

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

## Sources of Exposure

## Toxicokinetics and Normal Human Levels

## Biomarkers/Environmental Levels

# ToxGuide™

for

# Lead

# Pb

CAS# 7439-92-1

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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](http://www.atsdr.cdc.gov)

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### General Populations

- The most likely source of exposure is ingestion of contaminated food and drinking water. Exposure can also occur via inadvertent ingestion of contaminated soil/dust or lead-based paint.
- Lead can leach into drinking water from lead-soldered joints or leaded pipes in water distribution systems or individual houses. Lead may also enter foods if they are put into improperly glazed pottery or ceramic dishes.
- Some non-Western folk remedies may contain substantial amounts of lead. Some types of hair dyes and cosmetics may contain lead compounds.
- Other potential sources of exposure are hobbies that use lead: casting ammunition and m fishing weights; soldering with lead solder; making stained glass; using firing ranges. Leaded gasoline is still used in some race cars, airplanes, and off-road vehicles.

### Occupational Populations

- Potentially high levels of lead may occur in the following industries: lead smelting and refining industries, battery manufacturing plants, steel welding or cutting operations, construction, rubber products and plastics industries, printing industries, firing ranges, radiator repair shops and other industries requiring flame soldering of lead solder.

### Toxicokinetics

- Approximately 95% of deposited inorganic lead that is inhaled is absorbed.
- The extent and rate of gastrointestinal absorption of inorganic lead are influenced by the physiological state of the exposed individual and the species of the lead compound.
- Gastrointestinal absorption of lead is higher in children (40–50%) than in adults (3–10%). The presence of food in the gastrointestinal tract decreases absorption.
- Absorption of lead from soil is less than that of dissolved lead, but is similarly depressed by meals (26% fasted; 2.5% when ingested with a meal).
- In adults, about 94% of the total amount of lead in the body is contained in the bones and teeth versus about 73% in children.
- The elimination half-lives for inorganic lead in blood and bone are approximately 30 days and 27 years, respectively.
- Independent of the route of exposure, absorbed lead is excreted primarily in urine and feces.

### Normal Human Levels

- Lead levels in blood (geometric mean, 1999-2002):
  - 1.9 µg/dL for children 1-5 years
  - 1.5 µg/dL for adults 20–59 years
- Lead levels in urine (geometric mean, 2001-2002):
  - 0.677 µg/L for ≥6 years of age

### Biomarkers

- Analysis of lead in whole blood is the most common and accurate method of assessing lead exposure. Erythrocyte protoporphyrin (EP) tests can also be used, but are not as sensitive at low blood lead levels (<20 µg/dL). Lead in blood reflects recent exposure.
- Bone lead measurements are an indicator of cumulative exposure.
- Measurements of urinary lead levels and hair have been used to assess lead exposure; however, they are not as reliable.

### Environmental Levels

#### *Air*

- The concentration of lead in air samples (2002) is <0.05 µg/m<sup>3</sup>.

#### *Sediment and Soil*

- The natural lead content of soil typically ranges from <10 to 30 µg/g. However, lead levels in the top layers of soil vary widely due to deposition and accumulation of atmospheric particulates from anthropogenic sources.

#### *Water*

- Levels of lead in surface water and groundwater in the U.S. range between 5 and 30 µg/L.

### Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

## Chemical and Physical Information

## Routes of Exposure

## Relevance to Public Health (Health Effects)

### Lead is a metal

- Lead is a naturally-occurring bluish-gray metal that is rarely found in its elemental form, but occurs in the Earth's crust primarily as the mineral galena (PbS), and to a lesser extent as anglesite (PbSO<sub>4</sub>) and cerussite (PbCO<sub>3</sub>).
- Lead is not a particularly abundant element, but its ore deposits are readily accessible and widely distributed throughout the world. Its properties, such as corrosion resistance, density, and low melting point, make it a familiar metal in pipes, solder, weights, and storage batteries.
- Natural lead is a mixture of four stable isotopes, <sup>208</sup>Pb (51–53%), <sup>206</sup>Pb (23.5–27%), <sup>207</sup>Pb (20.5–23%), and <sup>204</sup>Pb (1.35–1.5%). Lead isotopes are the stable decay product of three naturally radioactive elements: <sup>205</sup>Pb from uranium, <sup>207</sup>Pb from actinium, and <sup>208</sup>Pb from thorium.

- Inhalation** – Primary route for occupational exposure. Larger particles (>2.5 μm) that are deposited in the ciliated airways (nasopharyngeal and tracheobronchial regions) can be transferred by mucociliary transport into the esophagus and swallowed.
- Oral** – Primary route of exposure for the general population.
- Dermal** – Studies in animals have shown that organic lead is well absorbed through the skin.

### Lead in the Environment

- Lead is dispersed throughout the environment primarily as the result of anthropogenic activities. In the air, lead is in the form of particles and is removed by rain or gravitational settling.
- The fate of lead in soil is affected by the adsorption at mineral interfaces, which are dependent upon physical and chemical characteristics of the soil (e.g., pH, soil type, particle size, organic matter content).
- Sources of lead in dust and soil can include lead from weathering and chipping of lead-based paint from buildings, bridges, and other structures.
- The solubility of lead compounds in water is a function of pH, hardness, salinity, and the presence of humic material. Solubility is highest in soft, acidic water.

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

### Minimal Risk Levels (MRLs)

- MRLs were not derived for lead because a clear threshold for some of the more sensitive effects in humans has not been identified.
- In lieu of MRLs, ATSDR has developed a framework to guide decisions at lead sites. This approach utilizes site-specific exposure data to estimate internal doses as measured by blood lead levels (PbBs) (see Appendix D in the Toxicological Profile).

### Health Effects

#### *Hematological*

- Decreased activity of several heme biosynthesis enzymes at PbB <10 μg/dL.

#### *Gastrointestinal*

- Colic in children – PbB 60–100 μg/dL.

#### *Cardiovascular*

- Elevated blood pressure – PbB <10 μg/dL.

#### *Renal*

- Decreased glomerular filtration rate at mean PbB <20 μg/dL.

#### *Neurological*

- Encephalopathy – PbB 100–120 μg/dL (adults) 70–100 μg/dL (children).
- Peripheral neuropathy – PbB 40 μg/dL.
- Neurobehavioral and neuropsychological effects in adults – PbB 40–80 μg/dL.
- Cognitive and neurobehavioral effects in children at PbB <10 μg/dL.

#### *Reproductive*

- Reduced fertility – PbB >40 μg/dL.

### Children's Health

- Children are more vulnerable to the effects of lead than adults.
- The most common source of lead exposure for children is lead-based paint.
- Lead exposures during infancy or childhood may result in anemia, neurological impairment, renal alterations, colic, and impaired metabolism of vitamin D.
- Lead exposures either *in utero*, during infancy, or during childhood may result in delays or impairment of neurological development, neurobehavioral deficits including IQ deficits, low birth weight, and low gestational age, growth retardation, and delayed sexual maturation in girls.
- Ensuring a diet that is nutritionally adequate in calcium and iron may decrease the absorbed dose of lead.