Mercury is probably best known as the silver liquid in thermometers. However, it has over 3000 industrial uses. Mercury and its compounds are widely distributed in the environment as a result of both natural and man-made activities. The utility, and the toxicity, of mercury have been known for centuries. New evidence demonstrates that even low levels of mercury exposure may be hazardous. The purpose of this document is to provide health professionals with updated information on mercury and guidance on preventing toxic exposures in health care workers and their clients.

HISTORY & REGULATIONS

Mercury occurs naturally in the environment as mercuric sulfide, also known as cinnabar. It is also present in some fossil fuels. Cinnabar has been refined for its mercury content since the 15th or 16th century B.C. Its health hazards have been known at least since the roman conquest of Spain. Due to the toxicity of mercury in cinnabar, criminals sentenced to work in quicksilver mines by the Romans had a life expectancy of only 3 years.

Mercury is present in numerous chemical forms. Elemental mercury itself is toxic and cannot be broken down into less hazardous compounds. Elemental or inorganic forms can be transformed into organic (especially methylated) forms by biological systems. Not only are these methylated mercury compounds toxic, but highly bioaccumulative as well. The increase in mercury as it rises in the aquatic food chain results in relatively high levels of mercury in fish consumed by humans. Widespread poisoning of Japanese fisherman and their families occurred in Minamata, Japan in the 1950's as a result of consumption of methyl mercury contaminated fish. Today, we continue to be exposed to mercury in our diets, primarily from fish and shellfish. As a result, the U.S. Food and Drug Administration (FDA) has an action level for mercury of 1 part per million (ppm) in fish and the Michigan Department of Public Health issues fish consumption advisories to anglers when mercury levels exceed 0.5 ppm in fish tissue.

Widespread industrial production of mercury, along with lack of careful handling and disposal practices, has contributed to environmental contamination. The U.S. Environmental Protection Agency (EPA) has made efforts to regulate the continued release of mercury into the environment. EPA regulates industrial discharges to air and water, as well as regulating some aspects of mercury waste disposal. In 1976, EPA banned most pesticide uses of mercury - with the exceptions of fungicidal uses in paints and outdoor fabrics, and for control of Dutch Elm disease. In 1990, mercury use as a fungicide in interior latex paint was halted by the EPA. This action stemmed from requests by Michigan officials after a child was poisoned from over formulated mercury-containing paint used in his home. More recently, the use of mercury compounds in exterior latex paint has also been halted.

In addition to the early workers in the cinnabar mines, modern workers in industries using mercury are at risk from overexposure. The Occupational Safety and Health Administration (OSHA) has been reviewing the current occupational exposure standard of 0.1 mg/m3 (milligrams per cubic meter of air) to determine if they should reduce the 8 hour acceptable exposure limit to 0.05 mg/m3. Although no
regulatory limit exists for airborne exposure to mercury outside of an occupational setting, the EPA suggests that 0.3 ug/m3 (micro-grams per cubic meter of air) of mercury is a no-effect level (or reference dose = Rfd) for chronic inhalation exposure.

USES

Desirable properties such as the ability to alloy with most metals, liquidity at room temperature, ease of vaporizing and freezing, and electrical conductivity make mercury an important industrial metal. In 1973, U.S. consumption of mercury was 1900 metric tons. Primary among its over 3000 industrial uses are battery manufacturing and chlorine-alkali production. Paints and industrial instruments have also been among the major uses. Until paint manufacturers agreed to eliminate the use of mercury in interior paints, 480,000 pounds of mercury in paints and coatings were produced each year. Table 1 provides a list of mercury uses.

EXPOSURE SCENARIOS

Humans come in contact with mercury through environmental, occupational or accidental exposure scenarios. An estimated 80% of utilized mercury is eventually released back into the environment. Because it is easily vaporized, air around chlorine-alkali plants, smelters, municipal incinerators, sewage treatment plants and even contaminated soils may contain increased levels of mercury. A primary route of exposure is through transport into surface waters, where mercury becomes biomagnified in fish tissues.

Workplace exposure to mercury occurs through inhalation of contaminated air, direct skin contact with liquid mercury, or oral exposure through contaminated hands, food, etc. A recent edition of the television show 60 Minutes highlighted concerns about mercury exposure in patients receiving silver dental fillings with mercury-containing amalgam. Insufficient scientific evidence exists at this time to either support or refute the claims that dental fillings may result in harmful exposure to mercury.

Accidents have resulted in several cases of mercury poisoning in Michigan in the past two years. Four members of a Lincoln Park family were killed after one member attempted to refine dental amalgam in his home while attempting to recover silver. High levels of mercury were found throughout the house, including wrapped food inside the freezer. The entire house had to be demolished and disposed of in a hazardous waste landfill.

A number of children have developed mercury poisoning after playing with small vials of mercury which they found at home or school. These children were hospitalized when symptoms became so severe that they could not longer walk. One contamination incident involved closing a school for weeks and entailed environmental investigation of residences, cars, school buses and day care centers.
Exposure to mercury can occur through inhalation, ingestion or dermal absorption. The amount of mercury absorbed by the body-and thus the degree of toxicity-is dependent upon the chemical form of mercury. For instance, ingested elemental mercury is only 0.01% absorbed, but methyl mercury is nearly 100% absorbed from the gastrointestinal tract. The biological half-life of mercury is 60 days. Thus, even though exposure is reduced, the body burden will remain for at least a few months. Elemental mercury is most hazardous when inhaled. Only about 25% of an inhaled dose is exhaled. Skin absorption of mercury vapor occurs, but at low levels (ex. 2.2% of the total dose). Dermal contact with liquid mercury can significantly increase biological levels. The primary focus of this article is elemental mercury, since that is the form of exposure to health care workers involved with mercury-containing instrument accidents.

In the human body, mercury accumulates in the liver, kidney, brain, and blood. Mercury may cause acute or chronic health effects. Acute exposure (i.e., short term, high dose) is not as common today due to greater precautions and decreased handling. However, severe acute effects may include severe gastrointestinal damage, cardiovascular collapse, or kidney failure, all of which could be fatal. Inhalation of 1-3 mg/m³ for 2-5 hours may cause headaches, salivation, metallic taste in the mouth, chills, cough, fever, tremors, abdominal cramps, diarrhea, nausea, vomiting, tightness in the chest, difficulty breathing, fatigue, or lung irritation. Symptoms may be delayed in onset for a number of hours.

Chronic effects include central nervous system effects, kidney damage and birth defects. Genetic damage is also suspected.

Nervous system effects. These are the most critical effects of chronic mercury exposure from adult exposure as they are consistent and pronounced. Some elemental mercury is dissolved in the blood and may be transported across the blood/brain barrier, oxidized and retained in brain tissue. Elimination from the brain is slow, resulting in nerve tissue accumulation. Symptoms of chronic mercury exposure on the nervous system include: Increased excitability, mental instability, tendency to weep, fine tremors of the hands and feet, and personality changes. The term "Mad as a Hatter" came from these symptoms which were a result of mercury exposure in workers manufacturing felt hats using a mercury-containing process.

Kidney effects: Kidney damage includes increased protein in the urine and may result in kidney failure at high dose exposure.

Birth defects: Neurologic damage from methyl mercury. The manifestations of mild exposure include delayed developmental milestones, altered muscle tone and tendon reflexes, and depressed intelligence.

Mercury exposure in children can cause a severe form of poisoning termed acrodynia. Acrodynia is evidenced by pain in the extremities, pinkness and peeling of the hands, feet and nose, irritability, sweating, rapid heartbeat and loss of mobility.
Substitutes for mercury-containing medical devices should be used whenever possible, e.g. thermometers and sphygmomanometers. When mercury devices must be used, special precautions should be taken. These devices should never be used on a cloth surface, such as upholstered chair or in a room with a carpeted floor. If a spill occurred in such an area, the upholstery or carpeting would need to be discarded as it could not be effectively decontaminated. Children should never be left unattended near these devices. If mercury thermometers are used, a mercury spill kit should be kept readily accessible. The kit should contain a sulfur powder to suppress volatilization and a collection device.

SPILL RESPONSE

If a spill occurs, evacuate the immediate area and ventilate as well as possible. An environmental consultant will need to be contacted for clean-up and disposal. DO NOT attempt to clean-up a mercury spill using rags or an ordinary vacuum. This will only serve to disperse the mercury and encourage volatilization. For further assistance, contact your local health department and/or the Michigan Department of Public Health, Division of Health Risk Assessment. For assistance with a large spill, call the Fire Department for assistance. For assistance with clean-up, you may look in your local phone book for environmental consultants. Table 2 contains a list of consultants known to respond to mercury spills.

DISPOSAL

The best method of mercury disposal is reclamation. Attached is a list of agencies in Michigan that will take used mercury. Button batteries can be recycled at many jewelry stores and other retail outlets that sell batteries. Larger quantities of mercury will need to be disposed of by a licensed hazardous waste hauler. Contact the Michigan Department of Natural Resources, Waste Management Division for assistance with mercury disposal.