United States Environmental Protection Agency

Actions taken to reduce ambient Mn concentrations

Ohio EPA has identified the S.H. Bell facilities as the source of airborne Mn in East Liverpool. S.H. Bell made a number of changes to operations to control Mn emissions resulting from the 2008 findings and orders from Ohio EPA. Some of these changes include:

- keeping dust down;
- enclosing parts of its operations; and
- covering trucks leaving the facilities;

Airborne Mn levels remained at unacceptable levels after the projects were completed. Ohio EPA determined that S.H. Bell needed to do more to control Mn dust. On February 8, 2010, Ohio EPA issued another set of findings and orders. These require S.H. Bell to:

- do more to keep dust down,
- stop handling Mn at the facility near East Elementary School;
- keep Mn out of the air by keeping it out of open air storage and loading areas; and
- Record efforts to reduce dust emissions in detail.

Ohio EPA believes enforcing these steps will keep the airborne Mn concentrations significantly below the levels observed prior to these enforcement actions.

US EPA and Ohio EPA are committed to ensuring continued oversight of S.H. Bell, continued compliance with the Clean Air Act, Ohio Laws and regulations, the Findings and Orders, and continued ambient air monitoring.

Next Steps

The findings outlined on this fact sheet are preliminary and portions have not been fully peer reviewed (most EPA scientific and technical work products must receive appropriate levels of peer review by independent scientific and technical experts). Ongoing data analysis may revise the conclusions slightly and additional research may be necessary. A website has been established that will provide a copy of the slides and fact sheet provided here today. The website will be updated with any new findings and publications.
Go to: http://www.epa.gov/nheerl/mnstudy

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Preliminary Results

Health Study of Airborne Manganese Exposure in East Liverpool, Marietta and Mt. Vernon, Ohio

Purpose

Workplace studies of occupations such as mining and welding have shown that inhaling high levels of manganese (Mn) can lead to nervous system health effects. Few studies have been done on the health effects of airborne Mn exposure in community settings on adults. The main purpose of this study was to evaluate whether nervous system health effects (neurotoxicity) were detectable in community residents with long-term, airborne Mn exposure.

Summary of Preliminary Results

- East Liverpool and Marietta have elevated Mn air concentrations, but health effects potentially consistent with Mn exposure were fewer and more subtle than in worker studies with much higher exposures.
- Results suggest that living closer to the Mn source for a longer time (more Mn air exposure) was associated with borderline to mild tremors and slightly lower motor speed and strength.

Background

In February 2008, the Ohio EPA completed an air quality study in East Liverpool that indicated residents were at risk from exposures to airborne Mn and chromium. Ohio EPA identified the S.H. Bell Company, a raw products storage and packaging facility, as the source of Mn and chromium sampled in community air monitors. The Director of the Ohio EPA requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate potential health impacts.

In November 2010, ATSDR completed a Health Consultation that concluded that the levels of airborne Mn in East Liverpool exceeded background levels and health-based guidelines. ATSDR stated that exposure to Mn concentrations in East Liverpool poses a public health hazard.

Approach

In August 2009, a Mn health study was conducted by San Francisco State University in Marietta (a community near a smelter emitting Mn) and Mount Vernon (a community without a large airborne Mn source), Ohio. The East Liverpool study in November 2011 followed a similar protocol so that data from all three communities could be compared.

Researchers randomly selected (when possible) adults in each of the three communities between the ages of 30-75.They collected data from the study participants including a general health questionnaire, blood test, neurological and mood assessments, and neuropsychological tests.

Blood Tests

Researchers analyzed blood for heavy metals including levels of Mn, cadmium, lead and mercury, and of serum ferritin – an indicator of iron stored in the body.

Neurological Assessments, Neuropsychological Tests, and Mood

Researchers used a battery of assessment tools to measure cognitive flexibility (switching categories), information processing, working memory and attention, visual tracking speed, verbal skills, motor dexterity and strength, postural sway and tremors. Each of these test results yield important information about the brain function of study participants that can be used to evaluate the potential impact of Mn exposure.

Air Modeling

An EPA air dispersion model and measurements of Mn air concentrations at several fixed locations estimated the concentration of Mn in air outside the homes of study participants. These estimates, along with the distance from the source and the years of residency were used to calculate an "exposure index" for each resident. This exposure index helped estimate inhalation exposure to airborne Mn.

Preliminary Results

No statistical differences were noted between residents of East Liverpool, Marietta and Mount Vernon communities for:

- General health categories (e.g., number of good, bad health days per month, smoking status, obesity, etc.)
- Amount of Mn consumed in diet (Mn is an essential nutrient and is found in many leafy green vegetables and beans)
- Blood Mn levels – the average blood Mn level in the general population ranges between 4-15 µg/L . The following average blood Mn levels were detected:
  - East Liverpool = 10.32 µg/L
  - Marietta = 9.65 µg/L
  - Mount Vernon = 9.48 µg/L
- Blood lead and serum ferritin levels

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- Neurological assessment testing: Activities of Daily Living (the things we normally do to care for ourselves, such as eating, bathing, dressing, grooming, work, etc.) and motor (movement) scores
- Neuropsychological tests: tests of attention and memory tests
- Mood tests: mood disturbance (depression, bipolar disorder, etc.)

Statistical differences were noted between the three communities for:

- ***Blood:*** East Liverpool residents had higher average blood cadmium levels than Mount Vernon residents, but they were still within the normal range found in the general population. East Liverpool residents had lower blood mercury levels than Marietta residents.
- ***Neurological assessment:***
  - East Liverpool residents showed slower movement initiation (results in delays in onset of movement) than Mount Vernon residents, but were slightly better than Marietta residents.
  - More hand tremors (involuntary shaking) were observed in East Liverpool residents than Marietta residents.
  - East Liverpool residents had more postural sway/instability (involuntary swaying or instability when standing on both feet) than Marietta and Mount Vernon
- ***Neuropsychological tests:***
  - Scores in all three communities were within normal range, except for divided memory, visual memory, and motor speed.
  - East Liverpool residents had lower scores for immediate memory (daily living) than Marietta
  - East Liverpool residents had lower scores than Marietta and Mount Vernon for word reading, motor speed, motor strength and motor tactile.

Exposure Index

The combined data from East Liverpool and Marietta showed that having a higher exposure index was related to lower neuropsychological and motor performance. Living a shorter distance from a manganese source was also associated with neuropsychological and motor performance. The strongest effects were seen for tremor, motor speed, and motor strength.

Conclusions

- Both East Liverpool and Marietta had significant airborne Mn exposures, but health effects potentially due to Mn exposure were fewer and more subtle than in occupational (worker) studies with much higher exposures.
- An association between low test scores, distance from the Mn source, and exposure index (combining East Liverpool and Marietta), suggests that living closest to the Mn source results in higher inhalation exposure and lower neuropsychological performance. East Liverpool residents lived closer to the Mn source than Marietta residents, which may have lead to higher Mn exposures that correlate with lower motor speed and strength in these study participants.