

Health Consultation

ELEMENTAL MERCURY CONTAMINATION
IN A WEST-CENTRAL WISCONSIN HOME

EPA FACILITY ID: WIN000510358

Prepared by
Wisconsin Department of Health Services

JULY 28, 2009

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.

You May Contact ATSDR Toll Free at
1-800-CDC-INFO

or

Visit our Home Page at: <http://www.atsdr.cdc.gov>

HEALTH CONSULTATION

ELEMENTAL MERCURY CONTAMINATION
IN A WEST-CENTRAL WISCONSIN HOME

EPA FACILITY ID: WIN000510358

Prepared By:

Wisconsin Department of Health Services
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Summary

In response to a request from a health care provider about a patient and husband with elevated mercury levels in blood and urine and related health symptoms, the Wisconsin Division of Public Health (DPH) investigated for mercury contamination in their west-central Wisconsin house. DPH inspected the house and tested for mercury vapors and found high mercury levels associated with adverse health effects. The U.S. Environmental Protection Agency (EPA) cleaned up elemental mercury at the affected house. DPH and the local county health department (CHD) are conducting follow-up indoor air screening of the house to ensure that mercury vapor levels continue to decrease and remain at safe levels. Air screening at several other locations did not find that mercury was inadvertently carried away from the affected house.

DPH has reached three conclusions in this health consultation report:

1. *DPH concludes that residents of the west-central Wisconsin house breathed high levels of mercury vapors, for possibly more than 1 year, and this may have harmed their health.* These exposures were confirmed by air testing, as well as elevated mercury levels measured in the resident's blood and urine. Breathing such levels of mercury vapor in indoor air over many months is associated with adverse health effects. As a result, the mercury vapor levels inside the house were unsafe for occupancy and posed a public health hazard. This assessment was the basis of the request for cleanup assistance from EPA. Residents should continue receiving medical care to address lingering symptoms and undergo bio-medical testing to ensure their mercury levels are decreasing.

Next Steps: No additional steps are needed by public health agencies to address this conclusion.

2. *DPH concludes that the EPA effectively cleaned up elemental mercury from the house and this resulted in it being safe for re-occupancy by the homeowners and their family.* Post cleanup air sampling in the house found a dramatic decrease in mercury vapor levels down to the ATSDR clearance level. While these mercury levels measured were slightly above the clearance level, the homeowner agreed to continue ventilation until levels stay below the clearance level.

Next Steps: Public health agencies will conduct additional rounds of air screening at the house to ensure mercury levels are consistently below the ATSDR clearance level. At the writing of this report 2 rounds of air screening have already been completed and these found that indoor air mercury levels continued to decrease and were below the action level. Once all 3 rounds of indoor air screening are completed, public health agencies will assess the results and consider whether any additional actions are needed.

3. *DPH concludes that elemental mercury was not accidentally spread to other locations and mercury is not a health concern.* Public health agencies screened for mercury vapors at several other locations visited by family members. Public health agencies found no evidence that mercury inadvertently carried away from the affected house.

Next Steps: No further air screening for mercury vapors is needed at these or any other off-site locations.

Background

On June 2, 2009, DPH was contacted by a physician about a 38 year-old female patient who was recently found to have elevated serum and urine mercury levels. On May 13, 2009, laboratory analysis of specimens found a serum mercury level of 111 µg/L (micrograms per liter) and a 24-hour urine mercury level of 1,325 µg/L. Both levels were described by the physician as “significantly elevated off normal levels.” Follow-up testing 3 weeks later, on June 2, 2009, found serum mercury at 44 µg/L in the patient, and 17 µg/L in her husband; both are above 10 µg/L, which is the upper end of the normal reference range for mercury in human blood. The physician also communicated with DPH that during the past year the patient has experienced a possible “coagulopathy bleeding disorder” and described a “constellation of atypical symptoms” that included “fatigue,” “migrainous type headaches,” “irascible mood,” “difficulty in concentration,” a “sense of gait imbalance,” and “unsteadiness” and “excessive bruising and bleeding.” The physician requested that DPH conduct an environmental assessment of the patient’s home to determine if there was a specific source of elemental or inorganic mercury in the home.

Initial Discussion With Patient/Homeowner

DPH staff contacted the patient/homeowner on June 3, 2009, to gather additional information and make arrangements for a visit by state and local public health agencies. During the phone conversation the homeowner reported she was not working and spends most of her time in the house, and where her activities include conducting long-distance, online training studies. The homeowner’s spouse is a 39 year-old male who works full-time and spends less time in the house. Also living with the homeowner is a 15 year-old son. When he is not at school he spends much time with friends at other locations near the home. A 19 year-old daughter moved away to college in September 2008, but has not returned home to visit. A 9 year-old daughter lives in another state with her father and does not typically visit except during summer months. The mother reported this daughter has not visited during 2009.

The homeowner and husband moved into the house in May 2003. The homeowner described an extensive fire that occurred at the house in March 2007, which she reported started inside of the former forced-air furnace (shortly before the fire the homeowner reported furnace was converted from propane to natural gas). Following extensive post-fire renovations, which included a complete replacement of the furnace and air ducts, in September 2007 the family moved back into the house. The homeowner stated that since moving back into the house there has occasionally been fine sooty particles appearing on indoor surfaces, but visitors have not described any noticeable odors. The homeowner was concerned earlier in 2009 about a possible mold issue in the home, and conducted extensive cleaning to mitigate any conditions that might allow mold to grow.

The homeowner reported that her health conditions and symptoms started appearing several months after moving back into the house in September 2007. She indicated there was a long

period of obtaining health advice and medical consultations which were unable to pinpoint the cause of her health problems. The homeowner said her husband has experienced some irritability issues, but she was not aware that he had any other unusual symptoms or health conditions. The homeowner added that prior to leaving for college 10 months earlier, her 19 year-old daughter was experiencing skin rashes, digestive problems, and mood shifts, and the daughter took several medications to address her health symptoms. Within five months of moving from the house the daughter's symptoms "went away" and the homeowner reported she stopped taking all medications.

Shortly before being medically tested for mercury in mid-May 2009, the homeowner reported removing an air filter from the forced air furnace and setting the filter on top of the nearby washing machine. When she lifted the air filter away the homeowner noticed many, very small, shiny beads evenly spread on top of the white enamel surface of the washing machine. For a short time the homeowner said she and her husband were fascinated with the physical characteristics of these unusual beads, and they touched and moved the beads about. However, when the novelty wore off they carefully collected the beads and put these into a small plastic bag. Once in the plastic bag the beads coalesced to approximately 1 milliliter of a silver liquid. The homeowner then inserted the filter into a plastic garbage bag and stored it in the garage, along with the bag of recovered beads. The homeowner said it was not until after consulting with others that she learned the recovered beads were likely elemental mercury. It was after that discovery that the homeowner said her family began rigorous ventilation of the house and drastically decreased the amount of time spent inside the house.

Site Visit

On the morning of June 10, 2009, staff from DPH, CHD, and Wisconsin Department of Natural Resource (DNR) visited the house. Staff met outside of the house with the homeowner and outlined the approach of the indoor air investigation. The house is in a community of approximately 600 residents, and is located in a west-central Wisconsin county. The house is on a frequently travelled street in a residential neighborhood, and the homeowner said the house was constructed in the 1940s. The house is situated a hill-side lot, with approximately 1,800 square feet of living space and has an attached garage. The kitchen, living room, and bedrooms are on the top main floor, with the basement floor comprised of a utility room, craft room, and 2-car garage at ground level of the exposed portion of the foundation.

At the request of DPH, starting the prior afternoon the homeowner closed all windows and the turned on the furnace/air conditioning to run and allow indoor air exchanges to represent typical cool weather indoor living conditions.

After meeting with the homeowner, DPH staff used Lumex – RA 915+ and Lumex – RA 915 *Light* portable mercury vapor meters to screen indoor air at the threshold of the three external entrances to the house. Staff opened the doors approximately 4 inches and found mercury vapor levels just inside all door thresholds that exceeded the 100 $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter) upper reporting limit of the meters. This level was well above the federal Agency for Toxic Substances & Disease Registry (ATSDR) residential relocation action level of 10.0 $\mu\text{g}/\text{m}^3$ (ATSDR 2000), and exceeded all established 8-hour occupational exposure guidelines (NIOSH

2007). Next, DPH staff donned appropriate personal protective clothing and respiratory equipment, and then entered the house. Staff placed air sampling equipment in the craft room (basement), the kitchen (main floor), and the master bedroom (main floor). Using portable calibrated pumps, air samples were drawn for approximately 30 minutes through glass tubes that contained Carulite[®] media. The samples were submitted on June 11, 2009, to the Wisconsin State Laboratory of Hygiene, Wisconsin Occupational Health Laboratory (WSLH/WOHL), and underwent analysis by WOHL in-house method WM007.2.1, which is based on NIOSH 6009. WSLH reported the results on June 12, 2009, and are summarized below in Table 1.

Table 1: Initial Indoor Air Mercury Levels
 West-Central Wisconsin Household
 June 10, 2009
 Concentrations in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)

| Sample Location | Mercury Vapor | Mercury Particulate | Total Mercury |
|------------------------------------|----------------------|----------------------------|----------------------|
| Craft Room - <i>basement</i> | 520 | <1.5 | 520 |
| Kitchen - <i>main floor</i> | 500 | 4 | 504 |
| Master Bedroom - <i>main floor</i> | 620 | 20 | 640 |

After DPH collected air samples on June 10, 2009, all windows were opened and indoor fans were turned on to ventilate the house and lower indoor air mercury levels. After ventilating the house for approximately 90 minutes, DPH staff screened indoor air and found mercury levels in basement rooms ranged between 35 and $>50 \mu\text{g}/\text{m}^3$, and between 16 and $29 \mu\text{g}/\text{m}^3$ in rooms on the main floor. The verification code for this document is 982657

At this time DPH staff also examined the furnace and a filter. Approximately 2 weeks before the site visit, the homeowner discovered mercury in the filter and installed a new air filter into the furnace. DPH staff removed the air filter that was installed 2 weeks before and placed it onto a black plastic sheet that was spread on the basement floor. The air filter was gently tapped and when the filter was lifted staff observed over 100 fine beads (the approximate diameter of fine-grained sand) of elemental mercury could be seen evenly spread across the sheet. Using a flashlight, staff were unable to discern any visible mercury beads inside and at the bottom of the furnace's narrow filter slot. DPH staff then carefully lifted and placed the air filter and plastic sheet inside of a black garbage bag, and also placed inside the bag the other air filter removed from the furnace 2 weeks earlier the homeowner found laden with mercury. Staff also placed inside this bag the smaller clear plastic bag in which the home owner placed elemental mercury collected from the first filter. This bag was sealed and marked as containing elemental mercury and contaminated filters. Staff also retrieved a new air filter from the home and placed it inside a clean plastic bag. After approximately 30 minutes staff screened the headspace of the plastic bag, which had only slightly elevated mercury levels ($0.9 \mu\text{g}/\text{m}^3$), which was likely due to residuals from being stored in a room with mercury levels at $48 \mu\text{g}/\text{m}^3$. This new air filter was then inserted into the furnace air filter slot.

Staff also screened for mercury in the air of the homeowner's two cars to assess if mercury had been tracked away from the home. One car had slightly elevated mercury levels (up to $0.2 \mu\text{g}/\text{m}^3$) possibly due to being removed that morning from inside of the attached garage. The second car had been away from the house since early that morning, but had much higher levels (15 to $24 \mu\text{g}/\text{m}^3$). Beads of elemental mercury were clearly visible beneath the driver's floor mat and sitting on top of carpet piling next to the driver's door.

Immediately following this on-site assessment, DPH and CHD staff met with the homeowner and husband and informed them that indoor air had very high levels of mercury vapors, which resulted in the house being unsafe for occupancy, and that these conditions posed a public health hazard. Staff discussed available options and the homeowners decided to request assistance from the EPA. In collaboration with the DNR, an On-Scene Coordinator (OSC) with EPA was contacted on the phone and agreed to assist the homeowners with identifying and cleaning up any sources and residuals of elemental mercury at the home. The EPA/OSC made arrangements with the homeowners to arrive at the home the following afternoon. While staff recommended that all family members temporarily move to an alternative location, the homeowner and her husband expressed a strong desire to stay in the house that night. Staff said this was acceptable only if children were not in the house, the adults stayed in a room that had the windows opened and was heavily ventilated, and the furnace/air conditioning system was not operating. Health staff urged the homeowners not drive the vehicle with visible mercury beads. CHD agreed to assist the homeowners with obtaining temporary housing until the house was cleaned up.

EPA Removal Action

On June 11, 2009, the EPA/OSC arrived and met with the homeowners and CHD staff. The homeowners were relocated to a nearby hotel for the next seven days while the EPA/OSC and EPA contractors identified and removed from the house sources of elemental mercury. Beads of elemental mercury were found and removed from the concrete basement floor, from inside of the furnace, and in the p-trap of an upstairs bathroom sink. Carpeting was removed from several rooms in the basement and main floor that were emitting unacceptable levels of mercury vapor. Carpeting and floor mats were also removed and disposed from the one affected vehicle. Non-fixed items, both porous and non-porous, were screened for mercury contamination, and were disposed when unacceptable levels were found. All clothing and porous items that were potentially contaminated with mercury vapor were collected from the house and placed into plastic bags. Bagged items were tested for potential contamination by screening the bag's headspace for mercury vapors. EPA screened 168 bags and 20 were disposed because mercury vapor levels in the headspace remained above $10 \mu\text{g}/\text{m}^3$, which is ATSDR's action level (2000) for the disposal of personal effects contaminated by elemental mercury. The EPA OSC estimated that 15 milliliters of elemental mercury was recovered from the house. Following these removal activities, all floors, non-porous furniture, and the washing machine were cleaned with a mercury amalgamating solution. The furnace blower and blower assembly was also replaced. Next the EPA OSC and contractors rigorously ventilated the house to bring mercury levels down to the ATSDR residential re-occupancy clearance level for mercury vapors of $1.0 \mu\text{g}/\text{m}^3$. After closing the house overnight to minimize outdoor/indoor air-exchanges and allow mercury vapors to reach a maximum level, air screening by the EPA/OSC and contractors with a Lumex – RA 915+ meter found indoor air levels were achieving this clearance level.

Post Clean-up Visits by Public Health

On June 16, 2009, DPH and CHD staff met with the EPA OSC and inspected the house, which had been closed since the prior day. Health staff screened indoor air with a Lumex – RA 915 *Light* meter and found levels slightly above the ATSDR clearance level. Staff also collected four indoor air samples (craft room, kitchen, master bedroom, and son’s room) and one outdoor air sample from the backyard, applying the same sampling protocols used on June 10, 2009. Air samples were drawn for at least 140 minutes to achieve lower detection limits. The samples were received June 17, 2009, by the WSLH/WOHL, and underwent analysis by WOHL in-house method WM007.2.1, which is based on NIOSH 6009. This laboratory data and indoor air screening results are summarized below in Table 2.

Table 2: Post-Mercury Removal Indoor Air Mercury Levels

West-Central Wisconsin Household

June 16, 2009

Concentrations in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)

| Sample Location | WSLH Analytical Data | | | Lumex – RA 915 |
|------------------------------------|----------------------|---------------------|---------------|---------------------------|
| | Mercury Vapor | Mercury Particulate | Total Mercury | Light Mercury Vapor Meter |
| Craft Room – <i>basement</i> | 3.3 | <0.30 | 3.3 | 2.3 |
| Kitchen - <i>main floor</i> | 1.9 | <0.28 | 1.9 | 1.9 |
| Master Bedroom - <i>main floor</i> | 1.7 | <0.30 | 1.7 | 1.6 |
| Son’s Bedroom - <i>main floor</i> | 2.3 | <0.32 | 2.3 | 2.0 |
| Outdoor – <i>backyard</i> | <0.35 | <0.35 | <0.35 | <0.2 |

Although the mercury levels found on June 16th were slightly above the ATSDR post-mercury spill residential clearance level of $1.0 \mu\text{g}/\text{m}^3$, DPH determined that the house was safe for re-occupancy if the homeowner agreed to continue rigorous ventilation until future rounds of air screening finds the indoor air mercury levels consistently remain below the ATSDR clearance level. DPH made this determination because closing the house represents worst case air-exchange conditions for the summer, and indoor conditions during the recommended rigorous ventilation would likely continue to decrease indoor air mercury levels well below the ATSDR clearance level. Taking into account the very high mercury levels that existed in the house prior to the EPA removal action, it could take time before mercury vapors are completely cleared from dead spaces (eg. in-between internal walls) and the residual levels in these spaces completely attenuate and reach equilibrium with the rest of the house. Follow-up indoor air screening conducted on June 23rd and July 7th by CHD staff indicated that mercury vapor levels inside of the house have continued to follow a downward trend, as indicated below in Table 3.

DPH recommended at least 1 additional round of follow-up indoor air screening for mercury vapors at the house. The next screening should be approximately 6 weeks following the July 7th screening. Once these 3 rounds of indoor air screening are conducted, public health agencies will assess the results and consider whether any additional follow-up is needed.

Table 3: Post-Mercury Removal and Follow-up Indoor Air Mercury Levels

West-Central Wisconsin Household

June 16, June 23, & July 7, 2009

Concentrations in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)

| Sample Location | Lumex – RA 915 Light Mercury Vapor Meter | | |
|------------------------------------|---|---------|--------|
| | June 16 | June 23 | July 7 |
| Craft Room – <i>basement</i> | 2.3 | 1.4 | 0.5 |
| Kitchen – <i>main floor</i> | 1.9 | 1.1 | 0.6 |
| Master Bedroom – <i>main floor</i> | 1.6 | 1.1 | 0.4 |
| Son’s Bedroom – <i>main floor</i> | 2.0 | 1.1 | 0.9 |
| Outdoor – <i>backyard</i> | <0.2 | <0.2 | <0.2 |

DPH recommended air screening at several other locations to ensure that mercury beads were not inadvertently carried away from the affected house. On June 23, DPH and CHD staff screened indoor air at the husband’s office. Air screening used the Lumex – RA 915 *Light* meter throughout the office and within at the husband’s workspace, and did not find any evidence of mercury vapors nor potential mercury contamination. DPH also recommended that air screening for mercury vapors is conducted at locations frequently visited by the 15 year-old son. On July 2nd, CHD screened the air in the car and at the residence of the son’s friend and also found no indication of potential mercury contamination.

Discussion

Elemental mercury vapors inside of the west-central Wisconsin house were at levels associated with adverse health effects, and these levels may have been present for one or more years. These conditions posed a public health hazard for occupants of the house.

When DPH first visited on June 10th, laboratory analysis of air samples from inside the west-central Wisconsin house found metallic mercury vapors ranging between 520 and 600 $\mu\text{g}/\text{m}^3$. It is possible that previously the occupants were exposed to even higher mercury levels in indoor air. Shortly after the homeowner and husband first observed elemental mercury inside of the house in early May 2009 and discovering had elevated mercury levels in blood and urine, the occupants began ventilating the house as much as possible on a daily basis. While all windows in the house were closed for approximately 18 hours prior to DPH collecting air samples on June 10th, rigorous daily ventilation since early May likely decreased the overall amount of mercury inside of the house, and affected the levels measured by DPH. Additionally, based on pooled analysis of mercury vapor and urine studies by Tsuji et al. (2003), the highest mercury level found in the homeowner’s urine (1,325 $\mu\text{g}/\text{L}$) appears to be consistent with exposure to mercury vapor levels above 1,000 $\mu\text{g}/\text{m}^3$. When the homeowner was next tested on June 2nd, her mercury blood level was 44 $\mu\text{g}/\text{L}$, a notable decrease from the 111 $\mu\text{g}/\text{L}$ that was measured 3 weeks earlier. This suggests the homeowner benefited from a decreased mercury exposure, both by spending less time inside the house and by implementation of a ventilation regime.

Bio-medical testing of the homeowner and her husband found mercury levels well above what is normally found in humans, which confirmed their mercury exposures. In May and June 2009, the homeowner's blood mercury levels were 111 and 44 $\mu\text{g/L}$, respectively, and her June urine mercury level was 1,325 $\mu\text{g/L}$, while her husband's June blood mercury level was measured at 17 $\mu\text{g/L}$. On July 17th the homeowner reported to DPH that since the EPA cleanup of the house, she and three family members underwent a round of bio-medical testing. Mercury blood levels were measured at 12 $\mu\text{g/L}$ for the homeowner, 7 $\mu\text{g/L}$ for her husband, 2 $\mu\text{g/L}$ for her 15 year-old son, and 1 $\mu\text{g/L}$ for her 19 year-old daughter. The mercury blood levels in the homeowner and husband have decreased substantially since early June, and the son and daughter's levels appeared to be normal. The mean background concentration of mercury in urine is 4 $\mu\text{g/L}$ and for whole blood is 8 $\mu\text{g/L}$ (ATSDR 1999).

The source of the elemental mercury in this west-central Wisconsin house has not been completely established, but could, in part, be associated with the older furnace that was removed following the house fire in March 2007. Mercury from the older furnace may have originated from a mercury flame sensor. Mercury has been used for many years in older household appliances, with as much as several milliliters of mercury reported to be found in residential furnace components (EPA 2001, NEWMOA 2009). It is possible that residential furnaces installed in 1940s had flame sensors with larger amounts of mercury. Such mercury devices in furnaces are being replaced by the use of electronic ignition systems. It should be noted the EPA OSC estimated that approximately 15 milliliters of elemental mercury was recovered from the home.

Toxicological Implications of Inhaling Mercury Vapors

When first visited by DPH, indoor air of the west-central Wisconsin house had metallic mercury vapors ranging between 520 and 600 $\mu\text{g/m}^3$. These levels were above both the ATSDR chronic inhalation Minimal Risk Level (MRL) of 0.2 $\mu\text{g/m}^3$ and the U.S. EPA Reference Concentration (RfC) of 0.3 $\mu\text{g/m}^3$. These levels were also well above LOAELs (Lowest Observed Adverse Effect Level) used to derive these comparison values. Both the MRL and RfC cited a study by Fawer et al (1983) that reported workers who were exposed for an average of 15.3 years to elemental mercury vapors at 26 $\mu\text{g/m}^3$ had with an increased frequency of mild "intention tremors." The EPA RfC was also based on a study of chloralkali workers with long term exposures to mercury vapors (Piikivi 1989). Using electroencephalography (EEG) to measure brain activity, Piikivi et al. found that workers exposed for average of 15.6 years to an estimated 25 $\mu\text{g/m}^3$ elemental mercury vapor had an increased number of EEG measured abnormalities and significantly slower and attenuated EEG measured brain activity than unexposed workers from a wood processing plant. Piikivi reported that exposed chloralkali workers had mean mercury blood level of 12 $\mu\text{g/L}$ and urine level of 20 $\mu\text{g/L}$.

Adverse health effects have been observed by studies of people from other settings who regularly inhaled mercury vapors at the levels measured in the west-central Wisconsin house. Some of the recent illness and symptoms reported for residents of the west-central Wisconsin house is not inconsistent with these other documented human cases. The central nervous system and kidneys are primary targets of metallic mercury toxicity, but a specific array of symptoms are not always consistently presented by humans, which can pose challenges with diagnosing mercury

poisoning. Cases of inhalation exposure to high mercury levels have presented a wide range of neurological effects, including fatigue, memory loss, “cognitive, personality, sensory, & motor disturbances” (ATSDR 1999).

The highest mercury levels measured in the homeowner’s blood and urine were 111 µg/L and 1,325 µg/L, respectively. Urine mercury levels ranging between 20 and 100 µg/L are associated with subtle neurological changes. The literature reports comparable mercury levels in a number of cases who had overt symptoms similar to the homeowner. For example, Yang et al. (1994) described a 29 year-old worker of a lamp-socket manufacturing facility who was exposed for 5 years to mercury vapor levels ranging between 225 and 945 µg/m³. The worker also had an initial urinary mercury level of 610 µg/L and a blood mercury level of 237 µg/L. This worker exhibited a variety of symptoms, including fatigue, irritability, tremors, and unsteady gait. The worker underwent chelation that resulted in a rapid improvement in gait and over a 4-month period completely recovered from all symptoms.

Neither DPH nor CHD staff have had the opportunity to interview or review medical information for the homeowner’s 19 year-old daughter. However, the mother described that one year earlier the daughter experienced skin rashes, digestive problems, and mood issues are also not inconsistent with an ongoing inhalation exposure to high mercury levels. Additionally, the reported disappearance of the daughter’s symptoms after moving from away from the house can be inferred as a possible result of halting her mercury inhalation exposures.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical and developmental differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe air closer to the ground that can have high levels of contaminated dust, soil, and vapors. A child’s lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If children are exposed to higher levels of contaminants during critical growth stages, their developing body systems can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children’s health.

Children who recently resided at the west-central Wisconsin house were exposed to elevated levels of mercury vapors. Young children are known to be particularly susceptible to the health effects caused by mercury exposures, and more prone to exhibiting such symptoms as acrodynia. Of the 3 children of the homeowner, only the 15 year-old son is living in the house, but the homeowner reports that the son often spends time with friends away from the house. However, the homeowner did not describe any specific symptoms or illnesses recently being experienced by their son. The homeowner reported her 19 year-old daughter experienced various symptoms prior to departing for college in September 2008, but she also reported that her daughter’s symptoms disappeared within a few months after being away from the house. While the 9 year-

old daughter has not recently visited the house, it is possible that this individual was also exposed to elevated mercury vapors when in the home. Due to uncertainties about the mercury exposures by the homeowner's children, DPH recommends that all family members be medically screened for mercury.

Conclusions

DPH has reached three conclusions in this health consultation report:

DPH concludes that residents of the west-central Wisconsin house breathed high levels of mercury vapors, for possibly more than 1 year, and this may have harmed their health. These exposures were confirmed by air testing, as well as elevated mercury levels measured in the resident's blood and urine. Breathing such levels of mercury vapor in indoor air over many months is associated with adverse health effects. As a result, the mercury vapor levels inside the house were unsafe for occupancy and posed a public health hazard.

DPH concludes that the EPA effectively cleaned up elemental mercury from the house and this resulted in it being safe for re-occupancy by the homeowners and their family. While mercury levels inside of the house immediately after the cleanup were slightly above the ATSDR clearance level, the homeowner agreed to continue ventilation until levels stay below the clearance level. Additional rounds of air screening at the house are needed to ensure mercury levels are consistently below the ATSDR clearance level.

DPH concludes that elemental mercury was not accidentally spread to other locations and mercury is not a health concern. Screening for mercury vapors was conducted at several other locations visited by family members and found no evidence that mercury inadvertently carried away from the affected house. No further air screening for mercury is needed at these or any other off-site locations.

Recommendations

In follow-up to the EPA-led cleanup of unsafe levels of elemental mercury from the west-central Wisconsin house, DPH made the following recommendations for resolution of this case:

- DPH recommends at least 3 rounds of follow-up indoor air screening for mercury vapors are conducted at the west-central Wisconsin house to ensure the house remains safe for residents. At the writing of this report 2 sampling rounds have already been completed and these found that indoor air mercury levels continue to decrease. Once all 3 rounds of indoor air screening are completed, public health agencies will assess the results and consider whether any additional actions are needed.
- DPH recommends that all members of the west-central Wisconsin household should continue seeking care from health care providers who specialize in mercury poisoning. They should also continue being tested for mercury in their blood and/or urine to ensure

that their mercury levels are decreasing. Follow-up testing in July shows that blood mercury levels are decreasing for the homeowner and her family.

Public Health Action Plan

The public health action plan (PHAP) identifies actions that have been or will be taken by public health agencies for the west-central Wisconsin house contaminated with elemental mercury. The PHAP ensures that public health hazards have been identified and that a plan of action is established to halt or prevent unsafe exposures to hazardous substances in the environment.

Actions that have been taken by agencies for this case include:

- DPH was requested by a health care provider to assess the west-central Wisconsin house of a patient who had elevated mercury levels in blood and urine.
- DPH investigated the west-central Wisconsin house and found clear evidence of mercury contamination.
- In response to a request from DPH and DNR, EPA conducted a time-critical removal action that cleaned up the house and made it safe for re-occupancy.
- DPH and CHD investigated other places visited by the occupants and did not find any indication that mercury was accidentally carried away from the house.

Current and future actions to be implemented by agencies are:

- DPH and CHD are conducting follow-up indoor air screening to ensure that mercury vapor levels in indoor air of the house continues to decrease. Once air screening is completed, agencies will assess whether any additional actions are needed.
- DPH will continue assisting DNR and CHD to address environmental health issues related to this mercury incident.

Authors, Technical Advisors

Henry Nehls-Lowe, MPH
Epidemiologist
Bureau of Environmental Health
Division of Public Health
Wisconsin Department of Health Services

ATSDR Regional Representative
Mark Johnson
Division of Regional Operations, Region V
ATSDR

ATSDR Technical Project Officer
Jennifer Freed
Superfund Program Assessment Branch
Division of Health Assessment and Consultation
ATSDR

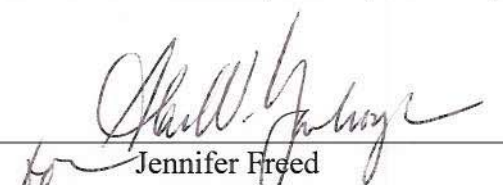
References

- Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological Profile for Mercury, Update. Atlanta, GA: U.S. Public Health Service, Department of Health and Human Services. Available at URL: www.atsdr.cdc.gov/toxprofiles/tp46.html
- ATSDR. 2000. Suggested Action Levels for Indoor Mercury Vapors in Homes or Businesses with Indoor Gas Regulators. Atlanta, GA: US Public Health Service, Department of Health and Human Services.
- Fawer RF, DeRibaupierre U, Guillemin MP, Berode M and LobeM. 1983. Measurement of Hand Tremor Induced by Industrial Exposure to Metallic Mercury. *Br J Ind Med*, 40: 204-208.
- National Institute for Occupational Health & Safety. September 2007. NIOSH Pocket Guide to Chemical Hazards. DHHS Publication No. 2005-149. Atlanta, GA: Centers for Disease Control and Prevention, Department of Health and Human Services. Available at URL: www.cdc.gov/niosh/npg/pdfs/2005-149.pdf
- Northeast Waste Management Official's Association. May 2009. Mercury Legacy Products, Appliances/Household Products. Available at URL: www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#gf.
- Piikivi L and Tolonen U. 1989. EEG Findings In Chlor-Alkali Workers Subjected To Low Long Term Exposure To Mercury Vapour. *Br J Ind Med*, 46: 370-375.
- Tsuji JS, Williams PRD, Edwards MR, Allamneni KP, Welsh MA, Paustenbach DJ, and Sheeran PJ. April 2003. Evaluation of Mercury Urine as an Indicator of Exposure to Low Levels of Mercury Vapor. *Env Hlth Persp*, 111(4): 623-630.
- U.S. Environmental Protection Agency (EPA), Region 5 Office. August 2001. Mercury Switches in Appliances: Final Report. Available at URL: www.epa.gov/region5/air/mercury/appliancereport.html
- EPA. 2009. Integrated Risk Information System. Elemental Mercury. Available at URL: www.epa.gov/ncea/iris/subst/0370.htm.



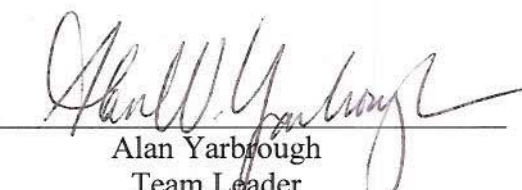
CERTIFICATION

This Health Consultation for the Elemental Mercury Contamination in a West-Central Wisconsin Home was prepared by the Wisconsin Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the Health Consultation was begun. Editorial review was completed by the Cooperative Agreement partner.



Jennifer Freed
Technical Project Officer
CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this Health Consultation and concurs with the findings.



Alan Yarbrough
Team Leader
CAT, CAPEB, DHAC, ATSDR