

# Health Consultation

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Residential mercury screening in St John (Clinton County), on  
September 25, 2009, due to a mercury thermometer break.

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

MAY 21, 2010

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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## Table of Contents

<b>Acronyms and Abbreviations .....</b>	<b>ii</b>
<b>Purpose and Health Issues .....</b>	<b>3</b>
<b>Background .....</b>	<b>3</b>
<b>Discussion .....</b>	<b>3</b>
Site Visit and Environmental Contamination .....	3
Exposure Pathways Analysis .....	6
Toxicological Evaluation .....	7
Children’s Health Considerations .....	8
<b>Conclusions.....</b>	<b>9</b>
<b>Recommendations.....</b>	<b>9</b>
<b>Public Health Action Plan.....</b>	<b>9</b>
<b>Preparers of Report .....</b>	<b>10</b>
<b>References.....</b>	<b>11</b>

## List of Tables

Table 1: Mercury concentrations in the air (ng/m <sup>3</sup> ) of a home in Clinton County, Michigan on September 25, 2009. ....	4
Table 2: Mercury concentrations in the air (ng/m <sup>3</sup> ) of a home in Clinton County, Michigan on September 25, 2009 .....	5
Table 3: Exposure pathway for people in home in St Johns (Clinton County), Michigan after a mercury fever thermometer break.....	6

## Acronyms and Abbreviations

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

## **Purpose and Health Issues**

A St John (Clinton County) resident called the Michigan Department of Community Health (MDCH) regarding a mercury fever thermometer break in her carpeted bedroom. This document reports results of screening the home. 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**

On September 24<sup>th</sup>, a mercury fever thermometer was broken in the master bedroom. The residents subsequently vacuumed the carpet in the area of the break and washed bedding that may have been contaminated with mercury. The vacuum was still in the bedroom and the resident stated it had not been used elsewhere in the house. Two adults live in the home as do two children (both under age 10). The children are home-schooled.

The resident notified the Michigan Department of Community Health of the spill on September 25, 2009. Personnel from the Michigan Department of Community Health arrived at the home later that day to screen the residence 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 September 25, 2009 to identify areas in the home that were contaminated with mercury. The first readings were taken of the outside air, which had a mercury vapor level of 14 nanograms per cubic meter (ng/m<sup>3</sup>). Background levels of mercury can range from 6.0 to 20 ng/m<sup>3</sup> (ATSDR 1999). The resident had turned off the heating and ventilation system and opened windows to the bedroom after calling MDCH. Table 1 presents the air mercury levels that were found in the home. Two screening values are included in the table: 10,000 ng/m<sup>3</sup> for air mercury levels before clean up of the mercury spill and 1,000 ng/m<sup>3</sup> as a cutoff for keeping or discarding porous items.

Table 1: Mercury concentrations in the air (ng/m<sup>3</sup>) of a home in Clinton County, Michigan on September 25, 2009.

Location	Reading (ng/m <sup>3</sup> )	Screening values <sup>a</sup> (ng/m <sup>3</sup> )
just inside the front door <sup>b</sup>	467 – 608	10,000 (air levels before cleanup)
Master bedroom (main floor)		
master bedroom (window open)	894	10,000
two inches above vacuum beater bar (in master bedroom)	<b>16,000</b>	1,000 (level for porous items or those not cleanable)
two inches away from vacuum bag (in master bedroom)	<b>23,000</b>	1,000
two inches above carpet (by windows) in area of break	<b>1,139 – 1,582</b>	1,000
two inches above bags for donation and school lessons	<b>1,591 – 4,108</b>	1,000
Second floor		
stairs to second floor	604 – 704	10,000
bedroom #1	480 – 535	10,000
bedroom #1 with windows open	315 – 321	10,000
bedroom #2	194 – 426	10,000
bathroom	230	10,000
girl's bedroom	230 – 256	10,000
third bedroom	41 – 38	10,000
computer alcove	65	10,000
Main floor		
laundry area	1,005	10,000
inside washer tub – cold	998 – <b>1,003</b>	1,000
inside washer tub – hot (after 5 minutes of running)	966	1,000
inside dryer – cold	705	1,000
inside dryer – hot (after 5 minutes of running)	986	1,000
two inches away from vacuum attachments (bathroom closet across the hall)	<b>11,000 – 13,000</b>	1,000
shelf above vacuum attachments	3,400	10,000

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

a = Screening values were from MDCH (2007); 10,000 ng/m<sup>3</sup> for air mercury levels before clean-up and 1,000 ng/m<sup>3</sup> 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

Elevated mercury vapor levels were present in the house, although mercury contamination was identified primarily in the carpet in the master bedroom, on the vacuum cleaner and on its

attachments. Mercury vapor levels were consistently higher in many areas of the carpet in the area of the thermometer break.

As the resident did not have any fans, the heating and ventilation system was turned on for 10 minutes, leaving one bedroom window slightly open, and closing the master bedroom door in order to remove any mercury vapor trapped in areas over the carpet. Outside air temperature was less than 70°F, and heated air from the house would leave through the open window.

The washing machine and dryer were screened as they were used to wash bedding that was suspected to be contaminated with mercury. Levels of mercury vapor in the washing machine and dryer were below the levels present in the laundry room, even after running both on hot for five minutes. After screening the laundry room, the master bedroom was re-screened.

Table 2: Mercury concentrations in the air (ng/m<sup>3</sup>) of a home in Clinton County, Michigan on September 25, 2009

Location	Reading (ng/m <sup>3</sup> )	Screening values <sup>a</sup> (ng/m <sup>3</sup> )
Master bedroom (heating and ventilation system on 10 minutes)		
master bedroom (just inside door) <sup>b</sup>	1,966	10,000 (air levels before cleanup)
two inches above vacuum cleaner beater bar	<b>13,000 – 24,000</b>	1,000 (level for porous items or those not cleanable)
two inches above carpet by door	<b>1,600 – 2,000</b>	1,000
two inches above floor vent	<b>1,591</b>	1,000
two inches above floor vent away from spill	<b>1,500</b>	1,000
two inches above carpet by dresser	<b>2,655</b>	1,000
two inches above school materials (box and cloth)	<b>2,788 – 3,784</b>	1,000
two inches above bedspread	<b>1,925</b>	1,000
two inches above carpet on side of bed with the thermometer break	<b>2,431 – 2,900</b>	1,000
inside nightstand drawer – (in break area)	<b>2,293 – 2,421</b>	1,000
two inches above top of nightstand (by phone)	<b>2,269</b>	1,000
two inches above carpet behind nightstand	<b>10,000 – 26,000</b>	1,000
two inches above carpet along bed	<b>2,499 – 2,603</b>	1,000

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

a = Screening values were from MDCH (2007); 10,000 ng/m<sup>3</sup> for air mercury levels before clean-up and 1,000 ng/m<sup>3</sup> 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



After circulating air in the room, elevated mercury vapor was detected in the master bedroom. Mercury vapor levels above floor vents and certain areas of the carpet were similar to the air levels in the room. An area of carpet next to the bed may have had mercury contamination (2,431 – 2,900 ng/m<sup>3</sup>), but the carpet behind the nightstand was identified as the primary source of mercury in the room.

Although mercury was still present in the carpet, air mercury levels in a majority of the house were all below 1,000 ng/m<sup>3</sup>, which is the screening value desired after cleanup of the mercury (MDCH 2007). Mercury contamination was identified on the carpet, the vacuum, vacuum attachment parts, and items on the floor in the master bedroom. The mercury spill appeared to be primarily localized in the master bedroom.

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 after a long-term exposure. Additional recommendations regarding the carpet were to cover the contaminated area with plastic, block the cold air return, keep the children out of the room, and continue to ventilate until the carpet could be removed. MDCH recommended not using the room until the carpet was removed, if possible. MDCH recommended discarding mercury-contaminated items, such as the vacuum cleaner and attachments. The adult was told to cut the power cord or otherwise disable the vacuum cleaner so it could not be re-used. MDCH also recommended discarding the bags of clothing they were preparing to donate and school materials that were also stored in the room on the floor near the break. It was suggested that if certain school materials could not be discarded, those items should be placed outside in the sun for 3 to 4 days, if possible, in order to off-gas the mercury remaining. The final recommendation was to air out the house, including the bathroom, where the vacuum cleaner attachments were stored.

### 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 home in St Johns (Clinton 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	Residents (two adults and two children) and visitors	Past	Eliminated
				Present	Complete
				Future	Potential

The residents were probably exposed to the highest levels of mercury just after the vacuuming until the windows were open on the day after the spill. The spill had occurred on the previous day and mercury vapor levels in a majority of the house were below the MDCH screening level for air mercury levels after a cleanup (1,000 ng/m<sup>3</sup>). MDCH recommended actions for the resident to take to reduce any mercury exposure until the mercury-contaminated carpet could be removed from the master bedroom, including blocking the cold air return, keeping the room ventilated, and keeping the children out of the room until the carpet was removed.

### 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 two days. Air mercury vapor levels were below 1,000 ng/m<sup>3</sup>, the air mercury concentration desired after cleanup (MDCH 2007), in the majority of the house. However, mercury vapor levels that the residents might be exposed to could result in adverse health effects if the contaminated carpet was left in the home for an extended time. MDCH provided recommendations to minimize the residents' mercury exposure until the carpet could be removed.

### 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 air 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). Acrodynia 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 St Johns home is not expected to harm people's health as long as exposure is limited. Mercury contaminated carpet was identified in the master bedroom along with a mercury-contaminated vacuum cleaner, vacuum cleaner attachments, and other items.

## **Recommendations**

1. Remove the mercury-contaminated carpet. Tape down plastic over the contaminated carpet, block off the cold air return in the room, continue to ventilate, and keep the children from the room until removal. If possible, the occupants of the room should not sleep there until the carpet is removed.
2. Dispose of the vacuum cleaner (disable before discarding), vacuum cleaner attachments, and other items. If school materials cannot be discarded, place outside in the sun for three or four days to allow mercury to off-gas.

## **Public Health Action Plan**

Clean-up steps were discussed with the resident and documented in a recommendations form.

A representative of the Mid-Michigan District Health Department followed up with the resident, and was informed of the carpet removal. No further action is necessary.

## **Preparers of Report**

### **Michigan Department of Community Health Division of Environmental Health**

Jennifer Gray, Ph.D.  
Toxicologist  
Toxicology and Response Section

Michelle Bruneau, MA  
Health Educator  
Toxicology and Response Section

### **ATSDR Region 5 Office**

Mark Johnson  
Office of Regional Operations

### **ATSDR Division of Health Assessment and Consultation**

Trent LeCoultré, Technical Project Officer  
Cooperative Agreement Program Evaluation Branch

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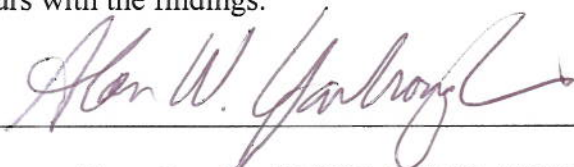
### **Certification**

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.

A handwritten signature in black ink, appearing to read "Linda J. R.", is written over a horizontal line.

Technical Project Officer, Cooperative Agreement Program Evaluation Branch (CAPEB),  
Division of Health Assessment and Consultation (DHAC), ATSDR

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

A handwritten signature in black ink, appearing to read "Alan W. Garbry", is written over a horizontal line.

Team Leader, CAPEB, DHAC, ATSDR