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## **Mercury Exposure and Pregnancy**

Vol 8, No.3; December 2001

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### **Mercury**

Mercury is a metal that occurs in several forms in the natural environment. In the elemental or metallic form, mercury is an odorless liquid present in thermometers, medical instruments, and barometers. If mercury combines with such elements as chlorine, sulfur or oxygen, the result is inorganic mercury or mercury salts. Most inorganic mercury is in the form of white powder or crystal. Organic mercury results from the combination of mercury with carbon. Organic mercury (methyl mercury) is generally found at hazardous waste sites in the form of white crystalline solids. (1)

### **Historic mercury exposures**

Abnormalities caused by methyl mercury (organic mercury) were reported in the mid 1960's when an outbreak of cerebral palsy and microcephaly in newborns was reported in the fishing village of Minimata Bay, Japan (2,3). Fetal intoxication with organic mercury has been referred to as Minimata disease since that outbreak. In Iraq, seed grain contaminated with methyl mercury was mistakenly used to make bread. Infants exposed in utero were found to have psychomotor retardation and cerebral palsy (4,5). Due to these historical methyl mercury exposures, there is continued concern about mercury exposure. However, most people are not exposed to methyl mercury but rather to elemental mercury. While there has been much concern raised lately regarding methyl mercury contaminated fish (swordfish, shark, large tuna), most do not have levels of methyl mercury which reach the FDA limit for human consumption of 1ppm. It is generally recommended that fish be eaten infrequently (no more than once a week) as part of a balanced diet during pregnancy. Elemental mercury will be the focus of this newsletter.

### **How is elemental mercury used?**

Elemental mercury is mined for use in thermometers, barometers, and batteries. Silver-colored dental fillings (amalgams) are about 50% elemental mercury. In certain Mexican-American and Asian populations, elemental mercury has been used to treat stomach disorders. It has also been used in Latin American and Caribbean cultures for occult practices(1).

### **How might one be exposed to elemental mercury?**

The most common route of exposure is through the breaking of a thermometer. Broken medical devices, old barometers and manometers, and dental fillings are also sources of exposure. People who participate in mining and refining operations for gold and silver ores may also be exposed. Recently Nicor, a company who supplies natural gas, has been the focus of the media for possible elemental mercury exposures in the greater Chicago, IL area.

### **How does elemental mercury enter and leave the body?**

The primary route of absorption of elemental mercury is inhalation. Studies have shown that exposure to 0.1-0.2 mg/m<sup>3</sup> mercury vapor resulted in 74-80% of inhaled mercury vapor being retained in human tissues. The body slowly eliminates mercury: the half-life of mercury is one month. Absorption after ingestion is low, approximately less than 1%, because the gastrointestinal tract is unable to absorb this form. This is true for topical exposure as well. Mercury readily diffuses across the alveolar membrane of the lungs. It is lipid soluble and therefore quickly attaches to red blood cells and cells of the central nervous system. Mercury that enters the body will be transformed into mercuric chloride. Mercury can enter the bloodstream and stay in the body for months. Absorbed mercury will remain mostly in the kidneys and brain. Elemental mercury enters through the respiratory system and will leave the body in urine, feces and breath. Mercury that is swallowed is not rapidly absorbed into the bloodstream and leaves the body in the feces.

### **Exposure Limits**

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for mercury vapor is 0.1 milligram per cubic meter (mg/m<sup>3</sup>) of air as a ceiling limit. A worker's exposure to mercury vapor should not exceed this ceiling level.

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for mercury vapor of 0.05 mg/m<sup>3</sup> as a time-weighted average (TWA) for up to a 10-hour workday and a 40-hour workweek. NIOSH also assigns a "Skin" notation, which indicates that the cutaneous route of exposure, including mucous membranes and eyes, contributes to overall exposure (6). This level The NIOSH limit is based on the risk of central nervous system damage, eye, skin, and respiratory tract irritation (6). The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned mercury vapor a threshold limit value (TLV) of 0.025 mg/m<sup>3</sup> as a TWA for a normal 8-hour workday and a 40-hour workweek and considers mercury vapor an A4 substance (not classifiable as a human carcinogen). The ACGIH also assigns a "Skin" notation to mercury vapor (7).

Table 1. Recommended airborne concentration of mercury (8)

Values

Mercury Vapor

Ethyl and Methyl Mercury

Threshold limit value (time-weighted average)

0.05 ug/m<sup>3</sup>

0.01ug/m<sup>3</sup>

Threshold limit value (ceiling)

0.1 ug/m<sup>3</sup>

0.04ug/m<sup>3</sup>

Short-term exposure limit

0.03ug/m<sup>3</sup>

0.03ug/m<sup>3</sup>

Immediately dangerous to life and health

No data

10mg/m<sup>3</sup>

### **Occupational Limits in Pregnant Women**

Pregnant women should not work in areas with high levels of mercury vapor. The recommended threshold limit value of 0.05 ug/m<sup>3</sup> for mercury vapor may not provide sufficient protection for fetuses. Therefore, women of childbearing age should not be exposed to mercury vapor concentrations

of 0.01mg/m<sup>3</sup> or greater (8).

### **What are the symptoms of elemental mercury exposure?**

The central nervous system is very sensitive to the effects of mercury. Symptoms may include personality changes (e.g. shyness, irritability), tremors, vision changes, and difficulties with memory. Motor system disturbances may be reversible but cognitive impairments, primarily memory deficits, may be permanent.

The kidney is also affected by elemental mercury exposure. The effects to the kidney generally disappear once the body clears itself of mercury, if damage was not too severe. In addition, short-term exposure to elemental mercury can cause nausea, vomiting, diarrhea, lung irritation, increased blood pressure, and skin and eye irritation (1).

### **How can exposure to elemental mercury be measured?**

A number of methods are used to determine the amount of elemental mercury exposure. Urine provides better information about recent exposures than long-term exposures and whole blood may be used to quantify these exposures as well. Short-term exposure can also be measured in expired air but only within a few days of exposure.

### **Exposure in pregnancy**

The effects of mercury have not been systematically investigated in pregnancy. Mercury readily crosses the placenta. Several studies have found no effect on fertility following immediate or chronic inhalation of elemental mercury in humans (9,10). In another study, women occupationally exposed to elemental mercury and elemental mercury vapor had more spontaneous abortions, stillbirths and congenital malformations and irregular, painful or hemorrhagic menstrual disorders than a control group of women not exposed to mercury (11). Reproductive difficulties and menstrual problems correlated with levels of mercury identified in pubic and scalp hair, suggesting a dose-response relationship. A study of 349 women exposed to unspecified amounts of elemental mercury in the workplace concluded that complications of childbirth were increased compared to nonexposed women and that these depended on length of exposure and concentration of mercury vapors (12).

A study on female rats exposed to 2.5 mg/m<sup>3</sup> of elemental mercury vapors per day found an increase in the length of menstrual cycle and hypothesized an effect of mercury on the central nervous system(13). In a preliminary report on pregnant squirrel monkeys, daily exposure to mercury vapor caused a variety of adverse effects including abortion, neonatal mortality, reduced brain weights and structural abnormalities(14). Details on amounts of mercury vapor, however, were not quantified.

### **Dental personnel**

Dental hygienists and dentists may be exposed to considerable amounts of mercury vapor in the workplace. One study found levels of mercury in the placenta of exposed dental workers to be 2 times higher than levels found in non-exposed women (15). Studies conducted on dental personnel have not shown a higher incidence of spontaneous abortions (16) nor have they shown an increase in birth defects or developmental effects (17). In a study evaluating the association between nitrous oxide exposure and spontaneous abortion, exposure to dental amalgams was measured. A relative risk of 1.8 was identified for exposure to more than 50 amalgams/week and spontaneous abortion (18,20). In a recent study in sheep, mercury was radiolabeled to determine the amount reaching the fetus (19). Neither maternal nor fetal toxic events were associated with the large quantities of dental amalgam used in the sheep. Nevertheless, the authors suggest avoiding mercury containing amalgams during pregnancy.

### **Paternal exposure**

There have been a number of studies examining the association of paternal exposure and an increased risk for spontaneous miscarriage (21,22). The studies did not control for possible maternal exposure

and therefore any association was questionable.

### **Exposure to a broken thermometer**

A broken fever thermometer is unlikely to threaten the health of the consumer or a pregnancy, especially if cleaned up properly and in a timely manner (see below). If elemental mercury is not cleaned up or if it becomes heated, the risks to the consumer and, more importantly, young children, becomes higher.

### **How to clean up a broken thermometer**

- Don't panic.
- People not involved in the cleanup should leave the area.
- Minimize tracking by removing shoes and clothing.
- Pick up free mercury with masking tape or a medicine dropper and store in a sealed plastic container.
- Ventilate room by opening doors and windows.
- Avoid vacuuming for 1-2 weeks (avoids aerosolizing the mercury and contaminating the vacuum cleaner).
- After all visible mercury has been collected, use a mercury cleanup kit to clean the spill area and work it into the cracks with a broom or brush. Do not add water. Materials in the mercury spill kit will rapidly bind to the remaining mercury and can be swept up with a broom and dustpan. Wash the area with trisodium phosphate detergent solution and rinse with water.
- Contaminated carpeting should be removed and discarded, starting with the spill room.
- Contaminated materials and mercury collected from small spills may be discarded along with household trash, but should be placed outside in a safe place until the household trash is picked up.

Referral Sources:

### **Poison Control**

Illinois Teratogen Information Service 1-800-252-4847

Illinois Department of Public Health 1 888 522-1282

Nicor Gas Mercury Information Line: 1 888 288-8110

### **Websites:**

Agency for Toxic Substances and Disease Registry (ATSDR)

<http://www.atsdr.cdc.gov/tfacts46.html>

Mercury Facts: Illinois Department of Public Health

<http://www.idph.state.il.us/envhealth/factsheets/mercuryspills.htm>

Mercury Fact Sheet Environmental Protection Agency

<http://www.epa.gov> - Home Page

### **References:**

- 1.) Toxicological Profile for Mercury (update). U.S. Department of Health & Human Services May 1994.
- 2.) Matsumoto H et al: Fetal Minimata disease. J Neuropath Exp Neurol 24:563-74,1965.
- 3.) Muramaki U: The effect of organic mercury on intrauterine life. Acta Exp Biol Med Biol 27:301-36, 1972.

- 4.) Marsh DO et al: Fetal methylmercury poisoning: Clinical and toxicological data on 29 cases. *Ann Neurol* 7:348-53, 1980.
- 5.) Amin-Zaki L et al: Perinatal methylmercury poisoning in Iraq. *Am J Dis Child* 130:1070-6, 1976.
- 6.) NIOSH (1992). Recommendations for occupational safety and health: Compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.
- 7.) ACGIH (1994). 1994-1995 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
- 8.) Moienafshari R, Bar-Oz B, Koren G. Occupational Exposure to Mercury. What level is safe? *Canadian Family Physician* 46: 43-45, 1999.
- 9.) Alcer KH, Brix KA, Fine LJ, Kallenbach LR, Wolfe RA: Occupational mercury exposure and male reproductive health. *Am J Ind Med* 15:517-29, 1989.
- 10.) Cordier S, Deplan F, Mandereau L, Hemon D: Paternal exposure to mercury and spontaneous abortions. *Br J Ind Med* 48:375-81, 1991.
- 11.) Sikorski R, Juszkievicz T, Paszkowski T, et al. Women in dental surgeries: Reproductive hazards in occupational exposure to elemental mercury. *Int Arch Occup Environ Health* 59:551-557, 1987.
- 12.) Mishonova VN, Stepanova PA, and Zarudin VV. Characteristics of the course of pregnancy and births in women with occupational contact with small concentrations of elemental mercury vapors in industrial facilities. *Gig Truda Prof Zabol* 24(2):21-23, 1980.
- 13.) Baranski, B, Szymczyk, I. 1973, Effects of mercury vapor upon reproductive functions of female white rats. *Med. Pr* 24:248.
- 14.) Berlin M, Jua J, Logdberg B, Warfvinge K: Prenatal exposure to mercury vapor: effects on brain development. *Fund Appl Toxicol* 19:324-6, 1992.
- 15.) Ericson A, Kallen B: Pregnancy outcome in women working as dentists, dental assistants or dental technicians. *Int Arch Occup Environ Health* 61:329-33, 1989.
- 16.) Rowland AS, Baird DD, Weinberg CR, Shore DL, Shy CM, Wilcox AJ: Reduced fertility among women employed as dental assistants exposed to high levels of nitrous oxide. *N Engl J Med* 1992;327:993-997.
- 17.) Heidam LZ: Spontaneous abortions among dental assistants, factory workers, painters, and gardening workers: a follow up study. *J Epidemiol Commun Health* 38:149-55, 1984.
- 18.) Patterson JE et al: Mercury in human breath from dental amalgam. *Bull Environ Contam Toxicol* 34: 459-68, 1985.
- 19.) Anonymous: Dental Amalgam: a scientific review and recommended Public Health Service Strategy for research, education and regulation. Dept Health and Human Service, Washington, DC. January, 1993.
- 20.) Rowland AS, Baird DD, Shore DL, Weinberg CR, Savitz DA, Wilcox AJ. Nitrous oxide and spontaneous abortion in female dental assistants. *Am J Epidemiol* 1995;141:531-7.
- 21.) Cordier S, Deplan F, Mandereau L, Hemon D: Paternal exposure to mercury and spontaneous abortions. *Br J Ind Med* 48:375-81, 1991.

22.) Rowland AS: Reproductive effects of mercury vapor. Fund Appl Toxicol 19:326-9, 1992.