HEALTH CONSULTATION

Arsenic Results from the Exposure Investigation at Coronet Industries

CORONET INDUSTRIES
(a/k/a BORDEN FEED PHOSPHATE COMPLEX)

PLANT CITY, HILLSBOROUGH COUNTY, FLORIDA

EPA FACILITY ID: FLD001704741

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Background

Coronet Industries is located at 4082 Coronet Road, south of the city limits of Plant City, Florida. The company processes phosphates for use in animal food supplements, primarily for the poultry industry. The facility has been operating for over 90 years. In the past, the company mined phosphate deposits in the area, but no mining operations are currently being conducted. Coronet Industries indicated that it will end operations on March 21, 2004.

Groundwater collected from monitoring wells at the facility is contaminated with fluoride, arsenic, cadmium, lead, and alpha radiation (1). Many residents who live near the site rely on private wells for potable water. Public health officials and residents expressed concern that water from these wells could contain chemical contaminants at concentrations of health concern. This contamination could originate from naturally-occurring minerals in the underlying phosphate deposits, or from chemicals released during operations or waste management practices at the facility.

During the first two weeks of August 2003, State officials collected water samples from the private wells of residents who lived within a ¼-mile radius of the facility. The Department of Health Laboratories tested water samples from 43 homes for volatile organic chemicals, metals (including lead, cadmium, arsenic, and boron), fluoride, and gross alpha radiation. The results of these test indicated that water from some of the wells contained boron, arsenic, and alpha radiation at concentrations in excess of state drinking water standards.

In order to better characterize human exposure to site-related chemicals for residents who were consuming the water, The Florida Department of Health (FDOH), the Hillsborough County Health Department (HCHD), and the Agency for Toxic Substances and Disease Registry (ATSDR) conducted an Exposure Investigation (EI). We collected urine samples from residents whose wells had been sampled by the state and tested the urine samples for lead, cadmium, uranium, arsenic, fluoride, and boron.

On December 5, 2003, ATSDR and FDOH released a health consultation that discussed the results of the urine testing for lead, cadmium, uranium, fluoride, and boron (2). At the time we released this report, the urine samples had not yet been tested for speciated arsenic. These tests have since been completed, and this report will discuss the arsenic test data.

This report is being issued as a follow up to the Health Consultation of December 5, 2003. This earlier consultation should be consulted for details on the selection of target population, sample collection and handling, and laboratory analysis of the urine samples for lead, cadmium, uranium, fluoride, and boron. This report will only discuss the arsenic testing.

Test Procedures

During the week of August 12, FDOH sent a flier to potential participants that alerted them to the upcoming EI. The flier informed them that urine samples would be collected the following week from eligible residents. The residents were advised not to eat any fish or shellfish for four days prior to donating a urine sample. These instructions were given because after eating fish, the urinary arsenic level could be temporarily elevated because of the high content of organic arsenic compounds in fish and shellfish. Nevertheless, people who had recently eaten fish were not excluded from the investigation, since biomarkers of exposure for the other contaminants would not be affected.

The National Center for Environmental Health Laboratory (NCEH) in Atlanta analyzed 104 urine samples for total arsenic using inductively coupled plasma dynamic reaction cell mass spectroscopy. The analytical limit of detection for total arsenic was 0.6 micrograms per liter (µg/L). It was not possible to analyze the urine samples provided by two people for arsenic because of the small volume of urine that was provided.

NCEH analyzed 106 urine samples for speciated arsenic using high performance liquid chromatography inductively coupled plasma dynamic reaction cell mass spectroscopy. The analytical limit of detection for the arsenic species ranged from 0.4 to 1.7 µg/L. Creatinine concentrations were measured using an automated spectrophotometric technique.

Results and Discussion

After a person ingests arsenic in water or food, the arsenic is rapidly excreted from the body into the urine. Researchers have estimated that 45-85 percent of arsenic is excreted into the urine within 1-3 days after ingestion (3). Therefore, urine concentrations of arsenic are an indicator of recent exposure.

The urine samples were first analyzed for the total concentration of all forms of arsenic, which includes both inorganic and organic arsenic. Low concentrations of naturally-occurring, inorganic arsenic are present in water and some foods. Relatively high concentrations of naturally-occurring arsenic are present in fish and shellfish. However, most of the arsenic in fish and shellfish is in an organic form, especially as arsenobetaine and arsenocholine. These organic forms of arsenic are of little health concern, because they are relatively non-toxic as compared to inorganic arsenic. In fish and shellfish, from 2 to 10 percent of the total arsenic can be in the form of inorganic arsenic or its methylated metabolites (4). Trace concentrations of organic arsenic can also be found in chicken meat, because fish meal is sometimes added to chicken feed.

To differentiate between inorganic and organic forms of arsenic in the urine samples, a second analysis was conducted for "speciated" arsenic, which consists of inorganic arsenic (As^{+3} and As^{+5}) and its methylated metabolites (monomethylarsonic acid and dimethylarsonic acid). The results of this test are of greater health significance because of the toxicity of inorganic arsenic.

The results of this analysis could also be indicative of exposure to inorganic arsenic in drinking water. However, well water testing by the Department of Health Laboratories showed that water from only one well contained arsenic at a concentration in excess of the pending state drinking water standard of 10 µg/L. The arsenic concentration (13 µg/L) in water from this one well only slightly exceeded the state standard.

Table 1 presents a statistical summary of the concentrations of total arsenic detected in the urine samples. The arsenic concentrations are also reported as creatinine-normalized values to correct for urinary dilution.

Table 1: Urine concentrations of total arsenic detected in EI participants

	µg/L	µg/g creatinine
mean	28.6	27.2
median	9.3	7.2
range	0.7 – 604	1.7 - 557

After the ingestion of a seafood meal, urinary arsenic concentrations can increase to a concentration of 1,000 µg/L or more. However, in people with no unusual exposure to arsenic or recent ingestion of seafood, total urinary arsenic concentrations are usually less than 50 µg/L (5, 6). In this investigation, 10 of the participants had total urine arsenic levels of 50 µg/L or more. To differentiate inorganic from organic arsenic, all urine samples were tested for speciated arsenic.

In reporting the results of the speciated arsenic analyses, the concentrations of inorganic arsenic and its methylated metabolites were added together to yield total inorganic arsenic. As shown in Table 2, the concentrations of total inorganic arsenic in 106 urine samples ranged from not detected to 30.8 µg/L. There is no national reference range for background concentrations of speciated arsenic in urine samples from the general United States population. However, the results of several studies in the scientific literature indicate that the concentrations of speciated inorganic arsenic in people with no unusual exposure to arsenic are usually less than 20 µg/L (7, 8, 9).

Table 2: Urine concentrations of speciated inorganic arsenic detected in EI participants

	µg/L	µg/g creatinine
mean	6.11	4.15
median	5.1	3.59
range	ND – 30.8	ND-23.9

ND – not detected

The average urinary concentration of speciated inorganic arsenic in the participants of this investigation was 6.1 µg/L. Only one participant had a speciated inorganic arsenic concentration (30.8 µg/L) in excess of 20 µg/L. However, this person also had a very high concentration of arsenobetaine (490 µg/L) in his urine sample, which indicates he likely ate seafood shortly before donating a urine sample. Therefore, the elevated speciated inorganic arsenic concentration in this person is likely due to the inorganic arsenic content of the seafood he ate.

Several studies have examined the health effects of long-term exposure to arsenic in the workplace. These studies reported that chronic exposure to high doses of arsenic, primarily in workplace air, is associated with peripheral neuropathy, altered kidney or liver function, and lung cancer. However, when adverse health outcomes were observed, the exposures, as measured by urine arsenic levels, were higher than those measured in this study. To protect adult workers in occupational settings, the American Council of Governmental and Industrial Hygienists has recommended a Biological Exposure Index for arsenic of 35 µg/L (10). None of the inorganic arsenic levels in urine detected in this investigation exceeded this level. Therefore, the urine arsenic levels measured in the participants of this investigation were below levels that have been associated with adverse health outcomes.

Limitations of this Investigation

The participants in this investigation varied considerably in their use of well water. Some reported using well water for drinking, cooking, and non-potable purposes in their household. Others used well water only for non-potable purposes and used bottled water for drinking. Some of the participants reported using water treatment devices such as water softeners, particulate filters, carbon filters, and reverse osmosis units. Furthermore, several of the participants reported that they stopped drinking the water after they received their water test results from the State, which was a day or two before this investigation was conducted. In addition, whenever possible, the State collected water samples prior to its passage through treatment devices. Therefore, the concentrations of chemicals in the raw water could differ from what the participants were drinking from the tap.

Because of these multiple sources of variability, it is difficult to estimate exposures to drinking water contaminants. Furthermore, this investigation was offered as a public health service, so we did not exclude any residents whose wells had been tested, regardless of their water consumption history or use of water treatment devices. Arsenic is rapidly excreted from the body after ingestion, so the urine levels are strongly influenced by recent consumption. Some of the participants in this investigation had stopped drinking the water a day or two before they donated a urine sample. The urine levels of arsenic that were measured in residents who were not drinking the water at the time of the investigation may not be representative of their past exposures.

Reporting Results

In March 2004, ATSDR mailed individual test results and an explanation of their significance to the participants of this investigation. A toll-free telephone number was provided so the participants or their physicians could call ATSDR if they had questions about their test results. The FDOH will mail copies of this report to the participants.

Conclusions

The urine arsenic test results indicated that the participants in this investigation were not being exposed to elevated doses of inorganic arsenic from the environment. The urine arsenic concentrations detected in this investigation have not been associated with adverse health outcomes. ATSDR concludes that the urine arsenic concentrations measured in this investigation pose no apparent public health hazard.

Recommendations

Residents whose wells produce water that contains contaminants in excess of drinking water standards should continue to use bottled water or an alternative water source for potable purposes.

Public Health Action Plan

The Florida Department of Health will prepare several health consultations for the Coronet Industries site. These reports will assess all available data and information for the site and determine if environmental contamination from the site poses a public health hazard.

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