

Health Consultation

Screening of a Berrien County Home, on October 9, 2008,
after Cleanup of a Mercury Thermometer Break.

**Prepared by the
Michigan Department of Community Health**

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Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Acronyms and Abbreviations

| | |
|-------------------|--|
| °F | degrees Fahrenheit |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| MDCH | Michigan Department of Community Health |
| ng/m ³ | nanograms per cubic meter |

Purpose and Health Issues

A Berrien County Health Department representative contacted the Michigan Department of Community Health (MDCH) to request screening of a Berrien County home after cleanup of a mercury fever thermometer in the master bathroom. Elemental mercury from a thermometer can remain in contaminated items and off-gas mercury vapor unless decontaminated or removed. Depending on the length of the exposure and the amount of mercury vapor, people, especially children, can develop health effects from breathing in mercury vapor. These health effects include: irritability, shyness, tremors, changes in vision or hearing, memory problems, damage to the stomach and intestines, nausea, diarrhea, or severe ulcers, and a rapid heart rate and increased blood pressure.

Background

A mercury fever thermometer broke in a family's master bathroom, on the second floor. The bathroom was tiled and adjacent to a carpeted bedroom. Unknown to the parents, a five year old child had moved the thermometer to a different drawer in the bathroom. The thermometer, no longer in the case, broke in the drawer on October 6th or 7th, 2008.

The homeowners called their local health department to discuss instructions for cleanup. Following directions from the Berrien County Health Department, the homeowners cleaned the spill. The cleanup efforts, as described, were thorough, but the homeowner wanted confirmation that all mercury was gone because a young child lived in the house. They requested a screening to confirm that there was no remaining mercury. MDCH personnel, along with a representative of the Berrien County Health Department arrived, on October 9th, 2008, with a Lumex to screen the home for any remaining mercury.

Discussion

Site Visit and Environmental Contamination

A Lumex (RA-915+, Ohio Lumex Co.) was used to identify any remaining mercury contamination in the home. The temperature inside the home was 72°F.

Initial readings, taken just inside the front door were over 5,000 nanograms per cubic meter (ng/m^3), which was five times the air mercury screening level desired after a cleanup (MDCH 2007). Mercury in the air increased (to over $8,000 \text{ ng}/\text{m}^3$) going up the stairs to the second floor. Air mercury concentrations should be $1,000 \text{ ng}/\text{m}^3$ or lower after the mercury cleanup in residences (MDCH 2007). See Table 1 for initial air mercury concentrations in the home. Because the mercury levels were elevated, screening was discontinued and most of the windows in the home were opened. The MDCH Lumex battery had completely discharged and the machine would not function even when plugged into to a wall socket. The Kalamazoo Lumex was graciously loaned to MDCH during ventilation of the house.

Table 1: Initial air mercury concentrations (ng/m³) inside of the Berrien County home on the morning of October 9, 2008.

| Location | Reading (ng/m ³) | Screening values ^a (ng/m ³) |
|--|------------------------------|--|
| Breathing zone just inside the front door | 5,390-5,900 | 1,000 |
| Living room breathing zone | 5,716 | 1,000 |
| Bottom flight of stairs, near carpet | 5,460 | 1,000 |
| Middle landing, breathing zone | 7,500 | 1,000 |
| Second flight of stairs, near carpet | 8,200 | 1,000 |
| Top of the stairs in the breathing zone | 7,400-8,145 | 1,000 |
| Master bedroom, breathing zone | 5,384 | 1,000 |

Items in **bold** are above the appropriate screening levels (MDCH 2007).

a = Screening values were from MDCH (2007).

MDCH personnel and the Berrien County Health Department representative returned approximately two hours later, after returning from Kalamazoo County. All windows of the house were closed and approximately 15 minutes later screening began.

After ventilation, air concentrations of mercury on the first floor of the house were lower than 300 ng/m³ and remained at approximately this levels going up the stairs to the second floor. Screening of the upstairs and bathroom area continued. See Table 2 for mercury concentrations in the second screening. Measured levels were compared to mercury screening level applicable both for items in the home with a porous surface and for air after cleanup (1,000 ng/m³ [MDCH 2007]). Mercury vapor levels in the master bedroom had fallen from over 5,000 ng/m³ to 300 to 1,000 ng/m³ following ventilation. All areas in the bathroom were below 1,000 ng/m³, except for the bathroom rug and the floor below it. Additional cleaning of the area was recommended. Recommendations were given to further air out and sun the rug, but the homeowner decided to discard it.

The homeowner requested that the washer and vacuum cleaner be screened. She had washed clothes that could have been contaminated and her husband had vacuumed the upstairs that morning.

Table 2: Air mercury concentrations (in ng/m³) after the Berrien County home aired out, for about two hours, on the afternoon of October 9, 2008.

| Location | Reading (ng/m ³) | Screening values ^a (ng/m ³) |
|--|---|--|
| Breathing zone of first floor (inside front door, living room, hall way) | All less than 300 | 1,000 |
| Downstairs closet and bathroom | 200-300 | 1,000 |
| Kitchen | 130-250 | 1,000 |
| Upstairs second bathroom, breathing zone (near stairs) | 129 | 1,000 |
| Other bedroom (near stairs) | 120-150 | 1,000 |
| Master bedroom breathing zone | 300-1,000 | 1,000 |
| Carpet by bathroom door (in master bedroom) | 1,000- 1,200 | 1,000 |
| Bathroom breathing zone | 300-500 | 1,000 |
| Bathroom cabinet | 139-215 | 1,000 |
| Front of cabinet | 236-331 | 1,000 |
| Bathroom rug | 930- 1,600 | 1,000 |
| Under rug | 1,600-2,900 | 1,000 |
| Washing machine tub | 550-700 | 1,000 |
| Vacuum cleaner | > 50,000 (upper accurate limit of the Lumex) | 1,000 |

Items in **bold** are above the appropriate screening levels (MDCH 2007).

a = Screening values were from MDCH (2007).

The washer tub had mercury concentrations that were lower than the air mercury in the master bedroom (less than 1,000 ng/m³). However, the vacuum cleaner had areas that were over 50,000 ng/m³, the upper accurate limit of the Lumex. Since the vacuum cleaner was contaminated, the air in the house was likely contaminated by that morning's vacuuming (approximately a two hour exposure). Berrien County Health Department personnel required discarding the vacuum cleaner and the homeowner requested that we take it away. At the homeowner's request additional areas of the house were screened, but were no higher than 300 ng/m³, which was below the 1,000 ng/m³ clearance value for a house with all sources of mercury removed.

Exposure Pathways Analysis

An exposure pathway contains five elements: (1) the contaminant source, (2) contamination of environmental media, (3) an exposure point, (4) a human exposure route, and (5) potentially exposed populations. An exposure pathway is complete if there is a high probability or evidence that all five elements are present. Table 3 describes human exposure to mercury vapor in the air after a mercury fever thermometer break.

Table 3: Exposure pathway for people in a house in Berrien County, Michigan after a mercury fever thermometer break.

| Source | Environmental Medium and Exposure Point | Exposure Route | Exposed Population | Time Frame | Exposure |
|---------------------------|---|----------------|--|------------|------------|
| Mercury fever thermometer | Mercury vapor in the air of the home | Inhalation | Homeowners, including a 5-year-old, and any visitors | Past | Potential |
| | | | | Present | Complete |
| | | | | Future | Eliminated |

Two adults and a five year old child lived in the house. This family was potentially exposed to mercury vapor for up to three days. The air mercury concentrations in the home were initially higher than the recommended air mercury values after cleanup (1,000 ng/m³ [MDCH 2007]), but within range of values for maintaining occupancy during cleanup (between 1,000 and 10,000 ng/m³ [MDCH 2007]). However, the homeowners had ventilated the bathroom for those three days. They had vacuumed on the morning of October 9th, the day of the screening, so they were expected to have only been exposed to elevated levels of mercury vapor for less than one day. The air levels would have likely remained higher than normal after clean up as long as the contaminated vacuum cleaner was present and remained in use in the home. As the exposure was short-term (less than one day), the residents were not expected to develop health effects and so no health-related follow-up was recommended.

Toxicological Evaluation

Metallic or elemental mercury is a silver liquid at room temperature with a melting point around -38°F (ATSDR 1999). Mercury and mercury compounds usually have no odor (ATSDR 1999). Detectable mercury vapor can form at temperatures as low as 47.3°F (Asano et al. 2000) and the vapor is heavier than air (Cherry et al. 2002).

About 70-80% of mercury vapors inhaled are absorbed by the lungs and enter the bloodstream (ATSDR 1999). Mercury vapor diffuses across cell membranes, crosses the blood/brain barrier, and crosses the placenta (Clarkson et al. 2007). However, ingestion of metallic mercury results in absorption of less than 0.01% by the stomach or intestines. Once absorbed, metallic mercury primarily accumulates in the kidneys, but will accumulate throughout the body, including the liver, spleen, bone marrow, red blood cells, intestines, and respiratory mucosa (ATSDR 1999). About 10% of the total body burden of mercury is sequestered by the central nervous system and has a half-life of several months (Knobeloch et al. 2007). Excretion of metallic mercury can be through urine, feces, and exhaled air (ATSDR 1999).

The nervous system is sensitive to all forms of mercury. Both methylmercury and metallic mercury vapors can reach the brain in larger relative amounts than inorganic mercury (ATSDR 1999). As the central nervous system continues to develop for several

years after birth, young children are particularly susceptible to the neurologic effects of mercury (Risher et al. 2003).

Mercury exposure can cause permanent damage to the brain or the kidneys. Short term exposure to high levels of metallic mercury vapors include: lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. There is a greater chance of a toxic effect from exposure to mercury if a person has a preexisting liver, kidney, lung, or nervous system condition (ATSDR 1999).

In cases of inhalation of extremely high levels of mercury vapor or ingestion of extremely high levels of inorganic mercury or organic mercury, death is possible due to respiratory failure. However, most of the deaths from mercury exposure are due to neurotoxicity (ATSDR 1999).

Mercury can also cause a hypersensitivity condition in humans, called acrodynia or pink disease. Symptoms of this condition are: itching, flushing, swelling, and/or sloughing of the skin of the palms of the hands or soles of the feet, morbilliform (measles-like) rashes, excessive sweating and/or salivation, tachycardia (rapid heart rate), elevated blood pressure, insomnia, weakness, irritability, fretfulness, and peripheral sensory disturbances (ATSDR 1999).

Chlor-alkali plants can use mercury to produce chlorine and caustic soda. Wastensson et al. (2008) examined 43 chlor-alkali workers, and 22 age-matched referents, for alterations in neuromotor function after low exposure to mercury vapor. Chlor-alkali workers had more rest tremors, intention tremors (finger to nose), and hyporeflexia (decreased reflex response) as compared to the age-matched reference group. There was no difference in hand-eye coordination between groups, although those that were older or were smokers had lower test scores. No significant adverse effects were found in the study participants, but some slight effects may be present (Wastensson et al. 2008).

Adults exposed to the air mercury levels for a short time are not expected to have any health effects from mercury exposure. However, air mercury levels that might have resulted from continuing use of the contaminated vacuum cleaner could have caused health effects after a chronic exposure. Sensitive populations, such as children, could also have had adverse health effects from continuing use of the mercury contaminated vacuum cleaner.

Children's Health Considerations

Children could be at greater risk as compared to adults from certain kinds of exposure to hazardous substances. While methylmercury is only found in tissue and other media, metallic mercury can be handled. It is a novel substance that may be very attractive to children. Exposure to mercury could be quite high from encounters with this shiny, silver, liquid metal. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough

during critical growth stages, the developing body systems of children can sustain permanent damage.

Mercury easily crosses the placenta, and both inorganic and organic mercury can be found in human breast milk (ATSDR 1999). Maternal exposure to mercury levels that cause little or no signs of toxicity can result in severe neurotoxicity for a fetus. A developing male fetus may be more sensitive to the effects of mercury than a female fetus. Developing organ systems can also result in reduced levels or no excretion of chemicals as compared to excretion in adults. Prenatal exposure may result in subtle developmental alterations that will not show up for years.

Children with chronic exposure to mercury can develop a condition called acrodynia or pink disease. Symptoms of this disease include severe leg cramps, irritability, abnormal redness of skin with peeling of the hands, nose, and soles of feet following. Additional symptoms might be itching, swelling, fever, elevated heart rate and blood pressure along with excessive salivation or sweating, rashes, fretfulness, sleeplessness and/or weakness (ATSDR 1999). It primarily occurs in children and it is a hypersensitivity reaction to mercury (Michaeli-Yossef et al. 2007).

Conclusions

After cleanup of the mercury spill and ventilation of the house, there was no public health hazard at the Berrien County home. Air mercury levels were initially high and were linked to a mercury contaminated vacuum cleaner, which was discarded on the day of the screening. Mercury contaminated items were identified and removed from the home on October 9th, 2008. As the exposure was short-term (less than one day) and within the range air mercury values for maintaining occupancy during cleanup, the residents were not expected to develop health effects and so no health-related follow-up was recommended.

Recommendations

MDCH and Berrien County Health Department recommended that the resident ventilate the home by opening windows to reduce the levels of mercury in the air.

MDCH and Berrien County Health Department recommended disabling and discarding the vacuum cleaner.

Public Health Action Plan

The house was ventilated on the day of the screening.

The vacuum cleaner was taken away, at the request of the homeowner, on the day of the screening

No further actions are necessary.

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Certification

This Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures. Editorial review was completed by the cooperative agreement partner.



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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.



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