Patient Information: Mercury

Introduction - Although mercury is a silvery white liquid, the metal is volatile at room temperature because of its high vapor pressure. Mercury also exists in different oxidation states and can form a number of organomercuric compounds. These physical properties contribute to the considerable toxicity observed with mercury. In order of importance, the principal organ systems affected by mercury poisoning are the central nervous system and the kidneys.

USES OF MERCURY — The unique physical properties of mercury have led to its use from prehistoric times to the present day.

- Colored cave drawings from more than 10,000 years ago have been found to contain the red stone of mercury ore (cinnabar, mercury sulfide, HgS).

- In the 19th century, epidemics of occupational mercury poisoning resulted from heavy exposure to mercury in the mirror and felt hat industries.

- Mercury is still used in the manufacture of many technical and medical instruments, including sphygmomanometers, manometers, thermometers, and barometers.

- Liquid metallic mercury can be used to concentrate gold from crushed ore or sediments. This technique is immediately dangerous to miners; it was commonly performed during the California gold rush and is still used in several countries. It has been estimated, for example, that approximately 500,000 gold miners in Brazil currently use liquid mercury to concentrate gold from sediments; this may cause considerable environmental contamination.

- During the Middle ages, mercury salts were used for the treatment of various diseases such as syphilis. The use of mercury in the treatment of psoriasis and, as a potent diuretic, for congestive heart failure persisted far into the 20th century. Certain mercury compounds still have limited use in human medicine (eg, vaccines, antiseptics, and skin ointments).

- Amalgam tooth fillings are widely used in dentistry and can be found in hundreds of millions of people around the world. Amalgam or dental silver is composed of a mixture of 50 percent metallic mercury and metal powder (which is usually composed of silver, tin, copper and zinc in certain proportions).

HUMAN EXPOSURE — Humans are exposed to mercury via many different routes and in different forms. The general population is primarily exposed to the metal from dental amalgam and the diet. As a rule, amalgam fillings are the most important source of inorganic mercury and fish are the most important source of methylated or organic mercury.

Amalgam fillings — The release of mercury from amalgam fillings is proportional to the number of fillings and the total amalgam surface area. It has been difficult to accurately estimate the release from amalgam fillings; however, an expert committee from the World Health Organization believes that the average exposure from dental amalgam is approximately 10 µg/day. Measurements of urinary

excretion of mercury have revealed that persons with a habit of tooth grinding release considerably more mercury from their dental fillings than those without this habit.

In recent years, health studies have focused on the identification of the early effects of mercury on the central nervous system. Overall, there is no evidence suggesting a link between exposure to mercury from amalgam fillings and degenerative changes of the nervous system. There is also little evidence to support the removal of existing fillings.

Exposure from diet — The concentration of mercury is very low in most foodstuffs (below 0.02 mg Hg/kg). However, certain types of marine fish (such as shark, swordfish, and tuna) and certain fish taken from polluted fresh waters (such as pike, walleye, and bass) may contain high concentrations of mercury. In this setting, mercury is almost completely in the form of methylmercury. It is not uncommon that concentrations of methylmercury in these fish are 1 mg/kg or even higher. Severe epidemics caused by the consumption of fish polluted with mercury have been reported from Minamata in Japan.

Monitoring of mercury in blood is commonly used to identify and quantify exposure to methylmercury. Heavy consumers of fish, in particular those who eat mercury-containing species, may have blood mercury levels in excess of 20 µg/L (normal value less than 5 µg/L).

There is also concern related to dietary exposure of children and fetuses (via the mother).

Occupational exposure — Occupational exposure to inorganic mercury occurs quite commonly in:

- Dentistry
- Chloralkali industries
- Thermometer factories
- Mercury mines

Measurements of mercury in blood and urine are useful in quantifying the degree of exposure. There is a linear relationship between air and urine concentration of mercury in most situations: the urine concentration (in µg/L) corresponds to air concentration (in µg/m3) multiplied by 1 to 2.

Exposure to mercury has significantly lessened during the last few years because of increased attention to minimizing exposure. In dentistry, for example, ambient mercury concentrations from 1960 to 1970 were frequently around 25 µg/m3; present values are below 5 µg/m3 due to improved ventilation and handling of amalgam.

Similarly, mercury miners and chloralkali industrial workers commonly encountered air concentrations of mercury in excess of 100 µg/m3 or even higher. Negative

health effects were common at such exposures. During recent years, the occupational threshold limit value (TLV) has been lowered to 50 µg/m3 or less in most countries.

Vaccines — Thimerosal, a mercury-containing preservative used in vaccines, is another potential source of mercury exposure. There have been concerns regarding the potential risk to infants and children from exposure to thimerosal-containing vaccines. This issue is discussed separately.

Biochemokinetics — The efficiency of absorption, route of elimination, and tissue deposition of mercury depends upon the route of exposure and the chemical form of the metal.

- Pulmonary absorption of mercury vapor is high; however, this form of mercury is only poorly absorbed from the gastrointestinal tract and across the skin. The kidney is the major site of deposition for mercury derived from inhalation exposure of mercury vapor. A significant fraction of the mercury vapor taken into the lung is eliminated via exhalation; most of the absorbed mercury is eliminated in the feces.

- Gastrointestinal absorption of Hg+1 or Hg+2 is on the order of 15 percent. The kidney is the major site of deposition for mercury derived from inorganic mercury compounds of these valences.

- Alkyl mercurials such as methylmercury are highly absorbed from the gastrointestinal tract and later de-alkylated. The kidney, hair, and central nervous system are major sites of deposition.

GENERAL TOXICITY — A severe and sometimes fatal interstitial pneumonitis may result when mercury vapor is inhaled at concentrations in excess of 1000 µg/m3. Additional symptoms and signs of severe poisoning may include:

- Intention tremor

- Inflammation of the gums with excessive salivation

- Psychiatric symptoms, such as excitability, insomnia, irritation and shyness

A variety of signs and symptoms occur after exposure to lower **air concentrations** of mercury in the range of 100 to 1000 µg/m3. Typically, the mercury poisoned patient has a severe intention tremor of the fingers and hands, making handwriting difficult. Mouth symptoms include tender and inflamed gums, excessive salivation, and swollen salivary glands. The third hallmark of mercury poisoning is a change in personality and psychiatric symptoms, including anxiety, erethism, irritability, excitability, fearfulness, shyness, memory loss, depression, fatigue, weakness, and drowsiness.

In recent years, occupational health studies have focused on the identification of the early effects of mercury on the central nervous system. A dose-response relationship between subjective symptoms and/or impaired performance on psychologic tests has been observed in several studies. Increased prevalence of neurotic symptoms may occur due to long term exposure to mercury vapors at concentrations exceeding 25 µg/m3.

Acrodynia — Small children who are exposed to high concentrations of mercury vapor may develop acrodynia (Pink disease). Acrodynia is a syndrome characterized by a body rash, swelling and irritation of palms and feet followed by skin desquamation, irritability, photophobia, fever, insomnia and profuse sweating, which may also follow oral exposure to mercury compounds.

Acrodynia was common among infants in the United Kingdom and the United States until the late 1940s when it was realized that the condition was primarily caused by exposure to calomel (mercurous chloride) in teething powders and in anthelminthic preparations. Some sort of allergic reaction towards mercury in combination with a highly variable individual susceptibility are considered to be important pathogenetically; affected individuals are almost universally infants and small children, and the syndrome develops only in a small proportion of those who are exposed (less than 1 percent).

Organic mercury compounds — Organic mercury compounds have given rise to severe epidemics of poisoning in Japan and Iraq. As observed with mercury vapor, the central nervous system is affected first, although the symptoms in this setting are slightly different. They include paresthesias (notably around the mouth), malaise, constriction of the visual field, deafness, and ataxia. The fetus is particularly vulnerable and may develop irreversible lesions even if the pregnant mother shows no signs of toxicity. As an example, children exposed prenatally to relatively low levels of methylmercury (as reflected by maternal hair levels of mercury) perform less well in several cognitive tests.

NEPHROTOXICITY — It was recognized as early as 1818 that mercury caused proteinuria in humans. Mercury is now recognized to cause the nephrotic syndrome and/or tubular injury with tubular dysfunction.

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