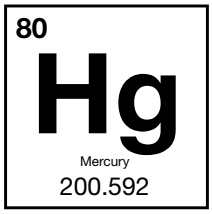
BC Clinician's

Guide to Mercury

BC Centre for Disease Control
Provincial Health Services Authority



Purpose

To provide guidance to BC clinicians on the assessment and management of patient exposure to mercury in its various chemical forms.

Summary

While mercury toxicity is rare in Canada, it can occur in a number of ways. High consumption of large predatory fish species (organic or methylmercury) is the main source of exposure in Canada. Occupational exposures to metallic mercury or its inorganic salts in chloralkali, smelting, recycling and other industries as well as spillage from products containing metallic mercury are also common sources. Health effects depend on the type of mercury; the dose, duration and route of exposure; and susceptibility of the patient, with the developing fetus being at most risk of toxicity. Effects range from neurotoxicity to pulmonary, renal and gastrointestinal injury. For patients presenting with signs and symptoms and an exposure history compatible with mercury toxicity, clinicians can order whole blood mercury levels for organic/methylmercury exposure, and urine (preferred) or whole blood mercury levels for metallic and inorganic mercury exposure. Management is generally supportive, and includes removing the patient from the exposure source and monitoring blood/urine mercury levels over time.

I Exposures to Mercury

Mercury occurs naturally in the environment, and exists in the air, water and soil, although it can also be released by human activity such as the burning of fossil fuels and smelting. Humans may be in contact with three distinct forms of mercury:

a. organic mercury (mercury combined with a carbon moiety, generally a methyl group)
b. metallic or elemental mercury (a liquid at room temperature)
c. inorganic mercury (elemental mercury in combination with chlorine, sulphur or oxygen)

In the environment, mercury cycles through the different forms through natural processes, including the conversion of inorganic mercury to organic mercury compound by bacteria in water. The routes and consequences of exposure differ among the three forms of mercury.

I Exposures to Mercury *(continued)*

a Organic Mercury

The principal and generally most important route of exposure to organic (mainly methyl—) mercury is through the consumption of fish. The concentration of methylmercury in fish, which both accumulates and bio-magnifies methylmercury, varies by species and by size of fish. Large, predatory fish such as fresh/frozen tuna (mean methylmercury content 0.93 mcg/g), shark (1.36 mcg/g) and swordfish (1.82 mcg/g) have high concentrations of methylmercury, while smaller species, such as anchovy, capelin, char, hake, herring, Atlantic mackerel, mullet, pollock, salmon, smelt, rainbow trout, lake whitefish, blue crab, shrimp, clam, mussel and oyster have low concentrations of methylmercury. More fish species and their mercury content are listed in Tables A1 in the appendix. Health Canada recommends that people who are or may become pregnant or are breastfeeding limit their consumption of predatory fish (including fresh/frozen tuna, shark and swordfish) to 150g (approximately one cup) per month, and to limit their consumption of canned albacore (white) tuna to 300g per week.

b Metallic Mercury

People are exposed to metallic mercury when objects containing the liquid break. Examples of such objects are older thermometers and blood pressure devices, thermostats, barometers, electrical switches, and fluorescent lamps, including compact fluorescent lamps and high intensity discharge lamps such as those found in some automobile headlights. People may also be exposed through hobby gold smelting and some folk remedies. Workers may be exposed through the manufacturing or recycling of metallic mercury-containing products, old instrumentation in control rooms of various industries, and medical or research laboratory equipment. Liquid mercury vaporizes at atmospheric pressure, the rate and degree of which increases with ambient temperature. Inhalation is the primary route of exposure, although dermal exposure and ingestion can be other exposure routes. Inhalational exposure depends on the amount of mercury spilled, the volume of the space where the spill occurs and where vapour accumulates, and the duration of exposure. Vacuuming a mercury spill volatilizes the liquid, increasing exposure as does heating liquid mercury or warming up the area of the spill. Contact with small amounts of mercury (such as the amount contained in a thermometer) is unlikely to affect health. Examples of exposures of concern for metallic mercury include vacuuming of spilled mercury, prolonged exposure in a small space and ingestion of amounts larger than those found in a thermometer.

c Inorganic Mercury

Exposure to inorganic mercury can occur through respiratory, gastrointestinal and dermal routes and is primarily a concern for workers in chloralkali and electroplating industries, chemical and metal processing plants, hazardous waste incineration plants, recycling facilities, boilers (power plants), and mining and smelting operations. For the general population, exposure to inorganic mercury through

I Exposures to Mercury

c Inorganic Mercury *(continued)*

the extensive use of skin lightening creams has been reported[123]. Exposure to mercury in dental amalgam, which occurs through tooth grinding, is rarely a significant health concern or an indication for mercury testing[4].

II Biological Effects of Mercury

a Mercury Metabolism

The metabolism of mercury is complex and depends on the form, dose, and chronicity of exposure. Overall, organic mercury is mainly excreted via the fecal (biliary) pathway with a half-life of 50-60 days; metallic mercury is excreted in urine with a half-life of 30-60 days; and inorganic mercury is excreted in urine and feces with a half-life of about 60 days. However, mercury is cleared more slowly from the brain, with a longer half-life compared to in the blood; therefore, clinicians should be aware of the potential prolonged effects of mercury exposure.[5]

b Health Effects

Poisoning by **methylmercury** primarily causes central nervous system toxicity. The main hazard of exposure is to the developing fetus, particularly during the second trimester, as methylmercury crosses the placental barrier. The effects of fetal exposure, which are long-lasting and dose-dependent, include neurodevelopmental delays, cognitive deficits, cerebellar ataxia, dysarthria, sensory impairments and a cerebral palsy-like syndrome. Acute high dose exposures to **metallic mercury** are associated with lung injury and renal dysfunction, whereas chronic exposures are associated primarily with neuropsychiatric disturbances. Exposures to **inorganic mercury** are associated with renal and gastrointestinal injury, dermatitis, and to a lesser extent than the other two forms of mercury, neurologic disturbances. In children, exposure to any form of mercury may result in acrodynia ("pink disease"), a syndrome characterized by palmoplantar irritation and desquamation, pain and edema of the extremities, body rash, hypertension, diaphoresis, photophobia, irritability, loss of appetite and insomnia.

[1] Tang HL, Chu KH, Mak YF, Lee W, Cheuk A, Yim KF, et al. Minimal change disease following exposure to mercury-containing skin lightening cream. Hong Kong Med J 2006;12(4):316-318.

[2] Weldon MM, Smolinski MS, Maroufi A, Hasty BW, Gilliss DL, Boulanger LL, et al. Mercury poisoning associated with a Mexican beauty cream. West J Med 2000;173(1):15-18.

[3] Tlacuilo-Parra A, Guevara-Gutiérrez E, Luna-Encinas JA. Percutaneous mercury poisoning with a beauty cream in Mexico. J Am Acad Dermatol 2001;45(6):966-967.

[4] Health Canada [Internet]. Ottawa: Government of Canada. 1996 Health Canada Position Statement on Dental Amalgam; 1996 [updated 2021 April 6]. Available from: **https://www.canada.ca/en/health-canada/services/drugs-health-products/reports-publications/medical-devices/safety-dental-amalgam-health-canada-1996.html**.

[5] 1) Rooney JP. The retention time of inorganic mercury in the brain—A systematic review of the evidence. Toxicology and applied pharmacology. 2014 Feb 1;274(3):425-35.
2) Vahter M, Mottet NK, Friberg L, Lind B, Shen DD, Burbacher T. Speciation of mercury in the primate blood and brain following long-term exposure to methyl mercury. Toxicology and applied pharmacology. 1994 Feb 1;124(2):221-9.
3) Rice DC. Brain and tissue levels of mercury after chronic methylmercury exposure in the monkey. Journal of Toxicology and Environmental Health, Part A Current Issues. 1989 Jun 1;27(2):189-98.

III Evaluation of Mercury Toxicity

a Work and Exposure History

A detailed occupational and environmental history should be conducted to identify potential mercury exposures of concern. A list of potential exposure sources is provided in Table A2 in the Appendix for quick reference. The form of mercury, the dose, duration and route of exposure, and the use of personal protective equipment should be assessed. Clinicians should enquire about fish consumption during consultation early in pregnancy and when pregnancy is planned. They should ask which species, whether self-caught or commercial, are consumed, and how much is consumed at each meal and in total over an average week. This is most important for populations where fish consumption is high, including indigenous peoples, East and Southeast Asian communities, sport fisher families, and pescatarians.

b Medical History and Physical Examination

Clinicians should identify signs and symptoms suggestive of mercury toxicity, which include: gingivitis, stomatitis, hypersalivation, cough, dyspnea, chest pain, abdominal pain, nausea, vomiting, diarrhea, dermatitis characterized by papular erythema, insomnia, irritability, depression, short-term memory loss, fatigue, anorexia, personality changes, emotional lability, paresthesia, ataxia, tremors, and limb weakness.

c Laboratory Investigation

For individuals with a clinical presentation and exposure history that points to **metallic or inorganic mercury** toxicity, **urine (or whole blood)** mercury levels can be ordered to characterize exposure and to assess its possible relation to clinical effects. Urine testing is preferred for chronic or low-dose exposures. For **methylmercury, whole blood** mercury levels should be ordered. Clinicians may offer testing to asymptomatic people in early pregnancy or who are planning on pregnancy if they exceed the Health Canada fish consumption guidelines as mentioned above. Since whole blood mercury represents recent exposure to methylmercury (half-life in blood of about 50 days), it should be measured after two days since the last fish meal to avoid the influence of transient exposure.

IV Management of Mercury Toxicity

a Interpretation of Tests

As per Health Canada, blood mercury levels below 20 µg/L are considered to be in the normal acceptable range for the general adult population, and below 8 µg/L for children (under 18 years of age), pregnant people, and people of childbearing age (under 50 years of age) who may become pregnant. The background level of whole blood mercury in Canadians aged 3-79 in 2016-2017 was a geometric mean value of 0.64 µg/L, whereas the 95th percentile value was 3.8 µg/L[6], much lower than the acceptable limits. The thresholds for signs and symptoms of mercury toxicity are considered to be a urine level of 20 µg/L or higher and a blood level of 50 µg/L or higher. Table 1 below can assist with correlating urine mercury levels with clinical presentation.

Table 1 | Relationship of Urinary Mercury Concentration with Effects [7]

Urinary mercury concentration (µg/L)	Signs and symptoms
<20	None
20-100	• Decreased response on tests for nerve conduction, brain-wave activity, and verbal skills • Early indication of tremor on testing
100-500	• Irritability, depression, memory loss, minor tremor, other nervous system disturbances • Early signs of disturbed kidney function
500-1000	• Kidney inflammation • Swollen gums • Significant tremor and nervous system disturbances

b Management

Patients with mercury toxicity should be removed from sources of exposure. Treatment is generally supportive, but mercury levels exceeding 100 µg/L in urine or blood may warrant chelation treatment, and should prompt referral to a specialist. Contact information for specialist services is provided below. For patients with elevated mercury levels, the test should be repeated at one half-life intervals (generally in 1-2 month intervals) to monitor and confirm a decline in levels back to acceptable range. For workers with elevated mercury levels, clinicians can contact the WorkSafeBC Health & Safety

[6] Health Canada. Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada, Results of the Canadian Health Measures Survey Cycle 5 (2016-2017). Ottawa: 2019 2019-11-13.
[7] Agency for Toxic Substances and Disease Registry. Evaluating Mercury Exposure: Information for Health Care Providers. 2009.

IV Management of Mercury Toxicity

b Management *(continued)*

(Prevention) department to request a workplace investigation and/or talk to an occupational hygiene (prevention) officer, which can be done anonymously if necessary.

People in early pregnancy or planning on pregnancy with a blood mercury level >8 µg/L should be advised to decrease their consumption of fish with high mercury content, and the test can be repeated at monthly intervals to confirm the decline in methylmercury levels following dietary change and the concordant decline of risk to a fetus. While fish does contain methylmercury, it also contains omega-3 fatty acids and is important to a healthy diet, and in some circumstances to food security and cultural identity. To help guide patients on safer dietary practices during pregnancy, clinicians may consult Table A3 in the appendix, which compares methylmercury and omega-3 fatty acid content in fish, and consider involving a dietician.

Specialist Services | Contact Information

BC Drug and Poison Information Centre (DPIC) and BC Centre for Disease Control Environmental Health Services (BCCDC EHS) can help with the assessment of exposure, interpretation of test results, and referral to specialists for further clinical evaluation and/or treatment.

BC Centre for Disease Control | Environmental Health Services
Phone: 604.707.2442
Fax: 604.707.2441
Email: environmentalhealth@bccdc.ca

BC Drug and Poison Information Centre
Poison Info: 1.800.567.8911 (Open 24hrs)
Drug Info: 1.866.298.5909 (For healthcare providers only. Mon-Fri, 9 am–4 pm)

WorkSafeBC Health & Safety (Prevention)
Phone: 604.276.3100 (Lower Mainland)
Toll-free: 1.888.621.7233 (1.888.621.SAFE) (Canada)

Occupational Medicine Clinic
Vancouver General Hospital, Gordon and Leslie Diamond Health Care Centre
Phone: 604.875.5706
Fax: 604.875.5906

Appendix

1 Methylmercury (MeHg) concentrations in different fish species:

Table 1

Fish species and mean methylmercury concentrations (only includes fish found to contain on average at least 0.2 µg/g total mercury) [8].

Fish Species	Mean [MeHg] (µg/g)
Barracuda B from the U.S.	0.77
Barracuda B not from U.S.	0.12
Cod	0.06
Cusk	0.35
Escolar	0.53
Grouper	0.45
Halibut	0.31
Marlin	0.69
Orange Roughy / Slimehead	0.47
Sablefish / Black cod	0.20
Sauger	0.46
Sea Bass	0.62
Shark	1.36
Shark (Spiny Dogfish, Northern Shark)	0.64
Shark, Porbeagle	0.87
Shrimp / Prawn	0.05
Swordfish	1.82
Tuna, albacore, canned	0.36
Tuna, albacore, fresh or frozen	0.37
Tuna, skipjack, canned	0.06
Tuna, yellowfin, canned	0.05
Tuna, yellowfin, fresh	0.29
Tuna, canned (species not specified)	0.14
Tuna, Bigeye	0.65
Tuna, Southern Bluefin	0.28
Tuna, fresh or frozen (species not specified)	0.93
Wahoo	0.31
Walleye / Yellow Pickerel	0.37

[8] Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch, Health Canada. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. 2007.

Appendix

2 Exposures to mercury

Table 2 | Potential sources of mercury exposure [9].

Occupational exposures	Non-occupational exposures
Chemical plants (chloralkali)	Fish consumption
Pulp/paper mills	Religious practices (azogue used in Voodoo, Santeria, Espiritismo)
Mercury recycling	Folk medicine/herbal remedies
Manufacturing of paints/pigments	Antiques (clocks, mirrors, lamps)
Manufacturing of fluorescent light bulbs	Fluorescent light bulbs
Manufacturing/use of electrical equipment	Outdated medicines (laxatives, worming medications, teething powders)
Manufacturing/use of medical devices	Broken thermometers & electrical switches
Dental medicine	Photography
Battery manufacturing	
Fungicide manufacturing	
Petroleum refineries	
Electroplating	

N.B. some of these may be only historically relevant.

[9] Office of Public Health, Louisiana Department of Health & Hospitals. Information for health care professionals – mercury exposure and toxicity. 2008 Dec.

Appendix

3 Comparison of methylmercury (MeHg) and omega-3 fatty acid (FA) content in fish

Table 3 | Estimated omega-3 FA and MeHg levels in commonly eaten fish [10].

Fish Species	Omega-3 (mg/6 oz)	[MeHg] (µg/g)
Cod, Atlantic	269	0.11
Flounder/sole	852	0.05
Halibut	1398	0.26
Herring, Atlantic	6424	0.04
Lobster	1129	0.24
Pollack	922	0.06
Salmon, Atlantic, farmed	3658	0.014
Sea bass	1295	0.27
Shark	1170	0.99
Shrimp	536	0.01
Swordfish	1392	0.97
Tilapia	240	0.01
Trout	1744	0.03
Tuna, canned, light	425	0.12
Tuna, canned, white	1462	0.35
Tuna, fresh, yellowfin	474	0.325

[a]MeHg data from the Food and Drug Administration; data for salmon reported as fresh/frozen and not distinguished according to source.

[10] Ginsberg GL, Toal BF. Quantitative approach for incorporating methylmercury risks and omega-3 fatty acid benefits in developing species-specific fish consumption advice. Environmental Health Perspectives. 2009 Feb;117(2):267-75