

Health Consultation

Screening of a Sports Utility Vehicle (SUV), on October 10 and 14, 2008,
after a Mercury Fever Thermometer Break in DeWitt, Michigan.

**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

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

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
SUV	sports utility vehicle

Purpose and Health Issues

A private citizen called the Michigan Department of Community Health (MDCH) and requested assistance with a mercury fever thermometer break in her sports utility vehicle (SUV). The thermometer broke in the backseat on the carpeted floor of the passenger side. 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

A mercury fever thermometer broke in the backseat of an SUV, a Chevrolet Trailblazer, on October 9th or 10th, 2008. The owner called the MDCH and requested advice. She had placed two mercury thermometers in her SUV in preparation to dropping them off to her local health department. While she or her grandson were rearranging items in the SUV, one of the mercury thermometers broke in the backseat. The owner often loaned her SUV to her teenage grandson and used it to transport her young grandchildren.

The owner found some glass pieces from the thermometer in the backseat. As she could not find the bulb of the thermometer or beads of mercury, screening of the vehicle was recommended. Rene Franco, from Ingham County Health Department, agreed to bring out a Lumex to screen the car. MDCH's Lumex was unavailable.

Discussion

Site Visit and Environmental Contamination

On October 10th and 14th, 2008, the two screening days, the outside temperature was between 70 and 77°F. Air mercury concentrations in the breathing zone of the SUV were between 200 and 980 nanograms per cubic meter (ng/m³). Items that had been in the back seat of the car were removed and bagged for screening. While items were removed from the SUV, mercury beads were identified in the backseat carpet on the floor of the passenger side. Mercury concentrations directly above that area were between 3,000 and 26,000 ng/m³. See Table 1 for air mercury concentrations in the SUV and bagged items. Mercury concentrations were compared to MDCH's screening values. 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: Air mercury concentrations (in ng/m³) of the inside of an SUV and items from inside of SUV on October 10, 2008.

Location	Reading (ng/m ³)	Screening values ^a (ng/m ³)
Outside of car	8; 6	6 to 20 (outside air) ^b
Breathing zone of closed car	980	Less than 10,000 (before cleanup)
Backseat of car	235	Less than 10,000
Backseat of car (over area of break)	500-600	Less than 10,000
Breathing zone of car backseat	430; 571; 700	Less than 10,000
Back passenger side seat	200	1,000
Backseat carpet with visible mercury beads	3,000; 7,000; 26,000	1,000
Bagged - Floor mat (passenger side)	24,000	1,000
Bagged - Clothes (jacket)	955; 1,500	1,000
Bagged - Clothes (yellow jacket)	21	1,000
Bagged - Car seat for child	235	1,000
Bagged - Backpack	200	1,000
Bagged - Child's doll	2,600; 1,752	1,000
Bagged - Miscellaneous clothes	3-6	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)

Visible mercury beads were removed using tape. Elevated mercury levels were measured in bags with the floor mat, a child's doll, and a jacket. MDCH and Ingham County Health department personnel recommended discarding the floor mat and child's doll.

Recommendations to heat and vent or sun items from the backseat, including the jacket were given to the owner. As for the carpet in the car, the owner was told that she could remove the carpet or heat and vent the car for three to four days. As Michigan had a few days of unseasonably warm weather, the owner decided to heat and vent the SUV and have it screened again.

After four days the SUV was screened again. The Ingham County Health Department Lumex was again used for this screening. Table 2 presents the air mercury concentrations from the screening. Mercury concentrations for the breathing zone of the SUV were compared to 3,000 ng/m³, the air screening value for non-residential settings after cleanup (MDCH 2007).

Table 2: Air mercury concentrations (in ng/m³) of the inside of an SUV and items from inside of SUV on October 14, 2008.

Location	Reading (ng/m ³)	Screening values ^a (ng/m ³)
Closed car – front seat breathing zone	13,000	3,000
Open door	6,000	3,000
Back seat high breathing zone (initial reading)	3,000- 9,000	3,000
Breathing zone of backseat (car doors were open for 3 minutes)	700	3,000
Backseat breathing zone (after heating car for 20 minutes with doors closed)	181; 166; 148; 219	3,000
Back/trunk area of vehicle breathing zone	279; 264	3,000
Every item that was sunned (clothes, backpack, car seat)	32	1,000
Carpet where mercury beads were located	230; 300	1,000
Driver's side backseat floor	37; 80; 200	1,000
Bag with additional items from the backseat (sunned items)	57	1,000
Purse and backpack (from backseat of car – not sunned)	700	1,000

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

a = Screening values were from MDCH (2007).

Items that the owner had sunned were all placed in a bag and the air mercury concentration was measured at 32 ng/m³. A few additional items from the backseat of the SUV were bagged for screening at this time. Some of the items had been sunned, and those had an air mercury concentration of 57 ng/m³. Items that were just removed from the SUV had air mercury levels of 700 ng/m³. MDCH and Ingham County Health department personnel recommended sunning or heating and venting any items that were newly removed from the SUV.

Levels in the SUV were initially high (3,000 to 13,000 ng/m³) on the day of the second screening as the vehicle had not been opened that day. Mercury levels in the SUV quickly lowered to 700 ng/m³. The carpet area that previously had mercury contamination now had levels of 200 and 300 ng/m³. The heater in the SUV was run, with the doors closed, for 20 minutes to confirm there was no remaining mercury. After heating the SUV, mercury levels in the breathing zone of the backseat were between 148 and 219 ng/m³. MDCH and Ingham County Health department personnel recommended heating and venting the SUV for several more days, to remove any remaining mercury.

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 DeWitt, Michigan after a mercury fever thermometer break in an SUV.

Source	Environmental Medium and Exposure Point	Exposure Route	Exposed Population	Time Frame	Exposure
Mercury fever thermometer	Mercury vapor in the air of the SUV	Inhalation	Owner, any other drivers and passengers, including grandchildren	Past	Potential
				Present	Complete
				Future	Eliminated

The driver and passengers in the SUV were exposed, while in the vehicle, to mercury vapor on one to two days after the thermometer break. Mercury levels in the SUV might have been elevated, especially after first getting into the vehicle on a sunny day. Air mercury levels in the car were below 1,000 ng/m³ (the screening value MDCH recommends for houses after mercury sources are removed) within minutes of opening the doors. It is unlikely that people would have been exposed to elevated mercury for a long enough time to develop health effects. As the exposure was short-term (while in the vehicle on one or two days), no health-related follow-up was recommended.

Toxicological Evaluation

Metallic or elemental mercury is a shiny, 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).

Death is possible after exposure to high levels of mercury vapor, due to respiratory failure, or ingestion of high levels of inorganic mercury or organic mercury. Heating mercury causes the release of high levels of mercury vapor. 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).

Mercury levels in the SUV were elevated, but are unlikely to cause adverse health effects in most people after short-term exposure. Sensitive populations, such as children or people with preexisting conditions that affect the nervous system, might have had adverse health effects from continued use of the SUV without cleanup of the mercury.

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 in the SUV, there was no public health hazard. Heating and venting of the SUV for four days allowed the mercury in the carpet to off-gas. Very little mercury remained in the SUV and therefore, people were exposed to little or no mercury vapor. As the exposure was short-term (while in the vehicle on one or two days) and air mercury levels were below 1,000 ng/m³ within minutes of opening the car doors, no health-related follow-up was recommended.

Recommendations

Heat and vent the SUV for several more days to remove the any remaining mercury in the SUV.

Sun or heat and vent additional items from the backseat of the SUV to further lower the levels of mercury on them.

Discard the floor mat and the child's doll.

Public Health Action Plan

The SUV and the items removed from the SUV on the initial screening day were heated and vented or sunned before the second screening and almost all of the mercury contamination was removed. Additional heating and venting will further reduce the levels of remaining mercury.

As more items are removed from the back of the SUV, sunning or heating and venting will remove any residual mercury contamination.

The floor mat and child's doll were discarded on the day of the initial screening.

No further actions were necessary.

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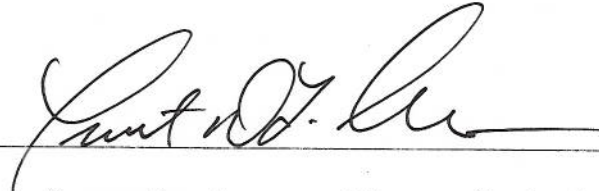
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Certification

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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