# Heavy Metals Surveillance in Michigan Residents: First Annual Report (October 2005 – December 2006)

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A Joint Report of

**Michigan Department of Community Health**

and

**Michigan State University**

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## Executive Summary – Michigan Heavy Metals Surveillance Project 2006 Annual Report

- In September 2005, MDCH promulgated rules requiring laboratories to report clinical laboratory results of all arsenic, cadmium, and mercury tests in blood and urine.
- The reporting requirement was established so that MDCH could improve on the tracking and mitigation of human health impacts of environmental and occupational exposures to these heavy metals.
- MDCH collaborated with the Michigan State University Division of Occupational and Environmental Medicine (MSU OEM) to establish action thresholds for conducting public health follow-up.
- Individuals with results exceeding these action thresholds are contacted by MSU or MDCH to determine the source of exposure to the metal and assess if public health interventions are warranted.
- The reporting period for the 2006 annual report spans 10/25/2005 through 12/31/2006.
- 15,755 total reports were received during the reporting period.
- 381 individuals had a result that exceeded one of the established action thresholds (377 adults and 4 children under the age of 16).
- Follow-up has identified an occupational cluster of individuals with elevated mercury levels who were exposed to air levels of mercury above the allowable workplace standard.
- Most elevated arsenic or mercury levels were associated with fish consumption. Individuals with an elevated mercury level were provided with information regarding healthy fish consumption.
- The high percentage of normal results has raised the concern about the indications for ordering these tests.
- Laboratory reporting and individual follow-up are continuing in 2007.

## Background

In September 2005, the Michigan Department of Community Health (MDCH) promulgated rules requiring clinical laboratories to report all clinical test results of arsenic, cadmium, and mercury in blood and urine, under the statutory authority of the Public Health Code (Appendix 1). Like other public health surveillance systems, the system built on this reporting requirement includes collection of sufficient information about tested individuals and their health care providers to conduct follow-up to identify the source of exposure, which then triggers public health actions to mitigate exposures to others, if appropriate. The reporting requirement was established so that MDCH could improve on the tracking and mitigation of human health impacts of environmental and occupational exposures to these heavy metals, including exposures from intentional acts. Appendices 2-4 contain two-page summaries of the health effects of arsenic, cadmium and mercury prepared by the Agency for Toxic Substances and Disease Registry (ATSDR)[1].

The reporting rule went into effect on September 23, 2005 and outreach to laboratories began in October. Major hospitals and reference laboratories were identified and letters were sent to laboratory directors notifying them of the change in the reporting rules. All of the laboratories are familiar with state reporting requirements and most of them currently participate in reporting of lead results to the state Childhood Lead Poisoning Prevention Program. Because of this existing reporting system for lead, the Heavy Metals Reporting Project data structure was modeled similarly to that utilized by the lead program.

Laboratories were asked to submit all arsenic, cadmium, and mercury blood and urine results for tests performed on Michigan residents. These results could be reported using form DCH-1282, a standard laboratory report form, or submitted electronically. The first reports were received in mid-October and laboratories continued to be added to the system through June 2006. As a result, the 2006 reporting year contains data on tests performed from 10/03/2005-12/31/2006. Because laboratories were still being added to the system throughout the beginning of 2006, not all laboratories reported a full year of data for 2006. This report is a summary of the reporting period 10/03/2005-12/31/2006.

## Registry Information

Initial recruitment efforts were targeted at hospital laboratories and commercial laboratories. As hospitals began to call and inquire about the reporting rule, it became apparent that these facilities were collecting blood and urine samples from individuals and then sending out the samples to be tested by one of the larger commercial laboratories. Laboratories recruited initially and through follow-up activities include: ARUP, Lab Corp of America, Mayo Medical Laboratories, Quest Diagnostics Incorporated, South Bend Medical Foundation, and Specialty Laboratories.

Data elements to be reported include personal identifiers, demographics, laboratory and ordering provider contact information, and clinical test results (see Appendix 1). Form DCH-1282 provides the variable information named in the metals reporting rule. This form was utilized initially by some laboratories to submit the required information via mail or fax. Most laboratories expressed interest in submitting some form of electronic report. Variable specifications were provided to those laboratories for use in constructing the format of their electronic reports. Test submissions were sent and approved before actual results were reported. Electronic reports are submitted using encrypted files, secure file exchange websites, secure file transfer protocol over secure connection directly to MDCH, or HL7

[1] ATSDR, Division of Toxicology and Environmental Medicine ToxFAQs, Arsenic, September 2005: http://www.atsdr.cdc.gov/tfacts2.pdf
ATSDR, Division of Toxicology and Environmental Medicine ToxFAQs, Cadmium, June 1999: http://www.atsdr.cdc.gov/tfacts5.pdf
ATSDR, Division of Toxicology and Environmental Medicine ToxFAQs, Mercury, April 1999: http://www.atsdr.cdc.gov/tfacts46.pdf

messaging. HL7 messaging capabilities are currently under development at MDCH and more laboratories will be encouraged to submit electronic messages in this format as the capacity increases.

Reports are submitted to MDCH at a minimum of once per week. These reports are compiled into a central spreadsheet and the data is cleaned to ensure the files match the variable specifications. Every month the data are sorted by date of birth and test type. All reports for Michigan residents age 16 and older are submitted to the Michigan State University Division of Occupational and Environmental Medicine (MSU OEM). Under a data sharing agreement, MSU OEM is the bona fide agent of the state for public health follow-up of adult heavy metals surveillance reports. All reports for child residents are handled by MDCH.

Processed reports are triaged as normal or elevated according to the following action thresholds. These thresholds were developed in consultation with the MSU OEM. Thresholds are based on the following:

- The arsenic urine action threshold for adults corresponds to the time weighted average air exposure to arsenic allowed by the Michigan Occupational Safety and Health Administration (MIOSHA) and is also the biologic exposure index (BEI) level established by the American Conference of Industrial Hygienists.
- The arsenic urine action threshold for children is the value recommended in CDC's Case Definitions for Chemical Poisoning[2].
- The arsenic blood action threshold for adults and children corresponds to the value cited by ATSDR for use by primary care practitioners[3].
- The cadmium blood and urine action thresholds are based on requirements by MIOSHA for medical surveillance of workers with occupational cadmium exposure.
- Mercury blood and urine action thresholds have been established by the American Conference of Industrial Hygienists. These thresholds are BEIs intended for the evaluation of occupational exposures in workers.
- The mercury blood and urine action thresholds for children are the values recommended in CDC's Case Definitions for Chemical Poisoning[2].

**Table 1.** Action thresholds identified for follow-up by test and specimen type.

| Test Type | Specimen Type | Elevated |
|---|---|---|
| Arsenic | Blood | >70 µg/L |
| | Urine – adults | ≥35 µg/L |
| | Urine – children | ≥50 µg/L |
| Cadmium | Blood | >5 µg/L |
| | Urine | >2 µg/L or >3 µg/g creatinine |
| Mercury | Blood – adults | ≥15 µg/L |
| | Blood – children | >10 µg/L |
| | Urine – adults | >20 µg/L or >35 µg/g creatinine |
| | Urine – children | >10 µg/L |

MSU EOM conducts initial follow-up with adults, aged 16 and over. MDCH initiates follow-up with the families of children under 16 years of age, for reports exceeding action thresholds.

Individuals with test values that are at or above the action threshold are sent a letter. For children, the letter is sent to a parent or guardian. Contact information and a best time to call are established so that a metal-specific standardized questionnaire can be administered via telephone interview. Information collected during the interviews includes potential sources of environmental or occupational exposures. Health information is provided to the patient or family about limiting potential exposures. Exposures are also evaluated to determine if additional public health or occupational safety and health measures are warranted to prevent or reduce exposure to other individuals.

Summaries of the registry data and follow-up activities are being published for the first time in this annual report. Print copies of this report are distributed to partner agencies and electronic copies are available on the MDCH website: http://michigan.gov/mdch-toxic.

[2] Belson MG, Schier JG, and Patel MM. 2005. Case Definitions for Chemical Poisoning. MMWR 54(RR01);1-24 .
[3] Agency for Toxic Substances and Disease Registry. 2000. Case Studies in Environmental Medicine: Volume 1 – Arsenic Toxicity. Atlanta: US Department of Health and Human Services.

## Results

Statistics are presented summarizing all the reports and statistics by test type and specimen type for unique individuals.

Between October 1, 2005 and December 31, 2006, MDCH received 15,755 total lab result reports into the Heavy Metals Surveillance Project. These reports were submitted from the laboratories listed in Table 2.

**Table 2.** Distribution of reports across submitting laboratories in 2006 (n=15755).

| **Laboratory Name** | **n(%)** |
|---|---|
| ARUP | 2146 (13.6) |
| Lab Corp of America / LabCorp Dublin | 395 (2.5) |
| Marquette General Health System | 57 (0.4) |
| Mayo Medical Laboratories | 201 (1.3) |
| Quest Diagnostics Incorporated | 1953 (12.4) |
| SBMF | 64 (0.4) |
| Specialty Laboratories, Inc. | 2972 (18.9) |
| Not Recorded (Explanation below) | 7967 (50.5) |
| Total | 15755 (100.0) |

Over 8000 paper reports were received in the 2006 reporting year which created an unexpected backlog in data entry. Paper report entry was prioritized so that those reports above the action threshold were entered immediately and those under the action threshold were entered in the order they were received, as time permitted. In order to complete the data entry for reports below the action threshold, a decision was made to enter a core set of data limited to: Record ID, Patient Last Name, Patient First Name, Patient Date of Birth, Patient Zip Code, Provider Last Name, Provider First Name, Test Type, Specimen Type, Result Value and Result Units. Because of this decision a majority of the lab reports submitted on paper did not have laboratory name entered as shown by the 50.5% of the laboratory reports in Table 2 with laboratory name not recorded.

The distribution of gender is shown in Table 3. For the same reason, a majority of the records (53.8%) had missing or unknown gender information. For those records that did contain information on gender, more metals tests were performed on males (55.9%) than females (44.1%).

**Table 3.** Distribution of gender, when reported*, in 2006 (n = 7274).

| **Sex** | **n (%)** |
|---|---|
| Male | 4064 (55.9) |
| Female | 3210 (44.1) |
| Total* | 7274 (100) |

*Gender was missing/unknown in 8226 (53.8) of the total reports (N = 15755).

Race and ethnicity information were largely unreported. The available race information is in Table 4; 88.0% of the metals reports contained no race information. Because of the large amount of missing information in this variable, race information will be excluded from further breakdowns of the data. Information on ethnicity was requested, but this information was not captured by the laboratories, thus no information on ethnicity is reported.

**Table 4.** Distribution of race, when reported*, in 2006 (n = 1895).

| **Race** | **n (%)** |
|---|---|
| White | 1796 (94.8) |
| Black | 75 (4.0) |
| Asian | 5 (0.3) |
| Native American | 3 (0.2) |
| Mixed | 16 (0.8) |
| Total* | 1895 (100) |

*Race was missing/unknown in 13860 (88%) of the total reports (N = 15755).

The total number of 15,755 reports received in the 2006 reporting year represent six unique test (arsenic, cadmium, mercury) and specimen type (blood and urine) combinations. Table 5 shows how many total reports were received for each of these unique combinations. The following sections discuss each of these individual combinations. However, since a single person may receive repeated tests throughout the reporting year, each subset of test and specimen type was de-duplicated such that each individual may contribute only a single report per subset. First, the records were matched on date of birth, last name, and first name. Then the highest reported level was selected for each unique, or matched, individual. As a result, the sections that follow will contain fewer individual reports than the aggregate totals shown in Table 5.

**Table 5.** Breakdown of reports by test and specimen type for 2006 reporting year (n=15755).

| | **Specimen Type** | | |
|---|---|---|---|
| **Test Type** | Blood | Urine | Total |
| Arsenic | 3898 | 2414 | 6312 |
| Cadmium | 1826 | 798 | 2624 |
| Mercury | 5122 | 1697 | 6819 |
| Total | 10846 | 4909 | 15755 |

## Arsenic Urine

**Table 6.** Age mean, median and range of individual Michigan residents with urine arsenic tests in 2006 (n=2101*).

| Statistic | Years |
|---|---|
| Mean | 53.5 |
| Median | 54.3 |
| Range | 1.7-99.2 |

*9 individuals receiving tests were missing DOB or age and were excluded from analysis.

**Table 7**. Gender distribution, when gender is reported*, of individual Michigan residents with urine arsenic tests in 2006 (n=1331).

| Sex | n(%) |
|---|---|
| Male | 775 (58.2) |
| Female | 556 (41.8) |
| Total | 1331 (100.0) |

*Gender was missing/unknown in 770 (36.6%) of the total urine arsenic reports (n=2101).

**Table 8.** Specimen type submitted for urine arsenic tests of Michigan residents in 2006 (n=2101).

| Test Type | n(%) |
|---|---|
| Random Urine | 1471 (70.0) |
| 24 Hour Urine | 630 (30.0) |
| Total | 2101 (100.0) |

**Table 9.** Mean, median, and range of urine arsenic tests in 2006 of Michigan residents (n=2101).

| Statistic | Value* |
|---|---|
| Mean | 20.0 |
| Median | 11.4 |
| Range | 0-975 |

*Includes results measured in µg/24 Hours, µg/L, µg/specimen, and µg/g creatinine.

**Table 10.** Distribution of individual Michigan residents' urine arsenic results (n=2101).

| Distribution Categories | n(%) |
|---|---|
| Above Action Threshold | 275 (13.1) |
| Normal | 1230 (58.5) |
| Non-Detect | 596 (28.4) |
| Total | 2101 (100.0) |

**Table 11.** Number of individual Michigan residents ≥16 years of age with urine arsenic levels ≥35 µg/24 Hours, µg/L, µg/specimen or µg/g creatinine (n=2032).

| Level | n(%) |
|---|---|
| ≥35 | 273 (13.4) |
| Less than 35 | 1759 (86.6) |
| Total | 2032 (100.0) |

**Table 12.** Number of individual Michigan residents <16 years of age with urine arsenic levels ≥50 µg/24 Hours, µg/L, µg/specimen or µg/g creatinine (n=69).

| Level | n(%) |
|---|---|
| ≥50 | 2 (2.9) |
| Less than 50 | 67 (97.1) |
| Total | 69 (100.0) |

**Summary of Results**

The mean age of individuals with urine arsenic tests was 53.5, and 58.2% of the individuals, when gender was indicated, were male. Females accounted for 41.8%.

Specimens submitted were 70.0% random urine and 30.0% were 24 hour urine collections (Table 8).

The average result was 20.0 with a standard deviation of 42.5 (Table 9). The mean result value includes results for all test types which are measured in µg/L, µg/24 hours, µg/specimen, and µg/g creatinine. This average value is well below the action thresholds of 35 µg/L for adults and 50µg/L for children's arsenic urine tests.

Two hundred seventy-five individuals (13.1%) had arsenic urine values exceeding the action thresholds. A majority of the individuals (58.5%) were reported to be in the normal range of 0-35 µg/L and 28.4% had arsenic levels that were undetectable in urine.

The high number of individuals in the normal range reflects the low levels of naturally occurring arsenic found in some common foods and well water supplies.

Two hundred seventy-three individuals over the age of 16 exceeded the arsenic action threshold and were followed up by MSU OEM. To date 67 have been interviewed. Seafood was the source identified for 63 (94.0%), well water for 2 (3.0%) and work exposure for 2 (3.0%). The levels attributed to seafood were presumably organic arsenic, which does not have a toxic effect. The other individuals with elevated arsenic who were interviewed were below levels where symptoms of arsenic toxicity have been reported in the medical literature. Two individuals under the age of sixteen were followed up by the MDCH Heavy Metals Surveillance Project. Neither of the families of these children responded to the request to conduct an interview regarding their child's elevated arsenic level.

## Arsenic Blood

**Table 13.** Age mean, median, and range of individual Michigan residents with blood arsenic tests in 2006 (n=3732*).

| Statistic | Years |
|---|---|
| Mean | 49.2 |
| Median | 50.3 |
| Range | 0-99.4 |

*10 individuals receiving tests were missing DOB or age and were excluded from analysis.

**Table 14.** Gender distribution, when gender is reported*, of individual Michigan residents with blood arsenic tests in 2006 (n=1447).

| Sex | n(%) |
|---|---|
| Male | 691 (47.8) |
| Female | 756 (52.2) |
| Total | 1447 (100.0) |

*Gender was missing/unknown in 2285 (61.2%) of the total blood arsenic reports (n=3732).

**Table 15.** Mean, median, and range of blood arsenic tests in 2006 of individual Michigan residents (n=3732).

| Statistic | µg/L |
|---|---|
| Mean | 2.7 |
| Median | 0.3 |
| Range | 0-43 |

**Table 16.** Distribution of individual Michigan residents' blood arsenic results (n=3732).

| Distribution Categories | n(%) |
|---|---|
| Above Action Threshold | 0 (0.0) |
| Normal | 1881 (50.4) |
| Non-Detect | 1851 (49.6) |
| Total | 3732 (100.0) |

### Summary of Results

The demographic statistics of individuals receiving blood arsenic tests shown in Tables 13 and 14 differ slightly from those of the urine arsenic results shown previously. The mean age of individuals with blood arsenic tests is more than 4 years younger than individuals with urine arsenic tests (49.2 vs. 53.5) and there were more females tested than males (52.2% vs. 47.8%) where gender was known.

The mean result value was 2.7 µg/L which once again was well below the established action threshold of 70 µg/L.

No individuals were reported to exceed the 70 µg/L action threshold and the reported values were evenly split between normal and non-detect (Table 16).

No contact was attempted for individuals with blood arsenic tests since all levels were below the action threshold.

## Cadmium Urine

**Table 17.** Age mean, median, and range of individual Michigan residents with urine cadmium tests in 2006 (n=581*).

| Statistic | Years |
|---|---|
| Mean | 49.0 |
| Median | 48.9 |
| Range | 0.1-89.7 |

*13 individuals receiving tests were missing DOB or age and were excluded from analysis.

**Table 18.** Gender distribution, when gender is reported*, of individual Michigan residents with urine cadmium tests in 2006 (n=406).

| Sex | n(%) |
|---|---|
| Male | 286 (70.4) |
| Female | 120 (29.6) |
| Total | 406 (100.0) |

*Gender was missing/unknown in 175 (30.1%) of the total urine cadmium reports (n=581).

**Table 19.** Specimen type submitted for urine cadmium tests of Michigan residents in 2006 (n=581).

| Test Type | n(%) |
|---|---|
| Random Urine | 486 (83.6) |
| 24 Hour Urine | 95 (16.4) |
| Total | 581 (100.0) |

**Table 20.** Mean, median, and range of urine cadmium tests in 2006 of individual Michigan residents (n=581).

| Statistic | Value* |
|---|---|
| Mean | 0.9 |
| Median | 0.2 |
| Range | 0.0-59.3 |

*Includes results measured in µg/24 Hours, µg/L, µg/specimen, and µg/g creatinine.

**Table 21.** Distribution of individual Michigan residents' urine cadmium results (n=581).

| Distribution Categories | n(%) |
|---|---|
| Above Action Threshold | 45 (7.8) |
| Normal | 279 (48.0) |
| Non-Detect | 257 (44.2) |
| Total | 581 (100.0) |

**Summary of Results**

The mean age of individuals receiving urine cadmium tests was 49.0, and where gender was indicated, 70.4% were male and 29.6% female.

The mean result value for all urine tests (µg/L, µg/24 hours, µg/specimen, and µg/g creatinine ) was 0.9.

A total of 45 (7.8%) individuals exceeded the action threshold for cadmium in urine. 43 individuals had urine cadmium levels exceeding the 2 µg/L action threshold and 2 individuals were reported with urine cadmium creatinine exceeding 3 µg/g creatinine.

None of the individuals with levels exceeding the action threshold were under the age of 16. Follow-up with individuals was only conducted on adults. To date, four have been interviewed. The source of cadmium identified was smoking of cigarettes in three individuals (75%) and work exposure in one individual (25%).

## Cadmium Blood

**Table 22.** Age mean, median, and range of individual Michigan residents with blood cadmium tests in 2006 (n=1760*).

| Statistic | Years |
|---|---|
| Mean | 49.5 |
| Median | 49.3 |
| Range | 0.0-97.4 |

*4 individuals receiving tests were missing DOB or age and were excluded from analysis.

**Table 23.** Gender distribution, when gender is reported*, of individual Michigan residents with blood cadmium tests in 2006 (n=303).

| Sex | n(%) |
|---|---|
| Male | 203 (67.0) |
| Female | 100 (33.0) |
| Total | 303 (100.0) |

*Gender was missing/unknown in 1457 (82.8%) of the total blood cadmium reports (n=1760).

**Table 24.** Mean, median, and range of blood cadmium tests in 2006 of individual Michigan residents (n=1760).

| Statistic | µg/L |
|---|---|
| Mean | 0.7 |
| Median | 0.4 |
| Range | 0.0-10.6 |

**Table 25.** Distribution of individual Michigan residents' blood cadmium results (n=1760).

| Distribution Categories | n(%) |
|---|---|
| Above Action Threshold | 23 (1.3) |
| Normal | 1438 (81.7) |
| Non-Detect | 299 (17.0) |
| Total | 1760 (100.0) |

**Summary of Results**

The demographics of individuals receiving blood cadmium tests were consistent with those that received urine cadmium tests. The mean age was 49.5 (Table 22) and a similar male to female ratio with approximately twice as many males being tested as females 67.0% vs. 33.0% (Table 23). A large number of individuals 82.8% had no gender information reported, indicating that this information should be cautiously interpreted.

The mean blood cadmium level was 0.7 µg/L compared to the action threshold of 5 µg/L.

The distribution of blood cadmium results shows 23 individuals exceeded the action threshold, but most remained in the normal range. Seventeen percent of those tested had levels below the laboratories level of detection.

One child under the age of 16 was reported with a blood level exceeding 5.0 µg/L. MDCH Heavy Metals Reporting Project has been unable to gather enough information on this child to determine the etiology of this elevated blood level. To date, eight adults have been interviewed. The source of cadmium identified was smoking of cigarettes in five individuals (62.5%) and work exposure in three individuals (37.5%).

## Mercury Urine

**Table 26.** Age mean, median, and range of individual Michigan residents with urine mercury tests in 2006 (n=1536*).

| Statistic | Years |
|---|---|
| Mean | 53.5 |
| Median | 54.2 |
| Range | 0.0-99.2 |

*9 individuals receiving tests were missing DOB or age and were excluded from analysis.

**Table 27.** Gender distribution, when gender is reported*, of individual Michigan residents with urine mercury tests in 2006 (n =1152).

| Sex | n(%) |
|---|---|
| Male | 679 (58.9) |
| Female | 473 (41.1) |
| Total | 1152 (100.0) |

*Gender was missing/unknown in 384 (25.0%) of the total urine mercury reports (n=1536).

**Table 28.** Specimen type submitted for urine mercury tests of Michigan residents in 2006 (n=1536).

| Test Type | n(%) |
|---|---|
| Random Urine | 1285 (83.7) |
| 24 Hour Urine | 251 (16.3) |
| Total | 1536 (100.0) |

**Table 29.** Mean, median, and range of urine mercury tests in 2006 of individual Michigan residents (n=1536).

| Statistic | Value* |
|---|---|
| Mean | 0.5 |
| Median | 0.0 |
| Range | 0.0-77.0 |

*Includes results measured in µg/24 Hours, µg/L, µg/specimen, and µg/g creatinine.

**Table 30.** Distribution of individual Michigan residents' urine mercury results (n=1536).

| Distribution Categories | n(%) |
|---|---|
| Above Action Threshold | 3 (0.2) |
| Normal | 493 (32.1) |
| Non-Detect | 1040 (67.7) |
| Total | 1536 (100.0) |

**Table 31.** Number of individual Michigan residents <16 years of age with urine mercury levels >10 µg/L (n=41).

| Level | n(%) |
|---|---|
| >10 | 0 (0.0) |
| 10 and under | 41 (100.0) |
| Total | 41 (100.0) |

**Summary of Results**

The mean age of individuals receiving urine mercury tests was 53.5 years (Table 26). Where gender is known, more tests were performed on men than on women (58.9% vs. 41.1%) (Table 27). Gender was missing on 25.0% of test reports.

Most of the results (83.7%) came from random urine tests.

The mean result value was 0.5 for tests measured in µg/L, µg/24 hours, µg/specimen, and µg/g creatinine.

The distribution of results showed 3 urine mercury levels exceeding the action threshold and a majority of the remaining values were recorded as a laboratory non-detect.

None of the 167 urine mercury creatinine tests exceeded the 35 µg/g creatinine action threshold for follow-up.

All 3 values exceeding the action threshold were reported in individuals over the age of 16. To date, none of these individuals have been interviewed.

## Mercury Blood

**Table 32.** Age mean, median, and range of individual Michigan residents with blood mercury tests in 2006 (n=4836*).

| Statistic | Years |
|---|---|
| Mean | 47.8 |
| Median | 49.3 |
| Range | 0.0-99.4 |

*44 individuals receiving tests were missing DOB or age and were excluded from analysis.

**Table 33.** Gender distribution, when gender is reported*, of individual Michigan residents with blood mercury tests in 2006 (n =2141).

| Sex | n(%) |
|---|---|
| Male | 1067 (49.8) |
| Female | 1074 (50.2) |
| Total | 2141 (100.0) |

*Gender was missing/unknown in 2695 (55.7%) of the total blood mercury reports (N = 4836).

**Table 34.** Mean, median, and range of blood mercury tests in 2006 of individual Michigan residents (n=4836).

| Statistic | µg/L |
|---|---|
| Mean | 1.5 |
| Median | 0.7 |
| Range | 0.0-68.0 |

**Table 35.** Distribution of individual Michigan residents' blood mercury results (n=4836).

| Distribution Categories | n(%) |
|---|---|
| Above Action Threshold | 45 (1.0) |
| Normal | 2575 (53.2) |
| Non-Detect | 2216 (45.8) |
| Total | 4836 (100.0) |

**Table 36.** Number of individual Michigan residents <16 years of age with blood mercury levels >10 µg/L (n=501).

| Level | n(%) |
|---|---|
| >10 | 1 (0.2) |
| 10 and under | 500 (99.8) |
| Total | 501 (100.0) |

**Table 37.** Number of individual Michigan residents with blood mercury levels ≥30 µg/L (n=4836).

| Level | n(%) |
|---|---|
| ≥30 | 8 (0.2) |
| Less than 30 | 4828 (99.8) |
| Total | 4836 (100.0) |

**Summary of Results**

The mean age of individuals receiving blood mercury tests was lower than those receiving urine mercury tests (47.8 vs. 49.5 years).

The male to female ratio was nearly identical at 49.8% vs. 50.2% for those individuals where gender was indicated. Over half of the individuals 55.7% were missing gender information.

The mean result value was 1.5 µg/L (Table 34).

In the distribution of result values, 45 individuals exceeded the action threshold and of the remaining results there were slightly more normal values than laboratory non-detect.

Forty-five individuals exceeded the Heavy Metals Reporting Project's action threshold and of those 45, 8 individuals exceeded the Environmental Protection Agency's (EPA) level of concern, ≥30 µg/L (Table 37). This level was indicated as a level of interest to the EPA via personal communication with Maureen O'Neill[4].

One child under the age of sixteen had a blood mercury level exceeding 10 µg/L. An interview was conducted with the family of this child and the elevated level was attributed to a diet high in canned tuna. The family was informed of this exposure and was provided with information regarding ways to reduce mercury exposure through a change in diet.

To date 28 adults have been interviewed. The source of mercury identified was seafood ingestion in 21 individuals (75%), herbal supplement in one individual (3.6%) and work exposure in six individuals (21.4%). All six individuals with exposure from work were employed at the same facility. An investigation was conducted by Michigan OSHA staff to evaluate the work environment of these individuals. The company received a citation for exceeding the allowable air limit for mercury.

[4] Maureen O'Neill is a Senior Policy Advisor with the US Environmental Protection Agency, Office of the Regional Administrator.

## Follow-up Activities

In total, 381 individuals were identified through the Heavy Metals Surveillance project with an elevated level of arsenic, cadmium, or mercury where an attempt to determine the source of the metal was considered to be of possible public health significance. The distribution of these individuals according to their age group and specific subset of metal and test type is summarized in Table 38. Four children exceeded the established action threshold for follow-up and at the time of this report MDCH was able to contact the family of one of those individuals to assess exposure and provide follow-up information.

**Table 38.** Number of individuals by age, exceeding action threshold and requiring follow-up for each subset of test and specimen type.

| | Test and Specimen Type | | | | | | |
|---|---|---|---|---|---|---|---|
| **Age** | AsU | AsB | CdU | CdB | HgU | HgB | Total |
| 16 and over | 265 | 0 | 43 | 22 | 3 | 44 | 377 |
| < 16 | 2 | 0 | 0 | 1 | 0 | 1 | 4 |
| Total | 267 | 0 | 43 | 23 | 3 | 45 | 381 |

MSU OEM is conducting follow-up interviews with the 377 adults. To date, 107 individuals have been interviewed. Table 39 summarizes the sources of the metals for 107 individuals interviewed. Educational material was provided to individuals with elevated mercury from seafood ingestion. Individuals with elevated arsenic levels who indicated that they drank well water were mailed a brochure about arsenic in wells. A workplace investigation was conducted by MIOSHA at the facility where six individuals with elevated mercury are employed.

**Table 39.** Number of Adults exceeding action threshold where source of exposure has been identified, Michigan 2006.

| | Test and Specimen Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | AsU | AsB | CdU | CdB | HgU | HgB | Total |
| Seafood | 63 | 0 | - | - | 0 | 21 | 84 |
| Work-Related | 2 | 0 | 1 | 3 | 0 | 6 | 12 |
| Well Water | 2 | 0 | - | - | - | - | 2 |
| Cigarette Smoking | - | - | 3 | 5 | - | - | 8 |
| Herbal Supplement | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | 67 | 0 | 4 | 8 | 0 | 28 | 107 |

## Notable Findings

The first year of the Heavy Metals Surveillance project presented many challenges. Working with laboratories that were initiating reporting to agree on file format and transmission was very time consuming. The number of paper reports received until laboratories could be brought up to electronic reporting became very cumbersome and ultimately resulted in a loss of data quality in order to handle the volume of data entry. Additionally, the overall volume of reporting far exceeded initial expectations. More staff time was required than initially anticipated to manage, clean, and parse the surveillance data. Many of these problems were related to the initial start-up of the system and were resolved in year two of the project. Most laboratories have switched to electronic reporting leaving a more manageable amount of data entry from paper reports. Additional efforts are underway to encourage all laboratories to submit electronic reports. These changes will result in significant improvement to data quality in the second year of the project.

The volume of reports and the high percentage of normal values has raised questions about what is the indication for ordering the tests. We will be analyzing the 2007 data to assess the number of individuals for whom a heavy metals panel was done, compared to testing for a single metal. We will also evaluate the specialty of the providers ordering the samples for testing and will be exploring the

feasibility of a survey for more information on the indication for the testing. The goal of this survey will be to develop a targeted education campaign to assist healthcare providers in determining the indications for ordering testing for heavy metals and the indications when a single test or panel of tests would be clinically useful. Finally, we will also assess if health care providers need educational material to help in the interpretation of the laboratory results.

MDCH and MSU will continue to explore the data for environmental, occupational, and acute poisoning events effecting Michigan residents. The data will be used when indicated to conduct interventions to reduce exposures and potential adverse health effects to both the individuals with the elevated metal levels as well others who because of similar circumstances face similar risks.

# Appendix I

DEPARTMENT OF COMMUNITY HEALTH

BUREAU OF EPIDEMIOLOGY
DIVISION OF ENVIRONMENTAL AND OCCUPATIONAL EPIDEMIOLOGY

HEAVY METAL AND PESTICIDE ANALYSIS REPORTING

Filed with the Secretary of State on 9/23/2005
These rules take effect immediately after filing with the Secretary of State

(By authority conferred on the director of the department of community health by sections 5111 and 2226(d) of 1978 PA 368, section 8 of 1978 PA 312, and Executive Reorganization Order Nos. 1996-1 and 1997-4, MCL 333.5111, 333.2226(d), 325.78, 330.3101, and 333.26324)

R 325.61 to R 325.68 are added to the Michigan Administrative Code as follows:

R 325.61 Definitions.
Rule 1. (1) As used in these rules:
(a) "Heavy metal analysis report form" means the form used to report the required reportable information for blood and urine that has been analyzed for arsenic, cadmium, or mercury.
(b) “Pesticide poisoning report form” means the form used to report the required reportable information for blood that has been analyzed for acetylcholinesterase or pseudocholinesterase.
(c) “Pesticide” means any substance or mixture of substances including inert ingredients and adjuvants used to prevent, destroy, mitigate, or repel any pest. Pesticides include, but are not limited to, insecticides, herbicides, fungicides, rodenticides, repellents, fumigants, wood treatment products, and disinfectants.
(d) "Department" means the Michigan department of community health.
(e) "Physician/provider" means a person who is licensed under Article 15 of the public health code MCL 333.16101 to 333.18838 who provides health care services and who is authorized to request the analysis of blood and urine specimens.

R 325.62 Reportable information.
Rule 2. (1) Reportable information is specifically related to blood and urine samples submitted to clinical laboratories for analysis.
(2) Upon initiating a request for analysis of arsenic, cadmium, mercury, acetylcholinesterase, or pseudocholinesterase, the physician/provider ordering the analysis shall complete the client information (section I) and the physician/provider information (section II) of a heavy metal analysis report form or pesticide poisoning report form designated by the department. Or, the physician/provider shall complete a similar form that ensures the inclusion of the same required data and provide all of the following information:

(a) All of the following information with respect to the individual tested:
(i) Name.
(ii) Sex, if available.
(iii) Race, if available.
(iv) Ethnic group, if available.
(v) Birthdate or age.
(vi) Address.
(vii) Telephone number.
(viii) If the individual is a minor, then the name of a parent or guardian.
(ix) If the individual is an adult, then the name and address of his or her employer, if available.
(b) The date the sample was collected.

(3) The heavy metal analysis report form or pesticide poisoning analysis report form, or a document with the same data, shall be submitted with the sample for analysis to a clinical laboratory that performs the analysis.

(4) Upon receipt of the blood or urine sample for analysis, the clinical laboratory shall complete the laboratory information (section III) and provide all of the information required and/or submitted by the physician/provider along with all of the following:

(a) The name, address, and phone number of the laboratory.

(b) The date of analysis.

(c) The results of the analysis. All values, normal and abnormal, shall be reported. For arsenic, blood levels shall be reported in micrograms per milliliter (µg/ml) and urine levels in micrograms per liter (µg/L). For cadmium, blood levels shall be reported as micrograms per liter (µg/L) of whole blood and urine tests shall be reported as micrograms per gram of creatinine (µg/gram creatinine) or micrograms per liter (µg/L). Mercury shall be reported as nanograms per milliliter of blood (ng/ml) and micrograms per liter (µg/L) of urine. Acetylcholinesterase shall be reported as units per gram of hemoglobin (U/g hemoglobin), and the laboratory normal range shall be included. Pseudocholinesterase levels shall be reported as units per liter (U/L) of plasma, and the laboratory normal range shall be included. Alternate units will be accepted for reporting purposes, as approved by the department.

R 325.63 Reporting responsibilities.

Rule 3. (1) All clinical laboratories doing business in this state that analyze blood or urine samples for arsenic, cadmium, mercury, acetylcholinesterase, or pseudocholinesterase shall report all results to the Department of Community Health, Bureau of Epidemiology, Division of Environmental Health, PO Box 30195, Lansing, MI 48909.* Reports shall be made within 5 working days after test completion.

(2) Nothing in this rule shall be construed to relieve a laboratory from reporting results of a blood or urine analysis for arsenic, cadmium, mercury, acetylcholinesterase, or pseudocholinesterase to the physician or other health care provider who ordered the test or to any other entity as required by state, federal, or local statutes or regulations or in accordance with accepted standard of practice, except that reporting in compliance with this rule satisfies the reporting requirements of 1978 PA 368, MCL 333.1101.

R 325.64 Electronic communications.

Rule 4. (1) A clinical laboratory may submit the data required in R 325.62 electronically to the department.

(2) For electronic reporting, upon mutual agreement between the reporting laboratory and the department, the reporting shall utilize the data format specifications provided by the department.

R 325.65 Investigation and quality assurance.

Rule 5. (1) The department, upon receiving a report under R 325.63 may investigate to determine the accuracy of the report, patient's source of exposure, and adverse health effects resulting from the exposure.

(2) Requests for individual medical and epidemiologic information to validate the completeness and accuracy of reporting are specifically authorized.

(3) The copies of the medical records shall not be recopied by the department and shall be kept in a locked file cabinet when not in use.

(4) Reports may be released to other state, local, or federal agencies for those agencies to administer and enforce provisions of laws or rules to protect individuals from exposure to hazardous levels of arsenic, mercury, cadmium, or pesticides. Confidential information may be released to another governmental agency only after execution of a signed interagency agreement assuring that the other agency will abide by the confidentiality requirements of R 325.66.

(5) Nothing in this rule shall be construed to relieve or preempt any other entities from investigating hazards associated with these substances under state, federal, or local statutes or regulations.

R 325.66 Confidentiality of reports.

Rule 6. (1) Reports submitted to the department under R 325.63 are not public records and are exempt from disclosure pursuant to the freedom of information act, 1976 PA 442, MCL 15.234, section 13(1)(d).

(2) The department shall maintain the confidentiality of all reports of all tests submitted to the department and shall not release reports or any information that may be used to directly link the information to a particular

* Address corrected from published document 9/28/2005

individual, unless the department has received written consent from the individual, or from the individual's parent or legal guardian, requesting the release of information.

(3) Medical and epidemiological information that is released to a legislative body shall not contain information that identifies a specific individual. Aggregate epidemiological information concerning the public health that is released to the public for informational purposes only shall not contain information that identifies a specific individual.

R 325.67 Heavy metal analysis report form.

Rule 7. The heavy metal analysis report form reads as follows:

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH
HEAVY METAL ANALYSIS REPORT
DATA/INFORMATION REQUIRED BY ADMINISTRATIVE RULE R 325.62

I. CLIENT INFORMATION

Last name _____ First name _____ M.I. _____

Sex (M/F) _____ Race (White/Black/Asian/Pacific Islander/American Indian/Alaskan/mixed) _____

Ethnicity (Hispanic Y/N) _____ Birth date or age _____ Phone number _____

Street address _____ City _____ State/Zip Code/County _____

Name of parent or guardian if individual is a minor _____

Employer name (if adult) _____

Employer street address _____ City _____ State/Zip Code _____

II. PHYSICIAN/PROVIDER INFORMATION

Provider last name _____ First name _____ (_____) Phone number _____

Provider street address _____ City _____ State/Zip Code _____

III. LABORATORY INFORMATION

| | |
|---|---|
| Name of testing laboratory | (_____) Phone number |
| Laboratory street address | City / State/Zip Code |
| Date sample taken | Date sample analyzed |

Results

| Sample | Arsenic | Cadmium | Mercury |
|---|---|---|---|
| Blood | _____ µg/ml | _____ µg/L | _____ ng/ml |
| Urine | _____ µg/L | _____ µg/gram creatinine OR _____ µg/L | _____ µg/L |

MDCH – Division of Environmental Health, P.O. Box 30195, Lansing, MI 48909 • Fax number (517) 335-9775 • Phone number (517) 335-8

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

# ARSENIC
## CAS # 7440-38-2

**Division of Toxicology and Environmental Medicine ToxFAQs™** **September 2005**

**This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.**

**HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 784 of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).**

### What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenic (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton plants.

### What happens to arsenic when it enters the environment?

❑ Arsenic occurs naturally in soil and minerals and it therefore may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
❑ Arsenic cannot be destroyed in the environment. It can only change its form.
❑ Rain and snow remove arsenic dust particles from the air.
❑ Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
❑ Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

### How might I be exposed to arsenic?

❑ Ingesting small amounts present in your food and water or breathing air containing arsenic.
❑ Breathing sawdust or burning smoke from wood treated with arsenic.
❑ Living in areas with unusually high natural levels of arsenic in rock.
❑ Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

### How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service**
**Agency for Toxic Substances and Disease Registry**

Organic arsenic compounds are less toxic than inorganic arsenic compounds. Exposure to high levels of some organic arsenic compounds may cause similar effects as inorganic arsenic.

## How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the lungs, bladder, liver, kidney and prostate. Inhalation of inorganic arsenic can cause increase risk of lung cancer. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is a known carcinogen. The International Agency for Research on Cancer (IARC), and the EPA have determined that inorganic arsenic is carcinogenic to humans.

## How can arsenic affect children?

There is also some evidence that suggests that long-term exposure to arsenic in children may result in lower IQ scores. There is some information suggesting that children may be less efficient at converting inorganic arsenic to the less harmful organic forms. For this reason, children may be more susceptible to health effects from inorganic arsenic than adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

## How can families reduce the risks of exposure to arsenic?

❑ If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.

❑ If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.

## Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict how the arsenic levels in your body will affect your health.

## Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Arsenic (Draft for Public Comment). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

**Where can I get more information?** For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

# CADMIUM
# CAS # 7440-43-9



**This fact sheet answers the most frequently asked health questions (FAQs) about cadmium. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.**

**HIGHLIGHTS: Exposure to cadmium happens mostly in the workplace where cadmium products are made. The general population is exposed from breathing cigarette smoke or eating cadmium contaminated foods. Cadmium damages the lungs, can cause kidney disease, and may irritate the digestive tract. This substance has been found in at least 776 of the 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).**

## What is cadmium?

(Pronounced kăd′mē-əm)

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide).

All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses, including batteries, pigments, metal coatings, and plastics.

## What happens to cadmium when it enters the environment?

- Cadmium enters air from mining, industry, and burning coal and household wastes.
- Cadmium particles in air can travel long distances before falling to the ground or water.
- It enters water and soil from waste disposal and spills or leaks at hazardous waste sites.
- It binds strongly to soil particles.
- Some cadmium dissolves in water.
- It doesn't break down in the environment, but can change forms.
- Fish, plants, and animals take up cadmium from the environment.
- Cadmium stays in the body a very long time and can build up from many years of exposure to low levels.

## How might I be exposed to cadmium?

- Breathing contaminated workplace air (battery manufacturing, metal soldering or welding).
- Eating foods containing it; low levels in all foods (highest in shellfish, liver, and kidney meats).
- Breathing cadmium in cigarette smoke (doubles the average daily intake).
- Drinking contaminated water.
- Breathing contaminated air near the burning of fossil fuels or municipal waste.

## How can cadmium affect my health?

Breathing high levels of cadmium severely damages the lungs and can cause death. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease.

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service**
**Agency for Toxic Substances and Disease Registry**

**ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html**

Other long-term effects are lung damage and fragile bones. Animals given cadmium in food or water had high blood pressure, iron-poor blood, liver disease, and nerve or brain damage.

We don't know if humans get any of these diseases from eating or drinking cadmium. Skin contact with cadmium is not known to cause health effects in humans or animals.

## How likely is cadmium to cause cancer?

The Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds may reasonably be anticipated to be carcinogens.

## How can cadmium affect children?

The health effects in children are expected to be similar to those in adults (kidney, lung and intestinal damage).

We don't know if cadmium causes birth defects in people. Cadmium does not readily go from a pregnant woman's body into the developing child, but some portion can cross the placenta. It can also be found in breast milk. The babies of animals exposed to high levels of cadmium during pregnancy had changes in behavior and learning ability. Cadmium may also affect birth weight and the skeleton in developing animals.

Animal studies also indicate that more cadmium is absorbed into the body if the diet is low in calcium, protein, or iron, or is high in fat. A few studies show that younger animals absorb more cadmium and are more likely to lose bone and bone strength than adults.

## How can families reduce the risk of exposure to cadmium?

In the home, store substances that contain cadmium safely, and keep nickel-cadmium batteries out of reach of young children. If you work with cadmium, use all safety precautions to avoid carrying cadmium-containing dust home from work on your clothing, skin, hair, or tools.

A balanced diet can reduce the amount of cadmium taken into the body from food and drink.

## Is there a medical test to show whether I've been exposed to cadmium?

Tests are available in some medical laboratories that measure cadmium in blood, urine, hair, or nails. Blood levels show recent exposure to cadmium, and urine levels show both recent and earlier exposure. The reliability of tests for cadmium levels in hair or nails is unknown.

## Has the federal government made recommendations to protect human health?

The EPA has set a limit of 5 parts of cadmium per billion parts of drinking water (5 ppb). EPA doesn't allow cadmium in pesticides.

The Food and Drug Administration (FDA) limits the amount of cadmium in food colors to 15 parts per million (15 ppm).

The Occupational Safety and Health Administration (OSHA) limits workplace air to 100 micrograms cadmium per cubic meter (100 µg/$m^3$) as cadmium fumes and 200 µg cadmium/$m^3$ as cadmium dust.

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

**Where can I get more information?** For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

# MERCURY
# CAS # 7439-97-6

**Agency for Toxic Substances and Disease Registry ToxFAQs** **April 1999**

**This fact sheet answers the most frequently asked health questions (FAQs) about mercury. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.**

**HIGHLIGHTS: Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. This chemical has been found in at least 714 of 1,467 National Priorities List sites identified by the Environmental Protection Agency.**

## What is mercury?

(Pronounced mŭr′kyə-rē)

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

## What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

## How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury).
- Practicing rituals that include mercury.

## How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea,

vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

## How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

## How can mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also can pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

## How can families reduce the risk of exposure to mercury?

Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

## Is there a medical test to show whether I've been exposed to mercury?

Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

## Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).

The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 $mg/m^3$) and 0.05 $mg/m^3$ of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

**Where can I get more information?** For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.