Health Consultation

BENTON HARBOR RESIDENTIAL MERCURY SPILL EVENT

BENTON HARBOR, BERRIEN COUNTY, MICHIGAN

OCTOBER 26, 2004

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR 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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

BENTON HARBOR RESIDENTIAL MERCURY SPILL EVENT

BENTON HARBOR, BERRIEN COUNTY, MICHIGAN

Prepared by:

Michigan Department of Public Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

SUMMARY

MDCH received a call from a young mother whose child had broken a blood pressure cuff in the home she was renting. She had been given advice by the Poison Control Center and the local health department for cleaning up the spill and ventilating the vapors from the home. When the local health department and MDCH visited to perform the clearance test, they found extremely high levels of mercury vapor, evacuated the occupants, and sealed the house against reuse until the situation was ameliorated.

Background and Statement of Issues

On June 30, 2004, MDCH received a call from a citizen in Benton Harbor who had a mercury spill in the home she was renting. She had brought a sphygmomanometer (also known as a blood pressure cuff) home from work, and it had broken while one of her children was examining it. The mercury from the device flowed onto the carpeted floor in the living room. On June 29, the woman called the Poison Control Center (PCC) located in Grand Rapids, Michigan. The PCC gave her advice regarding packaging the broken device, securing the area, covering the affected part of the rug to minimize vapors, ventilating the home and removing and disposing of the contaminated carpet and pad. PCC also referred her to the Berrien County Health Department and the Michigan Department of Community Health for additional advice and assistance. She called the Berrien County Health Department and spoke to an environmental health representative there who reinforced the PCC advice and direction and referred her to MCDH.

When MDCH spoke to her on June 30, and reviewed with her what she had been told, it was determined that no additional advice was needed. MDCH recommended that she follow the advice she had been given and asked her to call the Berrien County Health agency to arrange clearance testing once she had completed the cleanup actions and thoroughly ventilated the home.

The woman called the local health agency the following week, and they called MDCH and requested to borrow MDCH's Lumex® RA 915+ Mercury Vapor Analyzer. The Lumex has a detection limit of 2 nanogram of mercury per cubic meter of air (ng/m^3) and a real time measurement response that displays readings at 1second intervals. The instrument was out on loan to another county at the time of the call. However, MDCH arranged to visit Benton Harbor on 7/13/04 with the device and perform clearance tests on this and two other Berrien County locations that had been the scenes of mercury spills.

On the morning of July 13, 2004, MDCH met a Berrien county health representative at his office and went to the home where the spygmomanometer had broken. The ambient outdoor air temperature was in the high 70s. They donned protective footwear on the porch of the two-story frame dwelling and started the vapor analyzer. The initial internal test of the device indicated it was working properly, and the readings stabilized at approximately 42 ng/m^3 in the outdoor air just outside the front door. The woman who had contacted the health agency was not home when the investigators arrived, but they were given entry to the home by one of her daughters. They entered via the front door

and were concerned to find the living room carpet still in place. A standing fan was on the living room carpet and was blowing air across an area in front of a coffee table. In the dining room stood an upright vacuum that they later learned had been used on the affected portion of the carpet against the recommendations of PCC and the county health department. None of the downstairs windows were open nor were any of the screen door panels. Other than in the vicinity of the fan, the air in the house was still and warm. The Lumex readings in the breathing zone of the living room just inside the front door climbed to the maximum detection limit of the device (92,000 ng/m^3). Thinking the machine might be malfunctioning, the investigators took the vapor analyzer outdoors and the machine gradually lowered its reported readings to 18 ng/m^3. On entering the residence again the readings immediately returned to a display that indicated the vapors exceeded the machines 92,000 upper detection limit. The limited data described are presented in Table 1.

Table 1.
Lumex Readings Taken on Field Visit 7/13/04
Units: ng/m^3

Pre-entry outdoors – breathing zone (bz)	42
Inside the front door bz	>92,000
Outside the home bz	18
Living room bz	>92,000

The state and local health representative told the daughter to speak to everyone else in the home, have them get dressed and leave the home immediately. The health staff then went about opening windows and door panels and repositioning the fan in the living room so it was exhausting air and vapor out an open window. The daughter called her mother at work and the mother arrived at the home soon after. She was asked to find an alternative place for herself and the occupants of the home to stay. MDCH asked her the names and ages of everyone who had spent any significant amount of time in the home since the mercury spill occurred. In all, there had been 8 people: two young adults and 6 children whose ages were 13, 12, 11, 11, 7 and one whose age is unavailable. MDCH suggested that the resident, who was the mother of 3 of the children, contact her physician and the parents of the other children. MDCH asked her to speak to them about arranging blood testing for mercury as soon as possible.

When everyone was out of the house and the doors were locked, the health representatives wrapped the front and back doors and railings with hazard warning tape as a temporary barrier to keep people from entering the home. MDCH called the owner of the rental property to notify him of the spill and to let him know that the county health department considered the home uninhabitable until the mercury hazard was removed. The owner was unavailable at the time, so a detailed message was left with his assistant.

The following day the county health agency learned that some of the exposed individuals had gotten their blood drawn the previous evening for mercury testing, and similar tests for others were pending. MDCH received a call from the mother's employer who indicated that their agency was going to coordinate addressing the spill and asked for our

assistance. The employer was a non-profit community services agency for whom the resident was using the sphygmomanometer to take blood pressure readings of senior citizens once a week in their homes. MDCH assisted her in coordinating the remediation of the home by suggesting she engage a professional contractor and sent her a list of 10 environmental contracting companies experienced in mercury response compiled by the Michigan Department of Environmental Quality.

MDCH consulted with two On Scene Coordinators (OSCs) from the U.S. Environmental Protection Agency's Emergency Response Branch at Gross Ile regarding how the contractor might characterize a home where the air concentrations had exceeded the Lumex maximum detection limit. They recommended that the contractor who was hired should first thoroughly ventilate the home for 2 days. This ventilation was necessary to lower the vapor levels and make it possible to identify specific areas where source mercury was spilled and where it might have been spread. The non-profit services agency (with whom the resident was employed) engaged an environmental contractor, and MDCH passed the recommendations from the EPA on to them.

MDCH learned that the agency had received the sphygmomanometer that had broken, and an additional one, from a hospital in Kalamazoo. MDCH suggested that they secure the second device and dispose of it with the other material the environmental contractor would remove from the house.

By July 22, 2004, the contractors had ventilated the house, identified the areas where elemental mercury was present, and removed impacted materials–including the carpet and carpet pad from the living and dining rooms. They had also removed and disposed of a contaminated couch and loveseat and ventilated the home in preparation for clearance testing. Clearance testing was conducted following the modified NIOSH 6009 protocol at 4 locations in the home: upstairs, basement, living room and dining room. The results are shown in Table 2.

Table 3. Clearance Test Results in ug//m^3

Location	Detection Limit	Result
Upstairs	0.2	0.5
Basement	0.2	0.2
Dining room	0.2	0.8
Living room	0.2	0.7

As soon as the Berrien County Health Department received the clearance test results they consulted with MDCH and then notified the renter, her employer, and the landlord that the home could once again be safely occupied.

Community Health Concerns

The spygmomanometer that broke in the house had been given to the non-profit community services agency by a hospital that was replacing mercury-bearing devices with mercury free alternatives. The donor had given two sphygmomanometers to the agency. After the spill and the seriousness of its implications became known to the agency, they immediately secured the second device and returned it to the hospital. The service agency was concerned that there might be other donated mercury devices in circumstances where a spill could occur. MDCH planned to follow up on the donation and ensure that there were not any other sphygmomanometers used in field or office situations form this source.

Discussion

MDCH frequently receives requests to assist with elemental mercury spills and is prepared to help in several ways. Staff can quickly fax or email procedural guidance to the caller which includes information on addressing small or large spills, sample press releases, sample letters to parents, patients and employees. Our response can include bringing in and coordinating the resources of other agencies such as ATSDR, the U.S. EPA Emergency Response Branch and the Michigan–based Poison Control Centers. We are also able to give guidance on containing the spill, managing the cleanup, and evaluating the need for biological sampling of exposed and potentially exposed people. We have assisted local health departments in drafting letters to home and business owners after the event for insurance coverage purposes.

The main routes of exposure for elemental mercury are ingestion, dermal absorption and inhalation of mercury vapors. Of the three, inhalation is the most hazardous route particularly to children and women of childbearing age.

Inhalation of high levels of elemental mercury can cause permanent neurological damage and kidney impairment. The Agency for Toxic Substances and Disease Registry (ATSDR) recommends that breathing zone mercury levels not exceed 1,000 nanograms of mercury per cubic meter of air (ng/m^3) for long term exposures as would be likely in a residence (1). This recommended level is based on both animal studies and human epidemiology studies that describe the health effects of inhalation of mercury-contaminated air. Workers who were exposed to mercury vapors in an occupational setting exhibited hand tremors, increases in memory disturbances, and slight subjective and objective evidence of autonomic nervous system dysfunction. The ATSDR minimal risk level (MRL) for mercury in air was derived from the lowest observed adverse effect level (LOAEL) from this study of 26,000 ng/m^3. Because workers were only exposed during working hours, the LOAEL was adjusted to account for continuous exposure. The resulting value was divided by an uncertainty factor of 10 to protect sensitive human subgroups and by a factor of 3 because a LOAEL was used rather than a no observed adverse effect level (NOAEL). The resulting MRL is 0.2 micrograms per cubic meter (ug/m^3) or 200 ng/m^3. An MRL is defined as an estimate of the daily exposure level to a hazardous substance that is likely to be without appreciable risk of adverse, non-cancer

health effects. ATSDR and MDCH guidance recommends that the breathing zone of a residence not exceed a mercury vapor concentration of 1000 ng/m^3 once the home has been remediated and ventilated. If levels exceed that guidance number there needs to be additional cleanup to remove residual source mercury and mercury vapor.

A mercury bearing spygmomanometer can contain between 9 and 16 cubic centimeters (cc) of mercury in its column and reservoir. This is less than the 3cc or 1 pound amount that triggers the required notification of the National Response Center, the Michigan Department of Environmental Quality's Pollution Emergency Alerting System (PEAS) or a Local Emergency Planning Committee (LEPC). The advice given to the resident of the rental home soon after the spill occurred would have been effective in minimizing exposure had it been implemented promptly by the resident. Instead the mercury-contaminated carpet was left in place, and the resident vacuumed the area against the advice given to her. The rate of mercury vaporization was exacerbated by the vacuuming and resulted in a spread of vapor further through the house. The closed-up condition in which the home was found on July 13, 2004 added to the high levels the rooms had attained.

The initial clearance testing of the Benton Harbor home on July 13, 2004, showed a level at least 90 times higher than the MDCH/ATSDR residential guidance of 1,000 ng/m^3 and indicated an acute hazard that also exceeded occupational regulatory standards (ACGIH Threshold Limit Value {TLV}, 8 hour average limit 25,000 ng/m^3; NIOSH Time Weighted Average {TWA} 50,000 ng/m^3).

Addressing the Unique Vulnerabilities of Children

Children may be at greater risk than adults from certain kinds of exposure to hazardous substances at sites of environmental contamination. They engage in activities such as hand-to-mouth behaviors that increase their exposure to hazardous substances. They are shorter than adults, which means they breathe dust, soil, and vapors close to the ground. Their lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages.

Children who breathe metallic mercury vapors for an extended period of time may develop a disorder known as acrodynia, or "pinks disease." The symptoms of this disorder include severe leg cramps, irritability; and abnormal redness of the skin, followed by peeling of the hands, nose, and soles of the feet. Itching, swelling, fever, fast heart rate, elevated blood pressure, excessive salivation or sweating, rashes, fretfulness, sleeplessness, and / or weakness may also be present. This disorder may also occur in teenagers and adults. Exposure to mercury vapors is more dangerous for children than for adults, because inhaled mercury vapors easily pass into the brain and nervous system of young children and may interfere with the development process. Exposure to high levels of mercury vapor can also cause lung, stomach, and intestinal damage. Death due to respiratory failure can result in cases of extreme exposures (3).

The adults and children exposed to mercury vapor in this circumstance did not report any symptoms to MDCH, nor did MDCH hear of any from the doctors who attended them. All of the exposed received one blood test. For some of them, the ones with higher concentrations, the doctors ordered a repeat test. The doctors did not order chelation for any of those exposed. The results of the blood tests are presented in Table 3.

Table 3. Mercury Blood Test Results in μg/L

Patient	Date Blood Drawn			
	7/13/04	7/14/04	7/16/04	7/21/04
Adult 1		16		
Adult 2		18		
Child age 7	25			7
Child age 11	13			4
Child age 11		18		
Child age 12			<4	
Child age 13	29			7
Child age (?)			<4	

The blood mercury concentrations detected on July 13 and 14, 2004 were elevated. According to the ATSDR Toxicological Profile for Mercury, levels of mercury in whole blood found on July 13 and July 14, 2004 are associated with health effects such as increased tremors and disturbances in tests on verbal intelligence and memory.

Conclusions

The following conclusions were made at the time of the initial site visit and shortly afterward:

The Benton Harbor home contaminated by a broken sphygmomanometer was considered an **Urgent Health Hazard** because mercury vapor was present at concentrations that can cause adverse health effects after short-term exposure. The situation called for immediate intervention to prevent serious health effects and perhaps permanent damage. Because this spill has been remediated, this home currently poses no public health hazard with respect to this mercury spill.

Recommendations

The following recommendations were made by MDCH and Berrien County during the investigation:

1. Evacuate the premises.
2. Arrange biomedical testing.

3. Seal the house and prevent anyone unauthorized from entering without appropriate personal protection clothing and equipment.
4. Notify the property owner and explain the implications of the circumstances.
5. Recommend the use of a professional environmental contractor to characterize, remediate, ventilate and perform clearance testing on the home.
6. Locate, secure and properly dispose of any additional mercury bearing equipment that the community service agency received as a donation.
7. Contact the donor of the sphygmomanometers and prevent spill resulting form any other devices.

Public Health Action Plan

All recommendations were implemented during the course of the investigation or shortly afterwards.

Berrien County and MDCH evacuated the home and sealed it against re-entry.

MDCH referred all the exposed people for mercury blood testing.

The MDCH provided verbal consultation to the renter and others in the home, the county health agency, the community services agency, and the landlord.

MDCH recommended a clearance level for the post-clean-up based on ATSDR guidance.

MDCH furnished a list of environmental contacting companies compiled by the MDEQ to the community service agency.

MDCH tracked the two sphygmomanometers back to the donor hospital and spoke to staff there to ensure the returned device was appropriately disposed of. MDCH also received their assurances that they had no additional mercury bearing devices in situations that could lead to spills and exposures.

MDCH will be available to address any public health questions or concerns regarding this contamination event. Please contact the Michigan Department of Community Health, Division of Environmental and Occupational Epidemiology at 1-800- 648-6942.

References

- ATSDR (Agency for Toxic Substances and Disease Registry). 2000. Suggested Action Levels for Indoor Mercury Vapors in Homes or Businesses with Indoor Gas Regulators.

- ATSDR (Agency for Toxic Substances and Disease Registry). 1999. Toxicological Profile for Mercury, Update.

PREPARERS OF THE REPORT

Michigan Department of Community Health
Division of Environmental and Occupational Epidemiology

Brendan Boyle, M.P.A., Health Assessor

Linda D. Larsen, Ph.D., Toxicologist

ATSDR Regional Representative

Mark Johnson
Regional Services, Region V
Office of the Assistant Administrator

ATSDR Technical Project Officer

Alan Yarbrough
Division of Health Assessment and Consultation
Superfund Site Assessment Branch

CERTIFICATION

This Benton Harbor Residential Mercury Spill Event 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 existing at the time the health consultation was begun.

Technical Project Officer, Cooperative Agreement Team, SPAB, DHAC, ATSDR

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

for Team Leader, CAT, SPAB, DHAC, ATSDR