

Health Consultation

Residential Mercury Screening on March 26, 2009,
Due to a Broken Mercury Thermostat Switch

Van Buren County, Michigan

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

August 19, 2009

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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Table of Contents

Acronyms and Abbreviations	ii
Purpose and Health Issues	3
Background	3
Discussion	3
Site Visit and Environmental Contamination	3
Exposure Pathways Analysis	5
Toxicological Evaluation	6
Children’s Health Considerations	7
Conclusions.....	8
Recommendations.....	8
Public Health Action Plan.....	8
Preparers of Report.....	9
References.....	10

List of Tables

Table 1: Mercury concentrations in the air (ng/m ³) of a split-level home in Van Buren County, Michigan on March 26, 2009.....	4
Table 2: Exposure pathway for people in home in Mattawan (Van Buren County), Michigan after a mercury thermostat switch break.	5

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 Van Buren-Cass Health Department representative requested assistance from the Michigan Department of Community Health (MDCH) in screening a home after a mercury switch from a thermostat broke in the carpeted living room. This document reports results of the screening and was sent to the representative of the Van Buren-Cass Health Department. Elemental mercury can remain in carpet and off-gas mercury vapor unless the carpet is removed. Depending on the length of the exposure and the amount of mercury vapor, people 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 switch from a thermostat broke around March 5, 2009 in a carpeted living room of a residence. Three adults and three children (ages 3, 5, and 8) live in the home. The residents moved a recliner, possibly contaminated with mercury, to the garage and covered the carpet with plastic where mercury beads were visible. Two floor vents in the area were also covered with plastic and windows in the room were kept open for ventilation.

The Michigan Department of Community Health was notified of the spill on March 24, 2009. Personnel from the Michigan Department of Community Health and the Van Buren-Cass Health Department arrived on Thursday, March 26, 2009 to screen the residence, a split-level house, for mercury with a Lumex RA-915+.

Discussion

Site Visit and Environmental Contamination

A Lumex mercury analyzer (RA-915+, Ohio Lumex Co.) was used on March 26, 2009 to identify areas in the home that were contaminated with mercury. The first readings were taken of the outside air, which was lower than the expected background levels due to the outside temperature, approximately 43°F. Background levels of mercury can range from 6.0 to 20 nanograms per cubic meter (ng/m³) (ATSDR 1999). According to one of the adult residents, windows are typically open in the home and had been open in the room with the mercury contaminated carpet since the day of the spill. These windows were closed the morning of the screening and the temperature in the house was raised above 70°F. The adult resident present stated that this was the warmest the house had been. Table 1 presents the air mercury levels that were found in the home. Two screening values are included in the table: 10,000 ng/m³ for air mercury levels before clean up of the mercury spill and 1,000 ng/m³ as a cutoff for keeping or discarding porous items.

Table 1: Mercury concentrations in the air (ng/m³) of a split-level home in Van Buren County, Michigan on March 26, 2009.

Location	Reading (ng/m ³)	Screening values ^a (ng/m ³)
Just inside the front door ^b	55 - 204	Less than 10,000 (air levels before cleanup)
Lower level		
Lower level main room	311	10,000
Lower level main room – play area	275 - 300	10,000
Steps leading to kitchen in upper level	400	10,000
Upper level		
Kitchen (upper level)	472 - 529	10,000
Kitchen rug (upper level) - 1-2 inches from rug	575	1,000 (level for porous items or those not cleanable)
Bedroom (upper level)	475	10,000
Laundry in basket in the bathroom (upper level) – 1 inch from clothing	580	1,000
Laundry on bed in children’s bedroom (upper level) – 1 inch from clothing	525	1,000
Area above plastic covered carpet (main room upper level) – 1 foot above floor	580	10,000
Carpet under plastic (furthest from the window; main room upper level) – 1-2 inches from carpet	6,300 - 10,000	1,000
Carpet under plastic (closest to the window; main room upper level) – 1-2 inches from carpet	29,000 - 31,000	1,000
Couch cushions (main room upper level) – 1-2 inches above cushions	800 - 850	1,000
Inside vacuum cleaner hose	775	1,000
Garage		
Recliner (in garage) – 1-2 inches above seat cushion	500 - 1,000	1,000

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

a = Screening values were from MDCH (2007); 10,000 ng/m³ for air mercury levels before clean-up and 1,000 ng/m³ for mercury vapor off-gassing from porous items

b = all reading are in the breathing zone (about three feet above the floor) unless otherwise noted

Although mercury was still present in the carpet, air mercury levels throughout the house were all below 1,000 ng/m³, which is the screening value desired after cleanup of the mercury (MDCH 2007). The mercury spill appeared to be well isolated. Mercury contamination was only identified on the carpet, under the plastic, and on the recliner in the garage.

Several recommendations were given to the adult resident present. The first recommendation was to remove the contaminated carpet, as mercury could continue to off-gas over time and possibly cause health effects in the children. The landlord was agreeable and the landlord’s agent in-state was coordinating activities. Additional recommendations were to continue to ventilate the house and to keep the contaminated carpet under plastic until it could be removed, and to sun the recliner for a week (4-5 days), when possible, in order to off-gas the mercury on the cushion. When asked, it was recommended to contact the children’s doctor or Poison Control if the parents had health concerns regarding their children’s exposure.

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 2 describes human exposure to mercury vapor in the air after a mercury thermostat switch break.

Table 2: Exposure pathway for people in home in Mattawan (Van Buren County), Michigan after a mercury thermostat switch break.

Source	Environmental Medium and Exposure Point	Exposure Route	Exposed Population	Time Frame	Exposure
Mercury thermostat switch	Mercury vapor in the air in the home	Inhalation	Residents (three adults and three children) and visitors	Past	Potential
				Present	Complete
				Future	Eliminated

The residents were probably exposed to the highest levels of mercury until the carpet was covered and the chair relocated to the garage, on the day of the spill. After that time only small amounts of mercury were off-gassing from the carpet. Although the residents were exposed to air mercury levels for approximately 20 days, the levels on the day of the screening, March 26, were below the clean up screening level (1,000 ng/m³). Since one adult resident stated that the day of the screening the house was warmer than usual, air mercury levels might not have been higher than those measured on March 26.

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).

When investigating exposure to mercury vapors, MDCH health assessors decide if health effects are expected and whether to recommend medical follow-up, such as a doctor's examination or urine or blood mercury testing, based on several factors:

- Who was exposed to the mercury and their condition (age of child, pregnancy status of woman, and pre-existing health conditions that could worsen upon exposure to mercury vapors)
- The exposure duration, either known or estimated, and the concentrations likely experienced, based on measurements taken during the investigation
- Whether the exposed persons are showing symptoms related to mercury toxicity
- The complexity of the spill (whether it occurred in a public area with high traffic versus a bathroom in a private home)

MDCH considers these factors, along with their experience investigating other mercury spills, and uses professional judgment to recommend appropriate and protective actions.

Although health effects are possible from breathing in mercury vapor, as discussed above, air levels that were present in the residents' house on the day of the screening are not expected to cause health effects in adults or children after an exposure of up to 20 days. All air mercury concentrations were below 1,000 ng/m³, the air mercury concentration desired after cleanup (MDCH 2007). However, air mercury levels that might result if the contaminated carpet was uncovered could cause health effects after a chronic exposure.

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

MDCH concludes that breathing in the amount of mercury present on the day of the screening in the Mattawan home is not expected to harm people's health. Mercury contaminated carpet was isolated under plastic and a recliner, suspected by the residents to be contaminated with mercury, was relocated to the garage shortly after the mercury spill. The residents took action to reduce their exposure to mercury vapor after the spill and as a result reported no symptoms of toxicity to mercury vapor. Conditions in the house on the day of the screening were designed to produce higher air mercury levels, but all air mercury levels measured in the house on the day of the screening were below 1,000 ng/m³. Due to these above factors, the residents were not expected to develop health effects from this mercury exposure and no health-related follow-up was recommended.

Recommendations

1. Remove the carpet (recommended by MDCH and required by the Van Buren-Cass Health Department).
2. Continue to store the recliner in the garage until it can be placed outside for four to five days in the sun.

Public Health Action Plan

The plastic, present on the carpet, was taped down on the day of the screening, as a temporary measure until the landlord could have the carpet removed.

The recliner will remain in the garage until it can be placed outside in the sun.

The Van Buren-Cass Health Department representative sent a letter to the residents.

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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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