

## ToxFAQs: CABS™/Chemical Agent Briefing Sheet

# Mercury

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### What is mercury?

Mercury is a naturally occurring element. Its distribution in the environment is the result of both natural and man-made processes.

### What are the forms of mercury?

There are three categories of mercury with unique characteristics and unique potential health effects:

- *Elemental or metallic mercury*
- *Organic mercury compounds*
- *Inorganic mercury compounds*

Not all forms are encountered by the general public. The forms most likely encountered by the general public are:

- **Elemental mercury vapor ( $Hg^0$ ) from metallic mercury or liquid mercury**—This is the elemental or pure form of mercury; i.e., it is not combined with other elements. It is the primary form of mercury released into the air by natural processes, such as volcanic activity.
- **Methylmercury**—Microorganisms in the environment can convert inorganic mercury to the organic form methylmercury. This form can build up in the environment and accumulate in certain freshwater and saltwater fish, and marine mammals. Methylmercury is the form of mercury that is most likely to cause adverse health effects in the general population.
- **Ethylmercury**—This is an organic form of mercury found in some medical preservatives. Also used in some parts of the world as an antifungal agent in grains.
- **Inorganic mercury (mercuric salts)**—This is an oxidized mercury that combines with other chemical elements to create salt forms.

## What are common uses of mercury?

Form	Uses
<b>Elemental mercury vapor (Hg<sup>0</sup>) from:</b> <ul style="list-style-type: none"> <li>• Metallic mercury</li> <li>• Liquid mercury</li> </ul>	<ul style="list-style-type: none"> <li>• Some folk medicines (Voodoo, Santeria, and Esperitismo) use mercury. This metallic mercury is sold under the name "azogue" (pronounced ah-SEW-gay) in stores called "botanicas."</li> <li>• Metallic mercury is the familiar liquid used in thermometers (also known as quicksilver).</li> <li>• Metallic mercury is used to produce chlorine gas and caustic soda. It is also used in electrical switches, barometers, dental fillings, fluorescent light bulbs, some blood pressure devices, and some batteries.</li> </ul>
<b>Ethylmercury</b>	<ul style="list-style-type: none"> <li>• Used medically as fungicides and antibacterials</li> <li>• Released from preservatives used in vaccines (thimerosal or merthiolate)</li> </ul>
<b>Inorganic mercury Compounds</b> <ul style="list-style-type: none"> <li>• Mercury salts</li> </ul>	<ul style="list-style-type: none"> <li>• Sometimes used in skin lightening creams and as antiseptic creams and ointments</li> <li>• Some use in folk medicines</li> <li>• Used in preserving solutions for some collected biological specimens</li> <li>• Used as a reagent in analytical chemistry reactions, photography, and metal etching solutions</li> </ul>

## What are routes of exposure for mercury?

Form	Routes of Exposure
<b>Elemental mercury vapor (Hg<sup>0</sup>) from:</b> <ul style="list-style-type: none"> <li>• Metallic mercury</li> <li>• Liquid mercury</li> </ul>	<ul style="list-style-type: none"> <li>• Breathing vapors in air from spills, incinerators, and industries that burn elemental mercury-containing fossil fuels</li> <li>• Release of mercury from dental work. Mercury exposure from dental amalgams is typically slight.</li> <li>• Breakage of devices that contain elemental mercury</li> <li>• Practicing rituals that include elemental mercury</li> </ul>
<b>Methylmercury</b>	<ul style="list-style-type: none"> <li>• Through eating certain freshwater and saltwater fish and marine mammals</li> </ul>
<b>Ethylmercury</b>	<ul style="list-style-type: none"> <li>• Some multi-dose vials of vaccines and a limited number of pharmacologic preparations</li> </ul>
<b>Inorganic mercury Compounds</b> <ul style="list-style-type: none"> <li>• Mercury salts</li> </ul>	<ul style="list-style-type: none"> <li>• Released into the air from mining of ore, burning of coal, and incineration of waste</li> <li>• Enters the body through the intestinal tract and skin</li> <li>• Breathing contaminated workplace air</li> <li>• Eating contaminated food</li> <li>• Practicing rituals that include inorganic mercury</li> </ul>

## What are possible toxic effects?

The different forms of mercury have distinct patterns of adverse health effects. Not everyone is equally susceptible to the effects of mercury. Some people may not show symptoms at the values reported, but the values do indicate the lowest levels at which the effects have been reported. The following chart shows the duration, intensity, route of exposure, and effects on the body of specific forms of mercury.

### Notes on units of measure:

- µg/l = micrograms per liter (a microgram is one millionth of a gram)
- mg/l = milligrams per liter (a milligram is one thousandth of a gram)
- ppb = parts per billion
- ppm = parts per million
- ppt = parts per trillion

Form	Toxic Effects		
<b>Elemental mercury vapor (Hg<sup>0</sup>) from:</b> <ul style="list-style-type: none"> <li>• Metallic mercury</li> <li>• Liquid mercury</li> </ul>	<b>High level exposure:</b> Urine mercury levels above 60 µg/l: <ul style="list-style-type: none"> <li>• Acrodynia (Pink's disease in children)</li> <li>• Insomnia</li> <li>• Possible respiratory effects</li> <li>• Rapidly shifting moods</li> <li>• Restlessness</li> <li>• Tremors</li> </ul>	<b>Medium level exposure:</b> Urine mercury levels of 40-60 µg/l: <ul style="list-style-type: none"> <li>• Acrodynia (Pink's disease in children)</li> <li>• Fever</li> <li>• Insomnia</li> <li>• Rapidly shifting moods</li> <li>• Tremors</li> </ul>	<b>Low level exposure:</b> No reports of effects for people in range of 21-39 µg/l have been documented, but this does not rule out the possibility of toxicity in sensitive individuals.  No clinical or subclinical effects reported for urine mercury levels below 20 µg/l.
<b>Methylmercury</b>	<b>Blood Hg µg/L</b>	<b>Effect (adults unless stated)</b>	
	<10	<ul style="list-style-type: none"> <li>• No apparent effect</li> <li>• Background levels for most of the U.S. population</li> </ul>	
	50-100	Self-reported, nonspecific complaints: malaise, weakness, cognition. For children, increasingly abnormal test components on neurodevelopmental testing in relation to cord blood concentrations.	
	100-200	<ul style="list-style-type: none"> <li>• low prevalence of paresthesias (sensory changes)</li> <li>• decreased visual fields</li> <li>• decreased hearing acuity</li> <li>• ataxia (loss of the ability to coordinate muscular movement)</li> </ul>	
	200 and above	Increasing prevalence and severity of the effects listed above. In children via maternal exposure, signs of delayed development. At much higher levels, retardation, blindness, and deafness.	
<b>Ethylmercury</b>	<ul style="list-style-type: none"> <li>• Toxicological information is very limited.</li> <li>• Studies show that the neurotoxicity of thimerosal would be much less than that of methylmercury because of the more rapid breakdown and elimination of ethylmercury from the body.</li> </ul>		
<b>Inorganic Mercury Compounds</b> also know as: <ul style="list-style-type: none"> <li>• Mercury salts</li> </ul>	The kidneys are the primary organs affected by chronic exposure to mercury salts. Severe renal damage can result from ingestion of mercury salts. At very high exposures there could be neurological effects.		

## What are the government guidelines for mercury exposure?

Source	Guidelines
<b>Air</b>	The United States Environmental Protection Agency (EPA) National Emission Standard: Emissions to the atmosphere from mercury ore processing facilities and mercury cell chlor-alkali plants shall not exceed 5 lbs of mercury per 24-hour period.
<b>Water</b>	The EPA standard for finished drinking water is 0.002 mg/L (2 parts per billion [ppb]).  The Food and Drug Administration (FDA) limits mercury in bottled water to 0.002 mg/L.  EPA currently recommends that the level of inorganic mercury in rivers, lakes, and streams be no more than 144 parts mercury per trillion [ppt].
<b>Fish and Shellfish</b>	FDA has set a maximum permissible level of methylmercury as 1 part per million (ppm) in seafood products sold through interstate commerce.  FDA may seize shipments of fish and shellfish containing more than 1 ppm of methylmercury.  This regulation applies to fish sold commercially, but not to sport fish consumed by the angler or to fish caught in-state and sold in local markets.
<b>Seed grain</b>	FDA may seize treated seed grain containing more than 1 ppm of mercury.

## What are the minimal risk levels (MRL) for mercury exposure?

An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.

	Minimal Risk Level (MRL)
<b>Mercuric chloride (oral)</b>	Acute: 0.007 mg/kg/day Intermediate: 0.002 mg/kg/day  mg/kg/day = milligrams per kilogram of body weight per day
<b>Mercury (Inhalation)</b>	Chronic: 0.0002 mg/m <sup>3</sup> (milligrams per cubic meter of air)

## What are the most important or common mediating factors?

Factors that determine how severe the health effects are from mercury exposure include:

- dose
- age of the person exposed (the fetus is the most susceptible)
- duration of exposure
- route of exposure—inhalation, ingestion, skin contact, etc.
- health of the person exposed
- nutritional status of the person exposed

## What are the defense systems of the body against mercury?

The skin is an effective barrier to most forms of mercury. Once in the body, enzymes work to convert the mercury to a form that is readily eliminated in the urine. Inorganic mercury binds to the protein metallothionein (MT). MT is found in all major organs affected by mercury, such as the brain and kidney. Most methylmercury is eliminated in a different manner. Methylmercury is excreted with the bile back into the intestine, from which much of it is eliminated in the feces. Regardless of the form of mercury, approximately one half of that absorbed from a single dose will be eliminated from the body every 2 months.

## Is there a test to see if my child or I have been exposed to mercury?

Tests are available to determine mercury exposure. The particular test depends on type of mercury to which a person believes he or she has been exposed.

Test	Procedure
<b>Urine mercury</b>	<ul style="list-style-type: none"> <li>Urine specimen is taken to a laboratory for analysis. This test is good for detecting exposure only to elemental or inorganic mercury, not methylmercury.</li> </ul>
<b>Hair mercury</b>	<ul style="list-style-type: none"> <li>Hair is only considered a reliable marker of exposure to methylmercury or ethylmercury.</li> </ul>
<b>Blood mercury</b>	<ul style="list-style-type: none"> <li>Blood is an excellent indicator of exposure to methylmercury only.</li> <li>Acute elemental exposures can be detected for a few days in blood. Otherwise, after 2 days, urine is a better indicator of past or cumulative elemental mercury exposure.</li> </ul>

## Future Research Needs:

To close current gaps in the scientific data base on the health effects of mercury, a *long – term* research program is needed to:

### Detect and track mercury exposures by:

- Developing biomonitoring methods to better detect mercury exposure to the various chemical forms (species) of mercury so that relative exposures from all sources of mercury may be delineated
- Applying these biomonitoring methods to specifically assess and track mercury exposures among the general U.S. population by simultaneous measurements of total mercury, methylmercury, and ethylmercury in the same samples
- Placing particular emphasis on studies of mercury exposures among vulnerable populations (for example, the fetus and newborn/nursing infants) and persons at-risk for high mercury exposures due to local environmental conditions, high dietary sources, and personal activities
- Conducting research on the various sources for human exposure to mercury (for example, how much human mercury exposure is derived from different exposure sources such as coal burning power plants, contaminated fish, dental amalgams, etc.)

### Assess/reduce health risks by:

- Determining if health effects are associated with biomonitoring levels of specific mercury species, including risk assessment calculations using modern computer modeling methods for the specific mercury species delineated by biomonitoring studies

- Preparing peer-reviewed clinical guidelines for physicians regarding appropriate diagnostic, therapeutic, and preventive actions for specific chemical species of mercury that are known or likely to cause disease
- Evaluating the health risks for neurologic disease from thimerosal use in childhood vaccines using new data for specific chemical species of mercury derived from biomonitoring studies
- Researching the potential for toxicity to organs such as the brain and kidney from combined exposure to mercury and other common toxic agents and genetic risk factors which may mediate individual susceptibility by incorporating molecular biomarker endpoints
- Developing risk communication products for the general public that explain risks of varying levels of exposure to the specific chemical forms of mercury and actions that could reduce risk

## For more information

ATSDR/Division of Toxicology and Environmental Medicine Toxicological Profile - Mercury  
[www.atsdr.cdc.gov/toxprofiles/tp46.html](http://www.atsdr.cdc.gov/toxprofiles/tp46.html)

ATSDR/Division of Toxicology and Environmental Medicine – Medical Management Guidelines for Mercury  
<http://www.atsdr.cdc.gov/MHMI/mmg46.html>

NIOSH Safety and Health Topic: Mercury  
<http://www.cdc.gov/niosh/topics/mercury/>

Occupational Safety and Health Administration – Safety and Health Topics: Mercury  
<http://www.osha.gov/SLTC/mercury/index.html>

Environmental Protection Agency – Mercury  
<http://www.epa.gov/mercury/>

NIOSH International Chemical Safety Cards – Mercury  
<http://www.cdc.gov/niosh/ipcsneng/neng0056.html>

## **For more information, contact:**

*Agency for Toxic Substances and Disease Registry  
Division of Toxicology and Environmental Medicine  
600 Clifton Road NE, Mailstop F-32  
Atlanta, GA 30333 Phone: 1-800-CDC-INFO (800-232-4636) TTY 888-232-6348*

*FAX: (770)-488-4178  
Email: [CDCINFO@cdc.gov](mailto:CDCINFO@cdc.gov)*