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Mercury in the Environment: A Danger to Children

by Sophie J. Balk, MD

Mercury is the only metal that is liquid at room temperature. It has been a source of fascination for centuries. Many of us remember accidentally breaking a thermometer when we were children. Some of us played with the silvery mercury beads.

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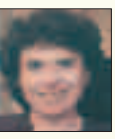

Dr. Balk's work and publications have focused on educating general pediatricians and pediatric residents in environmental health issues.

Mercury has long been used in industry and medicine. However interesting and useful it is, mercury is a highly toxic environmental pollutant. Of particular concern is mercury's toxicity to the developing central nervous system of children.

Forms and sources of mercury

Mercury occurs in three forms — elemental, inorganic, and organic. Each form has its own toxicity profile. Everyone is exposed to small amounts of mercury.

Elemental mercury (also known as metallic mercury or quicksilver) is liquid at room temperature and readily vaporizes. Elemental mercury is found in thermometers and blood pressure cuffs. These mercury-containing devices have been used extensively in homes, hospitals, and health care facilities. Mercury has been used as part of dental amalgams to fill teeth for almost 200 years. Other sources of mercury include fluorescent light bulbs (usually 2′ to 4′ tubes) and disc (button) batteries.

Environmental contamination occurs when these items are buried in landfills or burned in waste incinerators rather than recycled. In the United States, the largest source of mercury vapor in the atmosphere comes from burning fossil fuels, especially coal from coal-fired power plants. Mercury is emitted during mining and smelting, from waste incinerators (especially medical waste), crematoriums, and volcanoes. It may be used in homes in magical-religious ceremonies. For example, some immigrants from Haiti and other island nations use mercury in their practice of Santeria. During these rituals, elemental mercury sprinkled around the home may vaporize, exposing children and others.

Inorganic mercury compounds (salts) were used in consumer products such as *"calomel"* teething powders and skin lightening creams. These uses have been banned in the United States, but products are still available in other parts of the world.

Organic mercury compounds include methylmercury and ethylmercury. Methylmercury is the predominant form of organic mercury found in the environment and is the main form of mercury found in fish. Contamination of fish results when mercury emitted from natural and industrial sources enters the air and is deposited into water. Aquatic organisms living in sediments in lakes, streams, and oceans can convert elemental mercury to organic mercury. Small fish eat these compounds. Then larger and larger fish eat the contaminated smaller fish, causing accumulation of methylmercury in fish muscle. The highest concentrations tend to occur in large, long-lived, predatory ocean fish. The methylmercury content of fish varies by species and size of the fish and the harvest location. Fresh-water fish may also be contaminated with methylmercury, leading states to issue fish consumption advisories.

Ethylmercury, as thimerosal, was used in the past as a topical antiseptic (Merthiolate) and has also been used as a preservative for killed vaccines and other biological agents used for medical therapy. Organic mercury is also found in the once-common antiseptic Mercurochrome.

Health effects of mercury

The toxicity of mercury depends on the compound, the route of exposure (inhalation, ingestion, or exposure through the skin), the dose, and the age of the exposed person. Inhaling high concentrations of elemental mercury vapor produces severe respiratory tract symptoms that can lead to death. Longer-term (chronic) exposure primarily affects the central nervous system; symptoms include insomnia, forgetfulness, and tremor. The "Mad Hatter" character in *Alice in Wonderland* was based on the disease that affected hat makers using liquid mercury as a treatment for hat felt. Elemental mercury exposure can cause kidney disease. In contrast to exposure through inhalation, elemental mercury is poorly absorbed after ingestion; therefore, ingesting mercury from a broken thermometer is less likely to cause a health problem.

After ingestion, inorganic mercury can cause severe symptoms of the gastrointestinal tract, kidneys, or nervous system. Calomel teething powders could cause "acrodynia" also known as "pink disease" in exposed infants. Symptoms of this disease include pink itching hands and feet, swollen and painful extremities, as well as emotional disturbances.

Organic mercury compounds are most toxic to the central nervous system. The kidneys and immune system may also be affected. There is great concern about effects of organic mercury on the developing nervous system of the fetus and young child. Methylmercury, readily absorbed after ingestion, interferes with the normal processes of brain development; effects can be devastating with high mercury exposures.

Such a disaster occurred in Minamata Bay, Japan, in the 1950s when a factory discharged large amounts of mercury into the bay. There were 41 deaths and at least 30 cases of profound brain injury in infants born to mothers who ingested contaminated fish during pregnancy. Affected infants typically appeared normal at birth, but developed retardation, blindness, deafness, and seizures over time. Mothers who had few or no symptoms gave birth to severely damaged children, illustrating that the rapidly growing and developing fetal nervous system is extremely sensitive to mercury compared to the adult's nervous system.

Concerns about low levels of mercury

Because severe neurological effects can result after exposures to high levels of methylmercury, researchers have investigated the effects on the fetus of lower exposures to organic mercury. Two large studies were conducted in the Seychelle Islands in the Indian Ocean and the Faroe Islands in the Norwegian Sea. The goal of these studies was to identify subtle effects among children whose mothers' diets included large amounts of methyl-mercury and whose levels are higher than are commonly seen in the United States. The Faroe Islands' study revealed subtle adverse effects on tests of memory, language, and attention with higher mercury exposures when children were tested at age seven. Effects have not been observed thus far in the Seychelles' children.

In July 2000, the National Academy of Sciences (NAS) published a comprehensive assessment of methylmercury. Their analysis was based on data that included food consumption surveys and levels of exposure to methylmercury. The NAS concluded that most Americans are at low risk for adverse health effects. However, it was estimated that each year more than 60,000 children are born at risk for problems with neurological development associated with in utero mercury exposure. The most concern was expressed about children born to women who consumed large amounts of fish and seafood during pregnancy. The NAS recommended that every effort be made to reduce the release of mercury into the environment.

Some parents and others have raised concerns that mercury exposure may be implicated in the cause of autistic spectrum disorders (ASD). To date, there have been no published studies linking mercury exposure to the development of ASD or to demonstrate that children with ASD have had greater exposure to mercury than have unaffected children.

Diagnosing and treating mercury poisoning

Diagnosis of mercury poisoning can usually be made with a complete history and a physical examination. Laboratory tests may demonstrate increased mercury levels. Severe poisoning with elemental or inorganic mercury can be treated by chelation therapy which involves the use of chemicals to bind up the mercury so it can be excreted to reduce the amount of mercury in the body. It is not clear whether chelation decreases toxic effects or speeds recovery in people who have been poisoned. Severe mercury poisoning should be treated by or in consultation with a physician who has experience in this area. There is no chelating agent approved by the Food and Drug Administration (FDA) that is effective to treat methylmercury or ethylmercury poisoning. Chelating agents may be dangerous, resulting in liver damage and allergic reactions. Chelation therapy is not recommended for improving neurodevelopmental functioning in children with ASD.

Limiting exposure

Many efforts have been made to limit mercury exposure from all sources. Inorganic and elemental mercury should not be present in children's homes, schools, or child care settings. Physicians and hospital personnel have been urged to phase out mercury-containing devices, such as thermometers and blood pressure machines, from hospitals and office settings. Families and child care centers can decrease the amount of mercury in the waste stream by eliminating mercury thermometers from homes and child care facilities. Although the amount of mercury in a thermometer is usually not sufficient to produce a problem if the mercury is ingested, the mercury vapor can be inhaled and absorbed. There are reports of mercury poisoning in children and adults as a result of a mercury thermometer breaking onto a floor, being vacuumed, or spilling into a heating duct. Children should not play with metallic mercury.

Cleanup can be difficult if mercury contaminates a carpet, so contaminated carpeting usually must be discarded. In the event of an elemental mercury spill, it is advisable to use a mercury spill kit. If no spill kit is available, mercury can be picked up between two pieces of paper, and then disposed of in two plastic bags. This material should be treated as hazardous waste and properly disposed of. Vacuuming should not be done because this disperses the metal

droplets. Only trained professionals should remove spills larger than a mercury thermometer. Local or state environmental health departments and the Environmental Protection Agency should be notified of mercury spills in schools or other public facilities.

Intact mercury thermometers should not be thrown in the trash but put in a safe place until they can be properly disposed of. To encourage and facilitate the removal of mercury thermometers from homes, many states, hospitals, and local organizations have initiated a voucher or *buy back* program in which mercury thermometers can be replaced with non-mercury substitutes. Electronic digital thermometers reliably measure temperatures.

The most important source of methylmercury exposure is fish consumed by a mother before or during pregnancy, and by young children. The highest mercury concentrations are found in large predator fish. The US Food and Drug Administration (FDA) recommends that pregnant women, women who are breastfeeding, and young children avoid consumption of swordfish, shark, king mackeral and tilefish. FDA recommends that up to 12 ounces per week of a variety of other fish may be safely consumed (Center for Food Safety and Applied Nutrition, US Food and Drug Administration. An important message for pregnant women and women of childbearing age who may become pregnant about the risks of mercury in fish. Available at: http://vm.cfsan.fda.gov/~dms/admehg.html.)

When considering the risks of exposure to methylmercury in fish, it is important to also consider the nutritional and health benefits of eating fish. For some families, locally caught fish may be the only good source of protein in the diet. If fish with lower mercury levels are available, then it is sensible to substitute these rather than eat fish with high mercury content. Information about the mercury content of commercial fish can be found at http://vm.cfsan.fda.gov/~dms/admehg.html. Recreational and subsistence fishers should be aware of health department advisories about mercury and other contaminants, such as PCBs. Information about fish advisories can be found at www.epa.gov/ost/fish.

All vaccines in the routine childhood vaccination schedule are available without mercury-containing thimerosal. The FDA is working with the pharmaceutical industry and the medical community to decrease or eliminate exposures to mercury in vaccines and other products. Influenza vaccine that is currently available contains thimerosal, but vaccine manufacturers are working on how to produce the vaccine without it. Influenza vaccine is now recommended for children with certain health conditions and encouraged for all healthy children between 6 months to 23 months of age. Since other vaccines the child receives during this period no longer contain thimerosal, the amount of mercury a child would receive from vaccines should be below any amount that would cause toxicity.

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