 year).

Oral

- No acute-duration oral MRL was derived for cadmium.
- An MRL of $5x10^{-4}$ mg Cd/kg/day has been derived for intermediate-duration oral exposure to cadmium (15–364 days).
- An MRL of $1x10^{-4}$ mg Cd/kg/day has been derived for chronic-duration oral exposure to cadmium (≥1 year).

Health Effects

- The most sensitive targets of cadmium toxicity are the kidney and bone following oral exposure and kidney and lung following inhalation exposure.
- The effects observed in humans include renal tubular damage, glomerular damage, decreases in bone mineralization, increased risk of bone fractures, decreased lung function, and emphysema. These effects typically occur after long term exposure to cadmium.
- Some studies have cadmium workers have found increases in the risk of lung cancer. DHHS and IARC consider cadmium to be a human carcinogen. EPA considers cadmium to be a probable human carcinogen by the inhalation route.

Children's Health

- It is likely that effects observed in adults exposed to cadmium will also be seen in children. Because cadmium is a cumulative toxin and has a very long half time in the body, exposure to children in even low amounts may have long-term consequences. Studies in animals suggest that children may be more susceptible than adults on cadmium-induced bone damage.
- In laboratory animals, cadmium causes decreases in fetal or pup body weight, skeletal malformations, and behavioral alterations.