

Health Consultation

Berrien County Apartment Screening, on October 3, 2008,
after 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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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

Personnel at the Berrien County Health Department requested assistance from the Michigan Department of Community Health (MDCH) in screening an apartment after a mercury fever thermometer broke in the carpeted living room. Elemental mercury from a thermometer 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

On September 17, 2008, an apartment resident broke a mercury fever thermometer on a glass coffee table. The resident, an adult woman, could see “shiny things” in the carpet, either glass or mercury. She was sleeping in the living room, both before and after the break, and although she does not have young children living with her, her young grandchild visits. The resident was referred to the Michigan Department of Community Health (MDCH) by a representative of the Berrien County Health Department.

On September 18, 2008, MDCH provided recommendations over the phone. These were to keep the room ventilated (open windows and use a fan to blow air out of the room), and to place plastic over the area of the spill and in the normal traffic patterns of the room. The plastic on the carpet prevented further tracking of the mercury around the apartment and prevented mercury off-gassing into the room. As the area of the living room contaminated by the mercury was unknown and the resident’s young grandchild was occasionally present, MDCH and Berrien County Health Department personnel agreed to a screening. The screening was on October 3, 2008. The apartment manager had several discussions with a representative of the Berrien County Health Department before he would schedule the screening. The manager agreed to remove the areas of carpet that had mercury contamination on the day of the screening. There was no cleanup of the mercury before the day of the screening.

Discussion

Site Visit and Environmental Contamination

A Lumex (RA-915+, Ohio Lumex Co.) was used to identify areas in the apartment that were contaminated with mercury. The first readings were taken of the outside air, which was near the expected background levels, and of air in the apartment through an open window. Background levels of mercury can range from 6.0 to 20 nanograms per cubic meter (ng/m^3) (ATSDR 1999). See Figure 1 for the layout of the apartment.

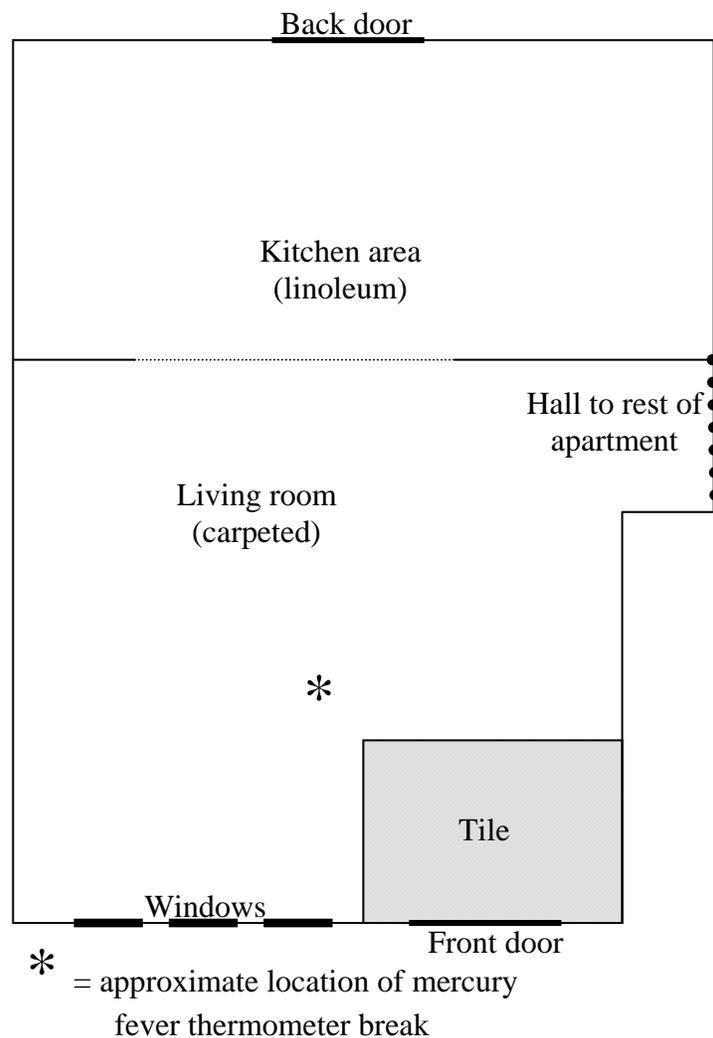


Figure 1: Diagram of the Berrien County apartment, including approximate location of the mercury thermometer break.

Air mercury levels were elevated, but well below the level (10,000 ng/m³) safe for occupancy during cleanup (MDCH 2007), both through the open window and just inside the door to the apartment. The resident had windows open and a fan running when MDCH and Berrien County Health Department personnel arrived. Plastic had been taped to the carpet over the area of the thermometer break and normal traffic patterns of the room, as recommended. It is likely that air mercury levels inside of the apartment would have been higher if the windows were closed and the fan was off. Table 1 presents air mercury concentrations during the initial screening of the apartment. The screening values used were 10,000 (for air mercury before cleanup) and 1,000 ng/m³ (for items with a porous surface, such as carpet and fabric) (MDCH 2007).

Table 1: Mercury concentrations in the air (ng/m³) of the apartment during the initial screening in a Berrien County apartment, Michigan on October 3, 2008.

Location	Reading (ng/m ³)	Screening values ^a (ng/m ³)
Outside – breathing zone on front door mat (front door closed)	7-11	6-20 (outside air ^b)
Outside – outside of open window to apartment	370	6-20 (outside air)
Outside – breathing zone in doorway (front door open)	200	Less than 10,000 (before cleanup)
Inside – carpet	100	1,000
Inside – carpet under coffee table	120-130	1,000
Inside – edge of plastic	100	
Inside – carpet under plastic	400- 3,000	1,000
Inside – carpet by tile	500-1,000	1,000
Inside – carpet by chair (kitchen side of room)	50-60	1,000
Inside – chair (by kitchen)	150	1,000
Inside – hall area carpet	80	1,000
Inside – ottoman (by kitchen)	200-500	1,000

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

a = Screening values were from MDCH (2007)

b = outside air mercury concentrations from ATSDR (1999)

Items that were contaminated with mercury were the carpet and the ottoman near the kitchen. As the carpet measured up to 3,000 ng/m³ in areas just under the taped down plastic, removal was recommended by MDCH representatives and required by the Berrien County Health Department representatives. The chairs, ottoman, and other items in the living room (shoes, books, pillows, and vacuum) were moved outside to a sunny area during removal of the carpet and carpet pad. Items were sunned for approximately 30 to 40 minutes before they were checked for mercury vapors.

After removal of the carpet, the air inside was well below (30 to 76 ng/m³) the acceptable air screening values for residences after cleanup, which is recommended as 1,000 ng/m³ (MDCH 2007). See Table 2 for air mercury values in the apartment after removal of the carpet and mercury values from the sunned items from the living room.

Table 2: Mercury concentrations in the air (ng/m³) of the apartment and living room items after carpet removal in a Berrien County apartment, Michigan on October 3, 2008.

Location	Reading (ng/m ³)	Screening values ^a (ng/m ³)
Outside – chair (originally by kitchen)	9-10	1,000
Outside – chair (originally by the front window)	10-16	1,000
Outside – vacuum brush	33	1,000
Outside – vacuum filter, canister	360-1,000	1,000
Outside – ottoman (originally by kitchen)	10-13	1,000
Outside – bottom of flip flops	10	1,000
Outside – bottom of shoes	Less than 10	1,000
Outside – books	10-12	1,000
Outside – pillows (originally from couch)	30	1,000
Inside – breathing zone air (adult height)	30-76	1,000 (after cleanup)
Inside – floor	35-60	1,000
Inside – hamper	30	1,000
Inside – coffee table	3	1,000

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

a = Screening values were from MDCH (2007).

As the vacuum filter and canister had mercury contamination as high as 1,000 ng/m³, it was recommended that it be discarded to avoid recontaminating the apartment with mercury vapor. All other items from the apartment were acceptable to return to the apartment.

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 an apartment 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 in the home	Inhalation	Resident, visitors (including a young grandchild)	Past	Potential
				Present	Complete
				Future	Eliminated

The resident was probably exposed to the highest levels of mercury vapor for up to two days after the initial mercury thermometer break. After that time, she received recommendations that would reduce her exposure to the mercury off-gassing from the carpet and any other contaminated items in the living room. Her exposure to higher levels of mercury was short-term (two days or less), before she placed plastic on the carpet, and based on air mercury levels on the day of the screening (all air mercury levels were below 1,000 ng/m³), she would not be expected to develop health effects and no health-related follow-up was recommended. The resident’s young grandchild had not been over to visit since the mercury thermometer broke, but if the mercury had remained in the carpet, the child likely would have been exposed to mercury vapor.

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).

Air levels that were present in the resident's apartment on the day of the screening are unlikely to cause health effects in an adult after an exposure of up to 15 days. All air mercury concentrations were below the 1,000 ng/m³, the air mercury concentration desired after cleanup (MDCH 2007).

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 complete cleanup of mercury in this apartment, there was no public health hazard present. Carpet containing mercury contamination was removed and a vacuum cleaner with mercury contamination was discarded on the day of the screening. There is no longer mercury present in this apartment, and therefore, no potential exposure for residents and visitors. As the resident's exposure was short-term (two days or less), she would not be expected to develop health effects from this mercury exposure and no health-related follow-up was recommended.

Recommendations

1. Removal of the carpet was recommended by MDCH and required by the Berrien County Health Department.
2. Disposal of the vacuum was recommended by MDCH and required by the Berrien County Health Department, along with clipping of the electric cord to prevent any one else from using the vacuum.

Public Health Action Plan

The carpet was removed on the day of the screening.

The vacuum was discarded, with alterations to prevent any use, on the day of the screening.

No further actions are necessary.

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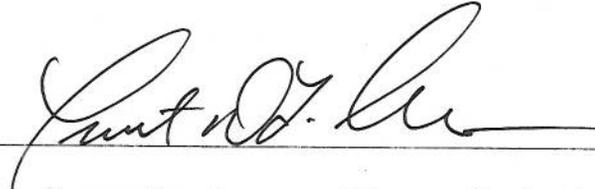
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Certification

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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