Health Consultation

STATE OF KENTUCKY

MERCURY CONTAMINATION IN INDOOR AIR

VILLA HILLS, KENTON COUNTY, KENTUCKY

MARCH 15, 2005

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

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Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Statement of Issues

On March 8, 2005, the Agency for Toxic Substances and Disease Registry (ATSDR) received a request from the U.S. Environmental Protection Agency (EPA) to evaluate mercury vapor levels detected in a home in Villa Hills, Kenton County, Kentucky. The site owners reported to EPA that mercury vials had been in the home for about 8 to 10 years. Based on air monitoring performed by EPA, it is suspected that those playing with the vials had contaminated some areas of the home with mercury.

EPA asked ATSDR to

- *evaluate the public health significance of exposures to indoor mercury vapor air concentrations within this home, and*
- *determine whether a clean-up goal of 0.3 microgram per cubic meter (µg/m^3) of mercury vapor in this home's indoor air would be protective of public health.*

Background

On March 4, 2005, EPA monitored mercury vapor throughout the Villa Hills home (Table 1). To protect the monitoring equipment, EPA stopped monitoring specific areas of the home when a mercury vapor concentration of 50 µg/m^3 was reached. In three instances (in the upstairs vacuum cleaner, in the downstairs vacuum cleaner, and under the blankets of the bottom bunk in bedroom #3), mercury vapor monitoring was stopped at 50 µg/m^3. Therefore, the maximum concentration of mercury vapor is unknown. Many areas in the home had levels greater than 20 µg/m^3.

Mercury vapor concentrations in all indoor air samples collected from this home exceeded both ATSDR's chronic environmental media evaluation guide (EMEG) of 0.2 µg/m^3 and EPA's inhalation reference concentration (RfC) of 0.3 µg/m^3. In many of the samples, particularly those obtained in the bedrooms, the mercury vapor levels exceeded the ATSDR and EPA comparison values by more than two orders of magnitude (that is, by 100 times or more). Furthermore, it is likely that mercury vapor concentrations have been above the maximum reported concentration of 50 µg/m^3.

EPA reported that up to nine people live in the home, including two children <6 years of age, one child 12 years of age, one child 15 years of age, two adults, and grandparents.

Discussion

Suspected spills of metallic mercury in this home have resulted in exposure to mercury vapors in indoor air. Very small amounts of metallic mercury (for example, a few drops) can raise air concentrations of mercury vapor to levels that can be harmful to health. When people breathe in mercury vapors, about 80% of the mercury enters the bloodstream directly from the lungs. The

mercury then travels rapidly to other parts of the body, including the brain and kidneys. Once in the body, mercury can be retained for weeks or months (ATSDR 1999).

Mercury vapors can affect many different areas of the brain and their associated functions. This can result in a variety of symptoms, including personality changes (irritability, shyness, and nervousness), tremors, changes in vision (constriction [or narrowing] of the visual field), deafness, muscular incoordination, loss of sensation, and difficulties with memory (ATSDR 1999). The kidneys also are sensitive to the effects of mercury, because mercury accumulates in the kidneys.

Short-term exposure (hours) to high levels of metallic mercury vapor in the air can damage the lining of the mouth and irritate the lungs and airways, causing tightness of the chest, a burning sensation in the lungs, and coughing. Other effects from exposure to high levels of mercury vapor include nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. Damage to the lining of the mouth and lungs can also occur from exposure to lower levels of mercury vapor over longer periods (years). Skin contact with metallic mercury can cause an allergic reaction (skin rashes) in some people. Studies of workers who had been exposed previously to metallic mercury vapors have not shown a mercury-related increase in cancer (ATSDR 1999).

ATSDR's chronic mercury EMEG and EPA's mercury inhalation RfC are based on a lowest-observed-adverse-effect-level (LOAEL) in healthy workers who have been chronically exposed. Healthy workers exposed to mercury vapor air concentrations of about 26 $\mu g/m^3$, 8 hours a day, 5 days a week, for several years experienced adverse health effects, including hand tremors and increases in memory disturbance. The adjusted LOAEL accounting for continuous exposures 24 hours a day, 7 days a week, for years is 6.2 $\mu g/m^3$.

People living in this home are exposed to mercury vapor in the air. In addition, they may have touched and ingested mercury. It is unknown when the release(s) of mercury contaminated the home, but the site owners reported to EPA that the vials had been in the home for about 8 to 10 years. Concentrations measured on March 4, 2005, were above the LOAEL for mercury. It is not known for how long (days, months, or years) and to what concentration (possibly >50 $\mu g/m^3$) the people living in this home have been exposed to the mercury. Assuming that the levels measured during the March sampling event are representative of ongoing exposures in this home, a public health threat exists.

Furthermore, mercury and its vapors are extremely difficult to remove from clothes, furniture, carpet, floors, walls, and other such items. If these items are not cleaned properly, the mercury can remain for months or years and continue to be a source of exposure. EPA proposed a clean-up goal of 0.3 $\mu g/m^3$ in indoor air, which is equal to the mercury inhalation RfC. To ensure that the mercury RfC protects even the most sensitive populations (such as children and the elderly), it was intentionally designed to be much lower than the LOAEL for mercury vapor, which was based on the neurotoxicity of chronic exposure in workers. EPA also considers that the RfC is adequate to protect children from being at risk for acrodynia (also known as pink disease) (EPA

2002). ATSDR concurs that a mercury vapor clean-up goal of 0.3 µg/m^3 in the home's indoor air is protective of public health.

Child Health Considerations

Children could be at greater risk than adults are after certain kinds of exposure to hazardous substances. A child's lower body weight results in a greater dose of hazardous substance per unit of body weight. Children also are more active and have higher heart and respiratory rates, causing them to have higher peak and mean exposures. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage.

Mercury levels in this home pose a public health threat to the children. This determination is based on several factors. First, the duration of exposure is unknown and may have been years. Second, the levels of mercury vapor detected in air in this home (most likely >50 µg/m^3) are above levels known to result in adverse health effects in healthy workers who have been chronically exposed. Third, mercury vapor is heavier than air resulting in higher concentrations near the floor, which is close to the breathing zone of children <6 years of age. Fourth, the developing body systems of children are at greater risk than adults for adverse health effects.

Conclusions

EPA asked ATSDR *to evaluate the public health significance of exposures to indoor mercury vapor air concentrations within this home.* ATSDR evaluated the mercury vapor levels detected in this home's indoor air with consideration of the available data on levels known to cause adverse health effects. ATSDR concludes that people living within this home are exposed to mercury vapor at concentrations that pose a public health hazard to children and adults.

EPA also asked ATSDR *to determine whether a clean-up goal of 0.3 µg/m^3 of mercury vapor in this home's indoor air would be protective of public health.* ATSDR concludes that setting the clean-up goal for indoor mercury vapor levels at 0.3 µg/m^3 protects public health.

Recommendations

ATSDR recommends the following actions:

1. Clean or dispose of all mercury-contaminated items within the home.
2. Monitor the indoor air for mercury vapor, working towards a goal[1] of 0.3 µg/m^3 before allowing the occupants to move back into the home. Monitoring should be done when the home is heated and measurements should be taken in the breathing zone of a child 3 years of age. Monitoring should also include areas near the floor where young children might play, particularly in their bedrooms and play areas.

[1] A clean-up goal of 0.3 µg/m^3 is recommended, with individual measurements no greater than 1 µg/m^3.

3. Monitor the indoor air for mercury vapor 3–6 months after reoccupation of the home as a follow-up to ensure mercury vapors remain below levels of health concern.

Public Health Action Plan

The purpose of the public health action plan is to ensure that this evaluation not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. EPA will work with the homeowners to ensure the home is cleaned to a safe level before reoccupation.

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[ATSDR] Agency for Toxic Substances and Disease Registry. 1999. Toxicological profile for mercury. Atlanta: US Department of Health and Human Services.

[EPA] Environmental Protection Agency. 2002. Integrated risk information system database. Mercury. File last revised on December 3, 2002. URL: http://www.epa.gov/iris/subst/0370.htm

Table 1: Mercury Screening Results in Indoor Air* — Villa Hills, Kenton County, Kentucky

Location	Description	Result (μg/m3))
UPSTAIRS		
Entryway, inside the front door	Breathing zone	0.6
Upper stairway	Breathing zone	0.7
Top of stairway	Breathing zone	9.7
Middle of the living room	Breathing zone	11.2
Pool room	Breathing zone	11.1
Hallway, toward the bedrooms	Breathing zone	21.2
Bedroom #3	Breathing zone	26.8
Bedroom #2	Breathing zone	21.6
Bedroom #1	Breathing zone	8.9
Hallway outside bedroom #1	Breathing zone	11.3
Kitchen	Breathing zone	10.8
Refrigerator	Top of the refrigerator	10.7
Vacuum	Inside hose	50.0
Hallway	Floor	25.0
Bedroom #3	Floor (near the baseboards)	40.0
Bedroom #3	Top bunk under the blankets	45.0
Bedroom #3	Top bunk under the pillows	32.5
Bedroom #3	Bottom bunk under the blankets	50.0
Bedroom #3	Bottom bunk under the pillows	31.0
Bedroom #3	Closet	30.8
Bedroom #3	Pile of clothes on the floor	32.0
Bedroom #2	Bed under the blankets	23.8
Linen closet	Breathing zone	37.0
Coat closet (without vacuum)	Breathing zone	21.9
DOWNSTAIRS		
Hallway at bottom of the stairs	Breathing zone	2.7
Room, at the doorway	Breathing zone	4.2
Room, in the middle of the room	Breathing zone	3.8
Room	Breathing zone	2.1
Kitchen	Breathing zone	1.8
Laundry room	Breathing zone	2.2
Washing machine	Inside the washer	1.1
Dryer	Inside the dryer	0.8
Furnace filter	Near the filter	2.1
Living room	Breathing zone	2.5
Vacuum	Inside the hose	50.0
Junk room	Breathing zone	1.5

*The U.S. Environmental Protection Agency obtained these sampling results on March 4, 2005.
$\mu g/m^3$ = micrograms per cubic meter.