Final Report

Dona Park, Manchester Place, and Academy Heights Blood and Urine Testing

Corpus Christi, Nueces County, Texas

November 9, 2011

TEXAS
Department of State Health Services

Table of Contents

Summary

Background

The Dona Park and Manchester Place neighborhoods are located adjacent to the former American Smelting and Refining Company (ASARCO) zinc smelter facility in Corpus Christi, Texas. Since 1994 there have been multiple investigations and soil removal actions conducted in these neighborhoods. In 2010, the Texas Commission on Environmental Quality (TCEQ) reviewed past assessments and cleanups conducted in the neighborhood and completed a Pilot Study. The results revealed that soil at three homes exceeded the TCEQ's Protective Concentration Levels (PCLs) for one or more metals. The community voiced concerns about residual contamination of residential soil and the potential for exposure to those contaminants.

Blood and Urine Testing

In response to community concerns, the Texas Department of State Health Services (DSHS) conducted blood and urine screening for residents (children and adults) of the Dona Park and Manchester Place neighborhoods. Due to proximity to the ASARCO facility, residents of the Academy Heights neighborhood also were included. Notice of the blood and urine collection clinic was provided to residents of Dona Park, Manchester Place, and Academy Heights; however, the clinic was open to anyone concerned about exposure to metals. Based upon environmental sampling results received from TCEQ, DSHS tested participants for total arsenic, cadmium, lead, and mercury.

The purpose of this screening was to provide people with information about the levels of arsenic, cadmium, lead, and mercury in their bodies compared to the normal ranges typically seen in clinical settings (clinical reference interval). Individuals with test results greater than the clinical reference interval were encouraged to share the results with their personal physician. Where possible, individual levels also were compared to those found in the general US population, as reported in the Centers for Disease Control and Prevention's (CDC's) National Health and Nutrition Examination Survey (NHANES). The blood collection clinic was held at St. Theresa Catholic Church in Corpus Christi, July 7 through July 10, 2011. DSHS collected blood samples from 417 participants and urine samples from 379 participants.

Conclusions

The presence of contaminants in soil is what drove this screening effort and the most likely way that people would be exposed to the contaminants would be through incidental ingestion of soil. Arsenic, cadmium, lead, and mercury are natural elements commonly found in the environment, in the foods we eat, the air we breathe, and the water we drink; thus, it is not unusual to find some level of these metals in people. For the people tested in this screening effort the levels of these contaminants found in their blood and urine were not consistent with unusual exposures. That is, even if individual soil concentrations were high, for the people tested, the amount of soil ingested and/or the frequency with which incidental ingestion of soil occurs is probably low. While DSHS found detectable levels of these metals in many participants, most people tested had levels below those of clinical significance.

Twenty three people had high levels of total arsenic in their urine and were offered follow-up testing. Results from the follow-up testing indicated that very little of the total arsenic was of the harmful inorganic form. In summary, this screening did not identify unusual levels of arsenic, cadmium, lead, or mercury in participants' blood or urine.

Limitations

The final report reflects the results of this screening effort which by themselves cannot be used to determine the source of arsenic, cadmium, lead, or mercury in any specific individual.

This screening was not designed as a research study; thus, the results are only representative of those people who were tested and may not be representative of all people who live or have lived in these neighborhoods.

While we compared blood and urine data to the 95th percentile from NHANES, this comparison could not be done for all age groups for each metal.

Purpose and Health Issues

The Texas Department of State Health Services (DSHS), Environmental and Injury Epidemiology and Toxicology Unit (EIET), conducted blood and urine metals screening for residents living in the Dona Park, Manchester Place, and Academy Heights neighborhoods in Corpus Christi, Texas. Where possible, the test results presented in this report were compared to those previously obtained from the general United States (US) population and to normal ranges for the metals typically seen in clinical settings. A full list of the acronyms and abbreviations used in this report are included in Appendix A. More information about arsenic, cadmium, lead, and mercury is included in Appendix B.

Background

The Dona Park and Manchester Place neighborhoods are located adjacent to the former American Smelting and Refining Company (ASARCO) zinc smelter facility in Corpus Christi, Texas. Since 1994 there have been multiple investigations and soil removal actions conducted in these neighborhoods. However, the community remains concerned about potential residual contamination of residential soil. In 2010, The Texas Commission on Environmental Quality (TCEQ) reviewed past assessments and cleanups conducted in the neighborhood and completed a Pilot Study in which soil from 59 of the approximately 300 residential yards was sampled. The results revealed that soil at three homes exceeded the TCEQ's Protective Concentration Levels (PCLs) for one or more of the metals. In 2011, TCEQ expanded their assessment to include all residences in the Dona Park and Manchester Place neighborhoods not previously sampled in the Pilot Study [1].

In response to concerns about the soil sample results and after meeting with local residents and citizen groups, it was agreed that the DSHS would measure total arsenic, cadmium, lead, and mercury levels in blood and urine from residents living in the Dona Park, Manchester Place, and Academy Heights (also located near the former ASARCO facility) neighborhoods (approximately 400 homes).

Biological Screening

The blood and urine metals screening clinic was held at St. Theresa Catholic Church in Corpus Christi, July 7 through 10, 2011. A flyer with the dates, times, and location of the clinic were mailed to all residents of Dona Park, Manchester Place, and Academy Heights.

Each participant signed an informed consent which outlined: the purpose of the testing; the procedures involved; the expected time commitment; any reasonably foreseeable risks or discomforts; potential benefits to the participant or to others; how their information will be kept confidential; and who they could contact with any questions or concerns regarding the consent form or the specimen collection procedures.

Participants were provided with their individual blood and urine test results and an explanation of their results via mail.

Blood Sampling

Blood samples were collected by public health nurses from Nueces County and DSHS Region 11 using validated procedures and materials to assure that the reported results were not biased by contamination or loss. Venous blood samples were placed into 4 milliliter (mL) EDTA tubes ("purple top tubes"), transported to the DSHS Laboratory in Austin, Texas, and analyzed for cadmium, lead, and mercury using inductively coupled plasma mass spectroscopy (ICP-MS).

Urine Sampling

Participants were provided with a specimen collection cup and asked to collect the first morning void urine sample and bring the sample to the collection clinic. Urine samples were transported to the DSHS Laboratory in Austin, Texas, and analyzed for total arsenic, cadmium, and lead using ICP-MS. Urine test results were standardized based on each individual's creatinine level and expressed as "urine test results per gram creatinine".

Data Analysis Procedures

The purpose of this screening was to provide people with information about how the levels of arsenic, cadmium, lead, and mercury in their bodies compared to the normal ranges typically seen in clinical settings (clinical reference interval) [2]. Individuals with test results greater than the clinical reference interval were encouraged to share the results with their personal physician.

Where possible, individual levels also were compared to those found in the general US population, as reported in the Centers for Disease Control and Prevention's (CDC's) National Health and Nutrition Examination Survey (NHANES). NHANES provides information about the health, nutrition, and exposure status of children and adults across the US. Individual values were compared to the levels found in 95% of the people by age group (the 95th percentile). It is important to note that on average 5% of the people tested might be expected to have levels greater than the 95th percentile and having a result greater than the 95th percentile as reported in NHANES does not mean that the people with these levels will experience harmful effects; it does suggest their exposure may have been higher than 95% of the people tested in their age group throughout the US.

Results and Discussion

From July 7 through 10, 2011, DSHS collected blood samples from 417 participants and urine samples from 379 participants; the results are presented below.

Arsenic

Urinary Total Arsenic

Arsenic is found in toxic (inorganic) and non-toxic (organic) forms. While inorganic arsenic is the form of arsenic of greatest toxicological concern, for conservative screening purposes urine samples were initially analyzed both for the inorganic and organic forms combined (total arsenic). Urinary total arsenic results, adjusted for creatinine, are presented in Table 1 as micrograms of arsenic per gram creatinine (µg/g-c). Of the 379 urine samples tested, 89 (23%) contained detectable levels of arsenic. For the 6 to 11 years, 12 to 19 years, and 20 years and older age groups 15 people (4%) had urinary arsenic levels greater than those found in 95% of the people tested in their respective age groups throughout the US. We were not able to make this comparison for the 1 to 5 years age group because NHANES does not contain information on metals in urine for children in this age group. Test results also showed that 23 people (6%) had urinary arsenic levels above the clinical reference interval.

Table 1. Summary of urinary arsenic sample results collected from 379 participants. The clinical reference interval for arsenic in urine is 0-35 micrograms of arsenic per gram creatinine (µg/g-c).

Age Group (years)	Number Tested	Range (µg/g-c)[a]	Number of Detects	95^{th} Percentile (µg/g-c)[b]	Number above 95^{th} Percentile	Number above Clinical Reference Interval[c]
1-5	14	ND[d]-31	<5[e]	Unknown[f]	Unknown	0
6-11	28	ND-74	<5	37.2	<5	<5
12-19	45	ND-454	8	22.5	<5	<5
20+	292	ND-1,579	74	59.4	11	19

[a] Standardizing the results per gram creatinine is a standard practice in medicine when presenting urine test results.

[b] The 95^{th} percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2007-2008. The 95^{th} percentile is the level at which 5% of the people in each age group tested in the US had values above. Having a result similar to or below the 95^{th} percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95^{th} percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.

[c] Clinical reference intervals are based on information provided in Tietz Clinical Guide to Laboratory Tests and are typically used in clinical settings. People with results higher than the clinical reference interval should consult with their physician.

[d] ND indicates the contaminant was not detected. The detection limit for total arsenic in urine was 16.25 micrograms of total arsenic per liter of urine (µg/L).

[e] Counts of 1 to 4 are expressed as <5 to protect confidentiality.

[f] Unknown indicates comparison to the 95^{th} percentile could not be made because NHANES does not contain information on metals in urine for children 1-5 years old.

Urinary Inorganic Arsenic

People identified with urinary total arsenic levels above the clinical reference interval were offered follow-up testing specifically for inorganic arsenic and on October 5 through 7, 2011, DSHS collected a second urine sample from 22 of the 23 people. This sample was analyzed by NMS Labs for inorganic arsenic using ICP-MS. These people also completed a survey regarding potential arsenic exposure sources. Urinary inorganic arsenic results, adjusted for creatinine, are presented in Table 2 as micrograms of inorganic arsenic per gram creatinine (µg/g-c). Of the 22 urine samples tested, less than 5[1] contained detectable levels of inorganic arsenic. When compared to the approximate 95th percentile of the sum of inorganic arsenic species[2], all urinary inorganic arsenic levels were consistent with those found in people throughout the US.

Table 2. Summary of urinary inorganic arsenic sample results collected from 22 participants[a]. The approximate 95th percentile[b] of the sum of inorganic arsenic species was 20 micrograms of inorganic arsenic per gram creatinine (µg/g-c).

Age Group (years)	Number Tested	Range (µg/g-c)[c]	Number of Detects	Number above 95th Percentile
1-5	0	NA[d]	NA	NA
6-11	<5[e]	ND[f]	0	0
12-19	<5	ND-8.4	<5	0
20+	19	ND-14	<5	0

[a] One of the 23 people did not provide a urine sample, thus only 22 urine samples were collected.
[b] The approximate 95th percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2003-2004. The 95th percentile is the level at which 5% of the people tested in the US had values above. Having a result similar to or below the 95th percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95th percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.
[c] Standardizing the results per gram creatinine is a standard practice in medicine when presenting urine test results.
[d] NA indicates not applicable. No children ages 1 to 5 years old were tested for inorganic arsenic.
[e] Counts of 1 to 4 are expressed as <5 to protect confidentiality.
[f] ND indicates the contaminant was not detected. The detection limit for inorganic arsenic in urine was 11 micrograms of inorganic arsenic per liter of urine (µg/L).

[1] Counts of 1 to 4 are expressed as <5 to protect confidentiality.
[2] The actual 95th percentile for the sum of inorganic arsenic species was 18.9 µg/L, for survey years 2003-2004. A value presented in µg/g-c was not available.

Cadmium

Blood Cadmium

Blood cadmium results are presented in Table 3. Of the 417 blood samples tested, 28 (7%) contained detectable levels of cadmium. For the 20 years and older age group 11 people (4%) had blood cadmium levels greater than those found in 95% of people tested in their respective age group throughout the US. We were not able to make these comparisons for the 1 to 5 years, 6 to 11 years, and 12 to 19 years age groups because the 95th percentile for these age groups was below the detection limit for cadmium reported by the DSHS lab. No blood cadmium test results exceeded the clinical reference interval.

Table 3. Summary of blood cadmium sample results collected from 417 participants. The clinical reference interval for cadmium in blood is 0-5 micrograms of cadmium per liter of blood (µg/L).

Age Group (years)	Number Tested	Range (µg/L)	Number of Detects	95th Percentile (µg/L)[a]	Number above 95th Percentile	Number above Clinical Reference Interval[b]
1-5	20	ND[c]	0	0.24	Unknown[d]	0
6-11	35	ND	0	0.26	Unknown	0
12-19	48	ND	0	0.9	Unknown	0
20+	314	ND-3	28	1.7	11	0

[a] The 95th percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2007-2008. The 95th percentile is the level at which 5% of the people in each age group tested in the US had values above. Having a result similar to or below the 95th percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95th percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.

[b] Clinical reference intervals are based on information provided in Tietz Clinical Guide to Laboratory Tests and are typically used in clinical settings. People with results higher than the clinical reference interval should consult with their physician.

[c] ND indicates the contaminant was not detected. The detection limit for cadmium in blood was 1 microgram of cadmium per liter of blood (µg/L).

[d] Unknown indicates comparison to the 95th percentile could not be made because the 95th percentile was less than the detection limit for cadmium in blood.

Urinary Cadmium

Urinary cadmium results, adjusted for creatinine, are presented in Table 4 as micrograms of cadmium per gram creatinine (µg/g-c). Of the 379 urine samples tested, 260 (69%) contained detectable levels of cadmium. For the 12 to 19 years and 20 years and older age groups 25 people (7%) had urinary cadmium levels greater than those found in 95% of people tested in their respective age groups throughout the US. We were not able to make this comparison for the 6 to 11 years age group because the 95th percentile for this age group was below the detection limit for cadmium reported by the DSHS lab. We also were not able to make this comparison for the 1 to 5 years age group because NHANES does not contain information on metals in urine for children in this age group. No urinary cadmium test results exceeded the clinical reference interval.

Table 4. Summary of urinary cadmium sample results collected from 379 participants. The clinical reference interval for cadmium in urine is 0-3 micrograms of cadmium per gram creatinine (µg/g-c).

Age Group (years)	Number Tested	Range (µg/g-c)[a]	Number of Detects	95th Percentile (µg/g-c)[b]	Number above 95th Percentile	Number above Clinical Reference Interval[c]
1-5	14	ND[d]-0.9	8	Unknown[e]	Unknown	0
6-11	28	ND-0.5	12	0.26	Unknown	0
12-19	45	ND-0.5	29	0.18	24	0
20+	292	ND-2	211	1.05	<5[f]	0

[a] Standardizing the results per gram creatinine is a standard practice in medicine when presenting urine test results.
[b] The 95th percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2007-2008. The 95th percentile is the level at which 5% of the people in each age group tested in the US had values above. Having a result similar to or below the 95th percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95th percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.
[c] Clinical reference intervals are based on information provided in Tietz Clinical Guide to Laboratory Tests and are typically used in clinical settings. People with results higher than the clinical reference interval should consult with their physician.
[d] ND indicates the contaminant was not detected. The detection limit for cadmium in urine was 0.25 micrograms of cadmium per liter of urine (µg/L).
[e] Unknown indicates comparison to the 95th percentile could not be made because NHANES does not contain information on metals in urine for children 1-5 years old. Also, for the 6 to 11 years age group, comparison to the 95th percentile could not be made because the 95th percentile was less than the detection limit for cadmium in blood.
[f] Counts of 1 to 4 are expressed as <5 to protect confidentiality.

Lead

Blood Lead

Blood lead results are presented in Table 5. Of the 417 blood samples tested, 58 (14%) contained detectable levels of lead. For the 1 to 5 years, 6 to 11 years, and 20 years and older age groups 22 people (6%) had blood lead levels greater than those found in 95% of the people in their respective age groups tested throughout the US. We were not able to make this comparison for the 12 to 19 years age group because the 95th percentile for this age group was below the detection limit for lead reported by the DSHS lab. No blood lead test results exceeded the clinical reference interval.

Table 5. Summary of blood lead sample results collected from 417 participants. The clinical reference interval for lead in blood is 0-10 micrograms of lead per deciliter of blood (µg/dL).

Age Group (years)	Number Tested	Range (µg/dL)	Number of Detects	95th Percentile (µg/dL)[a]	Number above 95th Percentile	Number above Clinical Reference Interval[b]
1-5	20	ND[c]-5	<5[d]	4.1	<5	0
6-11	35	ND	0	2.5	0	0
12-19	48	ND	0	1.9	Unknown[e]	0
20+	314	ND-8	55	3.9	21	0

[a] The 95th percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2007-2008. The 95th percentile is the level at which 5% of the people in each age group tested in the US had values above. Having a result similar to or below the 95th percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95th percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.

[b] Clinical reference intervals are based on information provided in Tietz Clinical Guide to Laboratory Tests and are typically used in clinical settings. People with results higher than the clinical reference interval should consult with their physician.

[c] ND indicates the contaminant was not detected. The detection limit for lead in blood was 2 micrograms of lead per deciliter of blood (µg/dL).

[d] Counts of 1 to 4 are expressed as <5 to protect confidentiality.

[e] Unknown indicates comparison to the 95th percentile could not be made because the 95th percentile was less than the detection limit for lead in blood.

Urinary Lead

Urinary lead results, adjusted for creatinine, are presented in Table 6 as micrograms of lead per gram creatinine (µg/g-c). Of the 379 urine samples tested, 102 (27%) contained detectable levels of lead. For the 6 to 11 years, 12 to 19 years, and 20 years and older age groups 13 people (4%) had urinary lead levels greater than those found in 95% of the people tested in their respective age groups throughout the US. We were not able to make this comparison for the 1 to 5 years age group because NHANES does not contain information on metals in urine for children in this age group. No urinary lead test results exceeded the clinical reference interval.

Table 6. Summary of urinary lead sample results collected from 379 participants. The clinical reference interval for lead in urine is 0-23 micrograms of lead per liter of urine (µg/L)[a].

Age Group (years)	Number Tested	Range (µg/g-c)[b]	Number of Detects	95th Percentile (µg/g-c)[c]	Number above 95th Percentile	Number above Clinical Reference Interval[d]
1-5	14	ND[e]-3	8	Unknown[f]	Unknown	0
6-11	28	ND-2	10	2.04	0	0
12-19	45	ND-0.8	8	0.9	0	0
20+	292	ND-10	76	1.92	13	0

[a] The clinical reference interval for lead is presented as micrograms of lead per liter of urine (µg/L). A creatinine corrected value for lead in urine is not available. However, based on clinical reference intervals for other metals, it is assumed the clinical reference interval for lead in micrograms of lead per gram creatinine would be similar to the clinical reference interval for lead in µg/L.

[b] Standardizing the results per gram creatinine is a standard practice in medicine when presenting urine test results.

[c] The 95th percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2007-2008. The 95th percentile is the level at which 5% of the people in each age group tested in the US had values above. Having a result similar to or below the 95th percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95th percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.

[d] Clinical reference intervals are based on information provided in Tietz Clinical Guide to Laboratory Tests and are typically used in clinical settings. People with results higher than the clinical reference interval should consult with their physician.

[e] ND indicates the contaminant was not detected. The detection limit for lead in urine was 0.75 micrograms of lead per liter of urine (µg/L).

[f] Unknown indicates comparison to the 95th percentile could not be made because NHANES does not contain information on metals in urine for children 1-5 years old.

Mercury

Blood Mercury

Blood mercury results are presented in Table 7. Of the 417 blood samples tested, 13 (3%) contained detectable levels of mercury. For the 12 to 19 years and 20 years and older age groups less than 5 people (less than 1%) had blood mercury levels that exceeded the levels found in 95% of the people tested in their respective age groups throughout the US. We were not able to make these comparisons for the 1 to 5 years and 6 to 11 years age groups because the 95th percentile for these age groups was below the detection limit for mercury reported by the DSHS lab. Less than 5 people (less than 1%) had blood mercury levels that were at the top end of the clinical reference interval, with a result of 10 µg/L.

Table 7. Summary of blood mercury sample results collected from 417 participants. The clinical reference interval for mercury in blood is 0-10 micrograms of mercury per liter of blood (µg/L).

Age Group (years)	Number Tested	Range (µg/L)	Number of Detects	95th Percentile (µg/L)[a]	Number above 95th Percentile	Number above Clinical Reference Interval[b]
1-5	20	ND[c]	0	1.32	Unknown[d]	0
6-11	35	ND	0	1.56	Unknown	0
12-19	48	ND	0	2.05	0	0
20+	314	ND-10	13	5.32	<5[e]	<5

[a] The 95th percentile is based upon the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) for survey years 2007-2008. The 95th percentile is the level at which 5% of the people in each age group tested in the US had values above. Having a result similar to or below the 95th percentile indicates an exposure similar to what we would find in most individuals. Having a result higher than the 95th percentile does not mean that people will get sick, it does however suggest a greater than normal exposure to the substance.

[b] Clinical reference intervals are based on information provided in Tietz Clinical Guide to Laboratory Tests and are typically used in clinical settings. People with results higher than the clinical reference interval should consult with their physician.

[c] ND indicates the contaminant was not detected. The detection limit for mercury in blood was 2 micrograms of mercury per liter of blood (µg/L).

[d] Unknown indicates comparison to the 95th percentile could not be made because the 95th percentile was less than the detection limit for mercury in blood.

[e] Counts of 1 to 4 are expressed as <5 to protect confidentiality.

Discussion

Introduction

The presence of chemical contaminants in the environment does not always result in exposure to or contact with the chemicals by people. In general, people may be exposed to chemicals by breathing, eating, drinking, or coming into contact with a substance containing the contaminant. The presence of contaminants in soil is what drove this screening effort and the most likely way that people would be exposed to the contaminants of concern in this neighborhood would be through incidental ingestion of soil. Most people ingest some soil through normal hand-to-mouth behaviors or by not washing hands before eating or smoking. The degree to which contaminants would show up in blood and urine depends on the concentration of the contaminants in the soil, the amount of soil that a person ingests, and how often the incidental ingestion of soil occurs. For the people tested in this screening effort the levels of these contaminants found in blood and urine were not consistent with unusual exposures; thus, even if individual soil concentrations were high the amount of soil taken in and/or the frequency with which the incidental ingestion of soil occurs is probably low. Below are summary results for the individual contaminants.

Arsenic

Approximately one-fourth of the people tested had detectable levels of total arsenic in their urine. Having some arsenic in the body is not unusual since arsenic is found naturally in the environment and people normally take in small amounts of arsenic in the air they breathe, the water they drink, and the food they eat. Of these, foods such as fish, shellfish, and rice are usually the largest source of arsenic and can cause relatively high urinary total arsenic levels. Of all the people tested, 23 people had levels of total arsenic (organic plus inorganic) above the clinical reference interval. Follow-up testing on these individuals found less than 5 to have detectable levels of inorganic arsenic (the more harmful form of arsenic) in their urine, and those with inorganic arsenic had levels consistent with what we would find in most people. Based upon the results from this screening, the levels of inorganic arsenic found in people's urine were not consistent with unusual exposures.

Cadmium

Only a small percentage of participants had detectable levels of cadmium in their blood but 69% had detectable levels in their urine. Cadmium present in the blood indicates a recent exposure to cadmium, while cadmium in the urine is more indicative of how much cadmium a person has in their body since cadmium can remain in the body for many years and is slowly excreted in urine over time [3]. Like arsenic, cadmium occurs naturally in the environment so people can be exposed to cadmium from the food they eat, the water they drink, from the air they breathe. In the US, the average person eats food containing about 30 micrograms (µg) of cadmium each day. People also can be exposed to cadmium from breathing in cigarette smoke as cadmium exposure from smoking cigarettes is a more serious health concern than cadmium in food. Smokers may double their daily intake of cadmium compared with nonsmokers. Each cigarette may contain from 1 to 2 µg of cadmium, and 40–60% of the cadmium in the inhaled smoke can pass through the lungs into the bloodstream. This means that smokers may take an additional 1–3 µg of cadmium into their body per day from each pack of cigarettes smoked. Exposure to smoke from other people's cigarettes probably does not cause nonsmokers to take in much additional cadmium [3]. For both blood and urine, none of the participants had levels of cadmium above the clinical reference interval. Based upon the results from this screening the levels of cadmium either in people's blood or urine were not consistent with unusual exposures.

Lead

The most widely used test for exposure to lead is the blood lead test, which indicates exposure to lead over the last several months. While urinary lead tests also indicate recent exposure, urinary lead tests are more variable than blood lead tests [4]. Due to the historical uses of lead in gasoline and paint, lead is commonly found in soil near highways and older homes. People may be exposed to lead by breathing air, drinking water, eating foods, or swallowing dust or soil that contain lead. Because lead is common in the environment and in food, low levels of lead in the blood, similar to what was found in this screening effort, are not unusual. For both blood and urine, none of the participants had lead levels exceeding the clinical reference interval. Based upon the results from this screening the levels of lead either in people's blood or urine were not consistent with unusual exposures.

Mercury

Very few participants had detectable levels of mercury in their blood, and mercury was not detected in any of the children tested. Less than 5 adults had blood mercury levels that exceeded the 95th percentile and were at the upper end of the clinical reference interval. A person may be exposed to mercury from breathing in contaminated air, from swallowing or eating contaminated water or food, or from having skin contact with mercury or mercury compounds. Mercury is common in some household products and in the environment. Mercury can build up in certain edible fish at concentrations that are many times greater than levels found in the surrounding waters. People may be exposed to higher levels of mercury if they have a diet high in these fish. Based upon the results from this screening, the levels of mercury in people's blood were not consistent with unusual exposures.

Limitations

This report reflects the results of the current screening effort which by themselves cannot be used to determine the source of arsenic, cadmium, lead, or mercury in any specific individual.

While information about the blood collection clinic was provided specifically to residents of Dona Park, Manchester Place, and Academy Heights, the clinic was open to all those concerned about exposure to these metals. Thus, these data only are representative of those people who came in to be tested and may not be representative of all residents who live or have lived in the neighborhoods near the former ASARCO facility. This screening was not designed to be a study and should not be interpreted as a study.

When appropriate, we compared test results to the 95th percentile from NHANES. However, NHANES does not contain information on metals in urine for children in the 1 to 5 years age group. Also, there were some instances in which the 95th percentile was below the detection limit for that metal. Because we could not detect some of these low levels of metals, we could not determine with any degree of certainty whether people in these age groups would have exceeded the 95th percentile. We indicated this as “unknown” in each table.

Conclusions

While we found detectable levels of these metals in participants, finding low levels of these metals in people is not unusual; most people had levels within the clinical reference interval. Follow-up testing on people identified with elevated levels of total arsenic in their urine indicated that very little was the harmful inorganic form, the levels of which were similar to those normally found in people. For the people tested in this screening effort the levels of arsenic, cadmium, lead, and mercury found in their blood and urine were not consistent with unusual exposures.

Recommendations

Individuals with health concerns regarding their test results should consult with their personal physician. Although there is normal dietary exposure to metals, people concerned about environmental exposure to metals should follow standard precautions for reducing exposure, such as washing hands after being outside and before eating. More information about reducing exposure to metals can be found at http://www.dshs.state.tx.us/epitox/education.shtm.

Authors and Technical Advisors

Carrie Bradford, MS, PhD
Toxicologist
Toxicology Program
DSHS - Austin, Texas

Tina Walker, EMT-I
Health Educator
Health Assessment and Consultation Program
DSHS - Austin, Texas

Susan Prosperie, MS, RS
Manager
Exposure Assessment, Surveillance, and Toxicology Group
DSHS - Austin, Texas

John F. Villanacci, PhD, NREMT-I
Principal Investigator/Director
Environmental & Injury Epidemiology and Toxicology Unit
DSHS - Austin, Texas

Acknowledgements

Funding for this screening was provided by the DSHS EIET State General Revenue funds. DSHS and Nueces County staff that assisted in sample collection and/or report review include Tom Ellerbee, David Rivera, Amanda Kindt, Richard Beauchamp, Celia Amey, Debbie Potter, Dwayne Potter, Rosa Fuentes, Melinda Martinez, and Dolores Arispe.

References

1. Texas Commission on Environmental Quality. Dona Park Neighborhood Assessment http://www.tceq.texas.gov/remediation/sites/donapark. Accessed October 21, 2011.
2. Wu AHB: Tietz Clinical Guide to Laboratory Tests, ed 4, St. Louis, MO, 2006, Saunders Elsevier.
3. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cadmium. Atlanta: US Department of Health and Human Services. July 1999.
4. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Lead. Atlanta: US Department of Health and Human Services. August 2007.
5. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Arsenic. Atlanta: US Department of Health and Human Services. August 2007.
6. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Mercury. Atlanta: US Department of Health and Human Services. March 1999.

Appendix A: Acronyms and Abbreviations

ASARCO	American Smelting and Refining Company
CDC	Centers for Disease Control and Prevention
DHHS	Department of Health and Human Services
DSHS	Texas Department of State Health Services
EIET	Environmental and Injury Epidemiology and Toxicology
EPA	Environmental Protection Agency
IARC	International Agency for Research on Cancer
ICP-MS	Inductively Coupled Plasma Mass Spectroscopy
µg	microgram
µg/dL	micrograms per deciliter
µg/g-c	micrograms per gram creatinine
µg/L	micrograms per liter
mL	milliliter
NA	not applicable
ND	not detected
NHANES	National Health and Nutrition Examination Survey
PCL	Protective Concentration Limit
TCEQ	Texas Commission on Environmental Quality
US	United States

Appendix B: Metals Information

Arsenic

Arsenic is a naturally occurring element found in the earth's crust, and is commonly found in soils, dust, and minerals. Arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. Understanding the difference between inorganic and organic arsenic is important because some of the organic forms are less harmful than the inorganic forms [5].

Since arsenic is found naturally in the environment, you normally take in small amounts of arsenic in the air you breathe, the water you drink, and the food you eat. Of these, food is usually the largest source of arsenic. Seafood contains the greatest amounts of arsenic, but in fish and shellfish, this is mostly in an organic form. Some seaweed products may contain inorganic forms of arsenic that may be more harmful. Most inorganic and organic arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air [5].

If you swallow water, soil, or food or breathe air that contains arsenic, it may quickly enter into your bloodstream. When this occurs your liver changes some of the arsenic to a less harmful organic form. Both inorganic and organic forms leave your body in your urine [5].

Some symptoms associated with swallowing excessive amounts of inorganic arsenic may include irritation of your stomach and intestines, which may cause stomachache, nausea, vomiting, and diarrhea. Other affects may include fatigue, abnormal heart rhythm, blood vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in the hands and feet. The single-most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include a darkening and thickening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. These skin effects are often associated with changes in the blood vessels of the skin and may predispose to the development of skin cancer [5]. These types of effects occur at doses significantly higher than typical environmental doses.

Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, and lungs. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is known to be a human carcinogen (a chemical that causes cancer). The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans. The Environmental Protection Agency (EPA) also has classified inorganic arsenic as a known human carcinogen [5].

Although most of the exposure pathways for children are the same as those for adults, children may be at a higher risk of exposure because of normal hand-to-mouth activities. Children who are exposed to arsenic may have many of the same effects as adults, including irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function. There is also some evidence that suggests that long-term exposure to arsenic in children may result in lower intelligence quotient scores. We do not know if absorption of arsenic in children differs from adults. However, some information suggests that children may be unable to convert the inorganic arsenic to the less harmful organic forms. For this reason, children may be more susceptible to health effects from inorganic arsenic than adults [5].

Cadmium

Cadmium is an element that occurs naturally in the earth's crust. Pure cadmium is a soft, silver-white metal. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements. Most cadmium used in the US is extracted as a by-product during the production of other metals such as zinc, lead, or copper. Cadmium has many uses in industry and consumer products, mainly in batteries, pigments, metal coatings, plastics, and some metal alloys [3].

Approximately half of the cadmium released each year is from the weathering of rocks. Forest fires and volcanoes also release some cadmium to the air. Human activities, including mining and burning of fossil fuels and household garbage also contribute to cadmium in air [3].

Cadmium can enter your body from the food you eat, the water you drink, from particles it may be attached to in the air you breathe, or from breathing in cigarette smoke that contains cadmium. In the US, the average person eats food containing about 30 micrograms (µg) of cadmium each day, but only about 1–3% of the cadmium from food is absorbed and enters the bloodstream. Studies indicate that more cadmium is absorbed into the body from the diet if the diet is low in calcium, protein, or iron, or if the diet is high in fat. Children who do not get enough iron, calcium, or protein may also absorb more cadmium [3].

Although food is a contributing route of exposure, you are at greater risk of being exposed to higher doses of cadmium through the air or tobacco smoke you inhale than from cadmium in foods you eat. Cadmium exposure from smoking cigarettes is a more serious health concern than cadmium in food. Smokers may double their daily intake of cadmium compared with nonsmokers. Each cigarette may contain from 1 to 2 µg of cadmium, and 40–60% of the cadmium in the inhaled smoke can pass through the lungs into the bloodstream. This means that smokers may take in an additional 1–3 µg of cadmium into their body per day from each pack of cigarettes smoked. Smoke from other people's cigarettes probably does not cause nonsmokers to take in much additional cadmium [3].

Although your body can change most cadmium to a form that is less harmful, too much cadmium can overload the ability of your liver and kidney to change the cadmium to a harmless form. A small portion of the cadmium that enters your body leaves slowly in urine and feces, however, most of the cadmium that enters your body can potentially remain there for many years [3].

The potential for cadmium to harm your health depends upon the form of cadmium present, the amount taken into your body, and whether the cadmium is eaten or inhaled into the lungs. There are no known good effects from taking in cadmium. Breathing air with very high levels of cadmium can severely damage the lungs and may cause death. Breathing air with lower levels of cadmium over long periods of time (for years) results in a build-up of cadmium in the kidney, and if sufficiently high, may result in kidney damage. Other effects that may occur after breathing cadmium for a long time are lung damage and fragile bones. Eating food or drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea, and sometimes death. Eating lower levels of cadmium over a long period of time can lead to a build-up of cadmium in the kidneys. If the levels reach a high enough level, the cadmium in the kidney will cause kidney damage, and also causes bones to become fragile and break easily [3]. These types of effects occur at doses significantly higher than typical environmental doses.

Lung cancer has been found in some studies of workers exposed to cadmium in the air and studies of rats that breathed in cadmium. The DHHS has determined that cadmium and cadmium compounds are known human carcinogens. The IARC has determined that cadmium is carcinogenic to humans. The EPA has determined that cadmium is a probable human carcinogen [3].

The health effects seen in children from exposure to toxic levels of cadmium are expected to be similar to the effects seen in adults (kidney, lung, and intestinal damage depending on the route of exposure). These effects are most easily seen in short-term high-level exposures [3].

Lead

Lead is a naturally occurring heavy metal. It usually exists in the environment with two or more other elements to form a lead compound. Lead compounds are used as a pigment in paint, dyes, and ceramic glazes and in caulk. However, the amount of lead used in these products has been reduced over the years. Lead can be combined with other metals to form lead alloys, which are commonly found in pipes, storage batteries, weights, ammunition, cable covers, and sheets used for blocking radiation. The use of lead in ammunition and fishing sinkers also is being reduced. Lead was previously used in gasoline as an additive to increase octane ratings. However, this use was phased out in the US in the 1980s, and beginning January 1, 1996, lead was banned for use in gasoline for motor vehicles [4].

Most lead used today is obtained from recycled lead-acid batteries. Other lead used in industry comes from mined ores (Alaska and Missouri in the United States) and recycled scrap metal. Although lead occurs naturally in the environment, most of the high levels found throughout the environment are the result of human activities. Prior to banning the use of leaded gasoline, most environmental lead came from vehicle exhaust. The greatest increase in environmental lead over the last three centuries (which occurred between 1950 and 2000) was attributed to the increased use (worldwide) of leaded gasoline. Other environmental sources of lead include releases from mining lead and other metals and from factories that make or use lead, lead compounds, or lead alloys. Weathering and chipping of lead-based paint from buildings and other structures also contributes to lead contamination in soil [4].

Lead is commonly found in soil near busy highways, railways, older houses, mining areas, industrial sites, landfills, and hazardous waste sites. People may be exposed to lead by breathing air, drinking water, eating foods, or swallowing dust or soil that contain lead. Skin contact with lead occurs daily, and inexpensive costume jewelry can contain high levels of lead. However, not much lead enters the body through the skin. Other potential exposures to lead include some hobbies, home remedies, hair and cosmetic products, occupational exposures, and home renovation that removed lead-based paint [4].

Lead that gets into the body travels in the blood to soft tissues and organs. After several weeks, most lead moves into bones and teeth. Lead can stay in the bones for decades, but may be released back into the bloodstream during pregnancy and periods of breastfeeding, after a bone is broken, and during advancing age [4].

Health effects related to exposure to lead are the same, regardless of the exposure route. For both adults and children, the main target for lead toxicity is the nervous system. Long-term, occupational exposure to lead has been linked to decreased performance in tests that measure nervous system function. Weakness in fingers, wrists, or ankles also is associated with sufficiently high lead exposure. Exposure to very high levels of lead can cause brain and kidney damage in adults and children, and may lead to death. Intermediate exposure levels in children can have adverse effects on blood, development, and behavior. At even lower levels of exposure, lead can adversely affect a child's mental and physical growth. It can also cause miscarriages in pregnant women and damage to organs responsible for sperm production in men [4]. These types of effects occur at doses significantly higher than typical environmental doses.

Mercury

Mercury is a chemical element that occurs naturally in the environment and is used in several industrial activities. The three primary chemical forms of mercury are elemental (metallic mercury), inorganic mercury, and organic mercury [6].

Metallic mercury is the elemental pure form of mercury. Metallic mercury is the familiar shiny silver liquid. Metallic mercury is used in a variety of household products and industrial items, including thermostats, fluorescent light bulbs, barometers, glass thermometers, some blood pressure devices, batteries, and electrical equipment manufacturing. Some traditional Hispanic and oriental cultures use liquid mercury in folk remedies. Metallic mercury fumes can be produced environmentally by spills, hazardous waste handling facilities, or facilities that burn fossil fuels such as coal [6].

Mercury combines with elements such as chlorine, sulfur, or oxygen to form inorganic mercury compounds. Some inorganic mercury is found in fungicides as well as in skin-lightening creams. Organic mercury is naturally formed when mercury combines with carbon. The most common organic mercury found in the environment is methylmercury. Methylmercury is of concern because it can build up in certain edible fish and marine animals at concentrations that are many times greater than levels found in the surrounding waters. People may be exposed to higher levels of methylmercury if they have a diet high in fish or shellfish that come from contaminated waters [6].

A person may be exposed to mercury from breathing in contaminated air, from swallowing or eating contaminated water or food, or from having skin contact with mercury or mercury compounds. Not all forms of mercury easily enter your body [6].

If small amounts of metallic mercury are swallowed, most passes on through the body in the feces and very little is absorbed into the bloodstream. However, if you breathe in mercury vapors most of the mercury enters your bloodstream directly from your lungs, and then rapidly goes to other parts of your body, including the brain and kidneys. Once in your body metallic mercury can remain for weeks or months. When metallic mercury enters the brain, it is readily converted to an inorganic form and is “trapped” in the brain for a long time. Most of the metallic mercury will accumulate in your kidneys, but some can also accumulate in the brain. Most of the metallic mercury absorbed into the body will eventually be eliminated either through urine, feces, or in the exhaled breath [6].

Inorganic mercury does not enter the body as easily as metallic mercury. Once inorganic mercury enters the body and gets into the bloodstream, it moves to many different tissues in the body. Inorganic mercury leaves your body primarily in the urine over a period of several weeks or months. Methylmercury is the form of mercury most easily absorbed through the stomach and intestines. After you eat fish or other foods that are contaminated with methylmercury, the methylmercury enters your bloodstream easily and goes quickly to other parts of the body. Methylmercury leaves the body primarily in the feces over a period of several weeks to months [6].

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 from chronic exposure to inorganic mercury compounds may result in severe fatigue, numbness or pins-and-needles sensations in the hands and feet, severe muscle aches in arms and legs, mouth ulcers or blisters on the gums, excessive sweating, chills, elevated blood pressure, irritability, shyness, tremors, changes in vision or hearing, and memory problems. Short-term exposure to high levels of metallic mercury vapors may cause various adverse effects including lung damage, with shortness of breath, burning sensation in the lungs, and coughing; other effects may include nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation [6]. These types of effects occur at doses significantly higher than typical environmental doses.