

EXPOSURE INVESTIGATION

**Spectrum Home Care
Mercury Spill Event**

Oakland and Macomb Counties, Michigan

Prepared by

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

Background and Statement of Issues

On Monday August 5, 2001, the clinical director for the Spectrum Home Care service called the Oakland County Health Department to report a mercury incident. One of its visiting nurses had brought a canvas bag containing about a dozen mercury thermometers from her place of work to a patient's home, and then to her own home. The thermometers had broken somewhere en route, and a chance of contamination was possible in several locations. The environmental health staff at Oakland County were unavailable to respond at that time or for the next few days, so the call was referred to the Michigan Department of Community Health (MDCH), Toxicology and Response Section (TARS). TARS staff consulted with the clinical director and recommended the intervention actions needed until the extent of contamination could be characterized.

On Tuesday morning, TARS staff called and decided that the several potentially contaminated locations should be screened as soon as possible to prevent exposure. Brendan Boyle and Abulhasan Sayed of MDCH went immediately to the Spectrum office at 27170 Dequindre Road, Warren, Michigan. They took MDCH's Lumex RA 915+ Mercury Vapor Analyzer, which is capable of measuring mercury vapor with real time result display and a detection limit of 2 nanograms per cubic meter (ng/m^3), with them. All mercury vapor measurements reported in this consultation are reported in ng/m^3 .

When they arrived, the president of the company and the clinical director helped them identify the materials and areas of the building that needed to be tested. The Lumex was put through a self test outside the building and then switched to sample outside air. The readings stabilized at 30-40 ng/m^3 due to residual mercury in the filter and tube. The building was air conditioned. In the building the MDCH team found approximately 400-900 ng/m^3 in a breathing zone 3-4 feet from the floor. An 8-foot square carpeted area in a large front room common area showed 1,500-6,000 ng/m^3 in measurements taken 5 inches from the floor. Someone on the staff reported seeing mercury beads in this area coming from a canvas bag that one of the nurses carried there on Friday, August 2. Both the canvas bag and a wallet that was in it were contaminated. The Lumex sampling tube was placed through a small opening of the passenger door of the nurse's vehicle, which was parked in front of the office in the sunlight. The machine instantly began reading in the 20,000-40,000 ng/m^3 range. Visual inspection of the passenger seat revealed small beads where the seat met the seat-back.

Table 1. Mercury measurements in the Spectrum Home Care office and vicinity, Warren, Michigan, August 2001

Location	Mercury (ng/m^3)
Outside building	40-50
Breathing zone front room	906
Large front room carpet near observed spill event	1,500–6,000
Canvas carry bag	6,600
Black multi-pocketed bag pockets	200 to 1,300
Nurse's vehicle interior	20,000 to 40,000
Vehicle passenger seat	45,000

Staff next went to the patient's Lee Street home in Southfield, Michigan, where the nurse had visited with the bag on August 2. The one story home was not air-conditioned and was very warm when the team entered. Initial readings taken in the kitchen area showed 4,000-5,000 ng/m³ in the breathing zone. Floor readings in that corner of the home were lower (900-2,462 ng/m³). Six of the 7 persons currently living there (adults and children) were present. The MDCH team sampled around the home and found the highest readings followed a path which started at the front door and then went down an "L" shaped hallway that was surfaced with both slate near the door and with carpet toward a back bedroom. Between the front door and the master bedroom, hallway floor levels varied from 6,400 to 79,000 ng/m³ (the highest Lumex will report). The hallway breathing zone averaged 10,000 ng/m³. As the sampling team entered the master bedroom, Lumen reported the breathing zone levels from 13,000 to 24,000 ng/m³. Retracing their steps back down the hallway, the team tested a den or family room at the side of the house. The carpet mercury concentrations in the den varied from 6,000 to 8,914 ng/m³. The breathing zone in the den measured 8,547 ng/m³.

The patient at the Lee Street residence was a 90-year-old gentleman whose daughter was the contact person. After a quick screening of the home, the investigators advised her that the home was seriously contaminated with mercury. They recommended opening windows and doors immediately to dilute the vapor levels, said the home needed to be cleaned of mercury, and that she and her family members must leave until that was done. They also advised that every person who lived in the home or spent more than a few hours there should have a blood test as soon as possible. MDCH staff contacted Spectrum Home Care and encouraged that it communicate with the residents immediately to arrange relocation, investigation, remedial actions, and after-testing. Spectrum was also asked to facilitate the blood testing of persons who had been exposed in the Lee Street home and elsewhere.

Table 2. Mercury measurements in the patient's Lee Street home, Southfield, Michigan, August 2001

Location	Mercury (ng/m³)
Back entrance floor	900 to 1,700
Kitchen area breathing zone	4,303
Hallway by front door	6,467
Middle of slate hallway	3,400 to 3,800
Floor at the junction of hallways	79,000
Hallway breathing zone	10,000
Midway of carpeted hallway	1,840 to 3,679
Master bedroom breathing zone	13,000 to 24,000
Den entry area carpet	8,914
Den breathing zone	8,547
Middle den carpet	6,000

MDCH staff then went to the nurse's home in Chesterfield Township, Macomb County. It was here she had first noticed beads leaking from the canvas bag on a kitchen counter beside the stove. She had cleaned up all visible beads and asked for a Lumex check of the home to identify areas needing further cleaning. Breathing zone measurements in the condominium, in which air-

conditioning was running, were in the 2,000-2,500 ng/m³ range. MDCH asked that the air-conditioning be shut off. The nurse and her mother were the only two occupants of the condominium. Her mother had vacuumed the kitchen after the spill event. The vacuum cleaner was very contaminated, so the nurse disabled it in preparation for disposal. The kitchen breathing zone range at first was below 2,000 ng/m³, but as the room warmed, it approached 3,200 ng/m³. The highest concentrations above the breathing zone background levels were in three throw carpets between the back door and the far end of the kitchen. Grouted areas between the ceramic tile in front of the counter and the stove were also high. The edge of the ceramic cook-top surface of the stove was also high. The nurse had not cleaned the floor between the stove and the counter on which she had seen beads. MDCH staff moved the stove and cleaned the space with powdered zinc, followed by shaving cream wiped on the side surface of the counter base. Shaving cream was also used on parts of the cook-top perimeter in hopes of capturing and removing some mercury that could not be seen.

Community Health Concerns

The spill from the leaking bag happened during the course of the nurse's duties on Friday August 2. The situation did not become apparent until the following Monday. Residents of the Lee Street home were very concerned about their health and safety because some of them spend their entire day in the home.

Public health concerns were greatest for the family members because the home was not air-conditioned, and mercury volatilizes more rapidly in warmer rooms and hallways. The initial screening found some of the highest levels in the carpeting and slate flooring of the Lee Street home.

Condition of the vehicle was of concern because space is very limited and beads were present both in and on the passenger seat. Even when air-conditioning is operating, the system could be set to recirculate the vehicle's cabin air which would cause high-level exposure.

The detection of relatively high mercury levels on the edge of the cook-top was a public health concern because of the heat source near the mercury.

Everyone likely to have been exposed to mercury vapors for more than a few hours between Friday and Tuesday, August 13, 2001, was encouraged to get a blood test as soon as possible.

The environmental contractors hired by the home care service found that most of the carpeting in the impacted portion of the home was contaminated. The contractors removed the carpet and pad and cleaned the floor surface underneath. They ventilated the home and monitored the mercury vapor levels using a Lumex RA-915 Mercury Vapor Analyzer after the final cleaning and stabilization. When it was determined that the source mercury had been remediated the home was stabilized and prepared for NIOSH method 6009 clearance testing. The NIOSH testing occurred on August 9, 2002. The results, presented in Table 4, show that the health hazard has been abated and the home is free of harmful levels of mercury vapor.

Table 4. Results of NIOSH 6009 clearance testing in the Lee Street home conducted 8/9/02 (in ng/m³, DN= not detected, Report limit = 250 ng/m³)

Kitchen	ND
Hallway to kitchen	ND
Hallway to bedroom	ND
Bedroom (patient's)	ND
Field blanks (2)	ND

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 to the caller procedural guidance which includes information on addressing small or large spills; sample press releases; and sample letters to parents, patients, and employees. MDCH's response can include bringing in and coordinating the resources of other agencies such as the Agency for Toxic Substances and Disease Registry (ATSDR), the U.S. EPA Emergency Response Branch, and the Michigan-based Poison Control Centers. We can also give guidance on containing the spill, managing the clean up, and evaluating the need for biologic sampling of exposed and potentially exposed persons. We have assisted local health departments in drafting letters to home and business owners for insurance coverage after an event. MDCH also conducts field investigations to respond quickly to mercury spill incidents using its Lumex RA 915+ mercury vapor analyzer. The device enables field staff to locate sources of mercury in preparation for clean up; to facilitate evacuation decisions; and to clear living spaces, possessions, and materials that are not contaminated.

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

Chronic inhalation of high levels of elemental mercury can cause permanent neurological damage and kidney impairment. ATSDR recommends that breathing-zone mercury levels not exceed 1,000 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 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) of 26,000 ng/m³ in this study. 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 µg/m³ or 200 ng/m³. 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. The ATSDR recommended value for residential setting of less than 1000 ng/m³ is an action level that, if exceeded, would prompt the need for further clean up or other remedial action.

In the circumstances surrounding the Spectrum Home Care spill event, mercury was spilled in 4 locations. The persons identified as most likely to have been exposed were the seven residents of the contaminated home. Three children in the Lee Street home refused to have blood tests and had urine tests instead. Results of the tests are shown in Tables 3 and 4 below.

Table 3. Results of mercury blood tests in persons exposed in the Spectrum Health Care mercury spill incident, Warren and Southfield and Macomb County, Michigan, August 2001. (micrograms mercury per liter [µg/L], detection limit = 3µg/L; N.D. = not detected)

Subject	Age (yrs.)	Mercury (µg/L)
Resident 1	89	8.7
Resident 3	65	3.3
Resident 5	54	N.D.
Resident 7	57	4.3
Resident 8	36	N.D.
Resident 9	22	N.D.
Nurse	52	N.D.

Mercury blood tests results for unexposed adults and children are usually less than 2 ug/l. Three of the residents or visitors to the Lee Street home had blood levels higher than 2. MDCH recommended that the results be shared with the primary care physicians serving the family and invited of them to discuss them. On MDCH’s recommendation, the 89 year old patient’s daughter consulted with a doctor from the Poison Control Center at Children’s Hospital in Detroit regarding treatment options. They spoke and concurred that the termination of exposure was sufficient and a course of chelation was not indicated for the patient at the time.

Addressing the Unique Vulnerabilities of Children

Children may be at greater risk than are adults from certain kinds of exposure to hazardous substances at sites of environmental contamination. They engage in activities such as playing outdoors and 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 result 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 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 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 pass easily 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 (2).

As mentioned earlier, the three children present for the 4 days of potential exposure declined blood tests but agreed to urine tests. The results of their tests are in Table 4.

Table 4. Results of children’s urine tests following mercury exposure in the Spectrum Health Care spill incident, Southfield, Michigan, August 2001. (in micrograms mercury per liter [µg/L], detection limit = 10 µg/L; not detected = N.D.)

Subject	Age (yrs)	Mercury (µg/m³)
Resident 2	11	N.D.
Resident 4	9	N.D.
Resident 6	8	N.D.

Conclusions

The residential situation on Lee Street and the vehicle with a contaminated passenger seat (two of four discrete contaminated locations associated with this investigation) were both considered as Urgent Public Health Hazards at the time of the spill. However, currently these locations are categorized as posing no public health hazard since proper remediation and follow-up testing occurred.

Recommendations

MDCH made the following recommendations during the investigation:

1. Evacuate all residents of the Lee Street home as soon as possible.
2. Educate those involved in the spill event about mercury and answer any questions they may have.
3. Remove the contaminated passenger seat and carpet square from the affected vehicle.
4. Remove the carpet and clean beneath it in the contaminated area of the home-care office.
5. Package the broken thermometers and contaminated cloth sack for MDCH removal and disposal.
6. Lay out mildly contaminated items (billfold, stethoscope, black carry-bag etc.) in the sun and outdoor air to vaporize mercury from them.
7. Engage the services of an environmental contractor to characterize the contamination of the Lee Street home, remove contaminated material, and remediate the home for reoccupancy.
8. Assure that the home complies with ATSDR and MDCH residential clearance value of <1,000 ng/m³ with no source mercury present
9. Administer blood tests for mercury as soon as possible to all persons who spent more than a few hours in the highly contaminated structure and vehicle.
10. Make resources available to the patients and physicians to interpret and understand the results of the biological testing.

Public Health Action Plan

1. MDCH directed evacuation of the contaminated residence.
2. MDCH educated the home's residents and staff from the home care service about mercury toxicity, testing, and remediation.
3. MDCH performed preliminary screening of all suspected areas of contamination.
4. MDCH removed the remaining broken thermometers and carry-bag.
5. MDCH provided the home care service with the names and phone numbers of several environmental contractors who do mercury work in Michigan.
6. MDCH provided advice and oversight for the biologic sampling of exposed persons.
7. MDCH helped the nurse with residential clean-up activities and advice for ventilating vaporized mercury from her home.
8. MDCH consulted with the clean-up contractors regarding testing, clearance levels, and re-occupancy of the dwelling.
9. MDCH notified and briefed the Oakland and Macomb County Health Departments' Environmental Health representatives regarding activities within their counties. Because of scheduling conflicts, both counties had been unable to respond at the time of the event.
10. MDCH offered to consult with, or refer to medical resources, the persons who received results of their biologic sampling.
11. MDCH asked the home care service to complete a brief evaluation survey regarding their experiences during the event and the public health services they received.
12. No additional actions are planned for this event.

References

1. Agency for Toxic Substances and Disease Registry. Suggested action levels for indoor mercury vapors in homes or businesses with indoor gas regulators. Atlanta: US Department of Health and Human Services; 2000
2. Agency for Toxic Substances and Disease Registry. 1999. Toxicological profile for mercury, update. Atlanta: US Department of Health and Human Services; 1999. Report No.

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CERTIFICATION

This Spectrum Home Care Exposure Investigation 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, SPS, SSAB, DHAC, ATSDR

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

Chief, State Program Section, SSAB, DHAC, ATSDR