

Letter Health Consultation

Evaluating Blood Barium Results

Meadowbrook Trailer Park

Muncy, Lycoming County, Pennsylvania

March 8, 2013

Prepared by:



Pennsylvania Department of Health
Division of Environmental Health Epidemiology

Health Consultation: A Disclaimer

The Pennsylvania Department of Health (PADOH) Health Assessment Program (HAP) collaborates with the Agency for Toxic Substances and Disease Registry (ATSDR), the lead federal public health agency, to prepare health consultation documents which determine if exposure to contaminants can harm people's health as well as prevent and reduce exposures and illnesses. A health consultation is a written response to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material, and considers the levels of hazardous substances at a site, whether people might be exposed to contaminants, by what pathways, and what potential harm the substances might cause to them. In order to prevent or mitigate exposures, a consultation may lead to specific actions and recommendations, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material. In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; conducting health studies; characterizing demographics; recommending changes/additions to related Commonwealth of Pennsylvania policies/regulations, improving quality of life; and/or providing health education for health care providers and community members.

ATSDR provides technical assistance and funding to PADOH to help identify and evaluate environmental health threats to communities using the best science, taking responsive public health actions, and providing trusted health information. While this health consultation was supported by funds from a cooperative agreement with the ATSDR, it has not been reviewed and cleared by ATSDR. More information about ATSDR is available online at www.atsdr.cdc.gov.

The conclusions and recommendations presented in this health consultation document are based on an analysis of the environmental sampling data and information made available to the PADOH within a limited time frame. The availability of additional sampling data, new information and/or changes in site conditions could affect the conclusions and recommendations presented in this document. PADOH will consider reviewing additional future data related to the site, if made available and deemed appropriate



To: Dr. Pamela Rutkoski, Primary Care Physician, Family Practice Center, Watsontown, Pennsylvania

From: Michael R. Makowski, Health Assessor, Health Assessment Program, Division of Environmental Health Epidemiology

Subject: Evaluate blood barium results from 3 patients' blood and whether barium concentrations are of public health concern.

A community well serves as a public water supply for Meadowbrook Trailer Park in Muncy, Lycoming County, Pennsylvania. In November 2012, quarterly testing of the well water revealed that barium levels (2.14 mg/L) exceeded the U.S. Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PADEP) Maximum Contaminant Level (MCL) for barium. (MCL for barium = 2 mg/L). On November 21, 2012, PADEP issued a public notice (Tier I order) to residents of Meadowbrook Trailer Park not to use this source of water for drinking and food preparation until the barium levels are below the MCL. After the public notice, three residents from Meadowbrook Trailer Park went to their primary care physician requesting that they be tested for barium. One patient complained of nausea, vomiting and diarrhea. The primary care physician ordered blood tests for barium. On January 18, 2013, the physician asked PADOH for assistance in evaluating the blood barium results from the three patients' blood tests and whether the barium concentrations are of health concern.

Background and Statement of Issues

The Meadowbrook Trailer Park was built in 1960. The trailer park consists of 84 home sites on 25 acres of land. A drilled well serves as the public water supply for the 84 units in Meadowbrook Trailer Park. This well is regulated by PADEP. Over the past 25 years the trailer park has had a history of water quality issues, two wells had to be abandoned due to high barium concentrations and there have been two previous notice of violation for the current well for barium MCL exceedances. After the notices of violation and prior to 2012, the trailer park management installed an ion exchange resin to treat for barium. On April 5, 2012, PADEP performed an inspection of the well because of pink water complaints. Water samples were collected and the results for barium in raw water were 1.45mg/L and 1.3 mg/L on finished water (after ion-exchange resin). Although the results for barium are not in violation of MCLs, the results suggested that the ion-exchange resin was not functioning properly. PADEP instructed Meadowbrook management to check the barium treatment system. [S. Hollister, PADEP

personal communication February 1, 2013] In October 2012, PADEP notified the Meadowbrook management they should be sampling the well quarterly for barium levels because MCL for barium has been exceeded. [S. Hollister, PADEP personal communication February 1, 2013; Pennsylvania Code: Drinking Water Regulations Chapter 109 section 301, Monitoring Requirements]. On November 7, 2012, PADEP was notified by the laboratory that water samples from the well at Meadowbrook Trailer Park exceed the MCL for barium (2.14mg/L) and a second confirmatory sample (November 21) confirmed the November 7th result. On November 21, 2012, PADEP issued a public notice (Tier I order) to residents of Meadowbrook Trailer Park not to use this source of water for drinking and food preparation until barium levels are below the MCL. In the public notice, residents were informed of the acute health effects of barium (gastrointestinal disturbances) and chronic health effects (increases in blood pressure). On November 26, 2012, PADEP sent a Notice of Violation to management of Meadowbrook Trailer Park. On December 6, 2012, PADEP advised management of Meadowbrook Trailer Park to furnish residents with bottled water. Corrective action was taken by the management of Meadowbrook Trailer Park and, on December 17, 2012 PADEP was notified by the laboratory that a water sample taken after refilling the well tanks was 0.04 mg/L for barium. The same day PADEP delivered a problem corrected notice to Meadowbrook Trailer Park, lifting the Do Not Drink order. [S. Hollister, PADEP personal communication February 1, 2013]

Results and Discussion

Blood Barium Data

After the public notice, three residents from Meadowbrook Trailer Park went to their primary care physician requesting that they be tested for barium. The three residents (patients) had their blood drawn to test for barium levels on the following days: December 12 (resident A), December 14 (resident B) and December 19, 2012 (resident C). On January 18, 2013, PADOH received the laboratory results of blood barium tests from the three patients. The blood barium levels for residents A thru C were 98 µg/L, 93 µg/L and 94 µg/L respectively. Resident B was re-tested for barium on January 4, 2013 (result -110 µg/L).

Toxicological Evaluation

Barium is a relatively abundant element found combined with other elements (a compound) in soil, rocks, and minerals and constitutes about 0.04% of the earth's crust (Reeves, 1979). Barium levels found in soils ranged from 100-3000 µg/g. (ATSDR Toxic profiles barium, 2007). Brooks (1978) estimated an average soil concentration of 500 mg/kg for barium. Barium can be transported into ground-water aquifers through the leaching and eroding of barium from sedimentary rocks. Barium was found in 94% of the surface waters examined, the concentrations range being 2-340 µg/liter (Kopp & Kroner, 1967).

Due to its abundance in soils, barium may be present in the air in areas with high natural dust levels. In the United States, the levels of barium that most people breathe contains about 0.0015 parts of barium per billion parts of air (ppb).

Despite the fact that barium is found naturally in soil, rocks, and water, the background levels in the environment are very low. The general population is exposed to barium mainly through consumption of food, drinking water and beverages, usually at low levels. Most surface water and public water supplies contain on average 0.030 parts of barium per million parts of water (ppm) or less, but can average as high as 0.30 ppm in some regions of the country. In some areas that have underground water wells, drinking water may contain more barium than the 2 ppm limit set by EPA. The highest amount measured from these water wells has been 10 ppm. [INCHEM org. EHC 107 Barium, 1990]

The major dietary sources of barium are milk, potatoes, flour, etc. Some foods, such as Brazil nuts, seaweed, and fish, may contain high amounts of barium. Gormican (1970) determined the barium content of a large number of food items, including dairy products, cereals, fruits and vegetables, and meats (see Table 1 in Appendix). The amount of barium found in food and water usually is not high enough to be a health concern.

The mean daily intake of barium from food, water and air is estimated to be slightly more than 1000 µg/day. Food is the primary source of barium exposure for the general population. However, where barium levels in water are high, drinking water may contribute significantly to barium uptake. The daily intake of barium is likely to vary with quantity and types of food ingested. [Toxic profiles barium, ATSDR 2007]

Most of the barium is removed from the body within one to two weeks mainly in the feces and urine. Barium can be measured in body tissues and fluids, such as bones, blood, urine and feces, but these measurements cannot be used to predict the extent of exposure. This is normally done only for cases of severe barium poisoning and for medical research. Also, there are no data correlating barium levels in bone, blood urine or feces with specific exposure levels. [Toxic profiles barium, ATSDR 2007] From the literature some of the reported “normal ranges” for barium in blood were 30 to 290 µg/dL [Carson, B. L et al], and 80-400 µg/dL. [Reeves, 1977]

The health effects associated with exposure to different barium compounds depend on how well the specific barium compound dissolves in water or in the stomach. For example, barium sulfate does not easily dissolve in water and causes few harmful health effects. Doctors sometimes give barium sulfate orally or by placing it directly in the rectum of patients for purposes of making x-rays of the stomach or intestines. The use of this particular barium compound in this type of medical test is not harmful to people. Barium compounds such as barium acetate, barium chloride, barium hydroxide, barium nitrate, and barium sulfide that dissolve in water can cause harmful health effects. Barium carbonate does not dissolve in water, but does dissolve in the stomach; it can also cause harmful health effects. [Toxic profiles barium, ATSDR 2007] Ingestion of soluble barium salts at high doses (e.g., barium carbonate, barium chloride) produces hypokalemia (a lower-than-normal amount of potassium in the blood) and acute hypertension (high blood pressure). [Koch, 2003; Downs et al., 1995] Systemic effects of acute barium toxicity include vomiting, diarrhea, cardiac

arrhythmia, muscular paralysis, and death. [CDC, 2003; 2002; Deng et al., 1991; Roza and Berman, 1971]

Several studies in humans suggested that chronic ingestion of barium from drinking water can produce high blood pressure. [U.S. EPA, Toxicological Review of Barium 2005]

Under the *Proposed Guidelines for Carcinogen Risk Assessment* [U.S. EPA, 1996b], barium is considered not likely to be carcinogenic to humans following oral exposure, and its carcinogenic potential cannot be determined following inhalation exposure.

Conclusion and Results

PADOH reviewed the results of the blood barium tests for these patients. In reviewing the literature on barium, PADOH found some of the reported “normal ranges” for barium in blood were 30 to 290 µg/dL. [Carlson, B. L et al], and 80-400 µg/dL. [Reeves, 1977] PADOH concluded that the blood barium levels in these patients (residents A thru C) (93 – 110 µg/dL) fell within the normal range and is not expected to cause any harm to these patients’ health. PADOH’s evaluation of the residents (A thru C) blood barium results was electronically mailed (e-mailed) to Dr. Rutkoski.

Corrective action was taken by the management of Meadowbrook Trailer Park to repair the barium ion-exchange treatment system for the well. On December 17, 2012, PADEP was notified by the laboratory that a water sample was now 0.04 mg/L for barium. PADEP lifted the Tier I order and residents were cleared to drink the well water. The management of Meadowbrook Trailer Park and PADEP should continue to monitor (quarterly) the trailer park’s well water for barium concentrations.

Sincerely,

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Appendix 1

Dietary sources of barium, from Gormican, A. (1970).

Food	Barium content (mg/100 g)
Beverages and dietary concentrates	
Chocolate syrup	0.17
Coffee	
Instant, dry	0.36
Ground, dry	0.32
Beverage, brewed	<0.008
Cocoa, dry	1.2
Meritene, plain flavor, dry	0.11
Sustagen, imitation vanilla flavor	0.056
Tea, orange pekoe	
Bag, dry	2.7
Beverage, steeped	
Breads, cereal products, crackers, and pastas	
Bread	
Rye	0.062
White	0.051
Whole wheat	0.11
Bran flakes, 40%	0.39
Cheerios (cereal)	0.13
Corn flakes (cereal)	0.04
Crackers	
Graham	0.11
Saltines	0.04
Egg noodles, uncooked	0.16
Macaroni, uncooked	0.11
Oatmeal, rolled oats (quick), uncooked	0.11
Puffed Rice	<0.04
Quick Cream of Wheat (cereal)	
Enriched, uncooked	0.2
Regular, uncooked	0.15
Rice Krispies	<0.04
Rice, white uncooked	<0.04
Shredded Wheat	0.22
Wheaties (cereal)	0.14
Spaghetti, uncooked	0.11

Cheese

American	0.12
Cottage, creamed	<0.04
Swiss	0.22

Eggs

Whole	0.76
White	<0.01
Yolk	0.058

Milk

Nonfat solids	<0.08
Fluid	
Whole	<0.01
Skim	<0.01
Buttermilk	<0.01
Ice cream, vanilla	<0.01
Sherbet, orange	<0.01

Fruits and fruit juices

Apple	
Raw, unpeeled	0.075
Juice, canned	<0.002
Sauce, canned, drained	<0.01
Apricots, canned, drained	<0.01
Banana, ripe	<0.01
Blueberries, waterpack, drained	0.014
Cantaloupe	<0.01
Cherries, Royal Anne, canned, drained	0.029
Grapes	
Fresh, with peel	<0.05
Juice, canned	0.023
Grapefruit	
Juice, canned	<0.008
Sections	
Fresh, skinless	<0.01
Canned, drained	<0.01
Orange	
Juice, frozen, reconstituted	<0.008
Sections, skinless	<0.008
Pineapple	
Crushed, canned, drained	0.014

Juice, canned	0.008
Peach, cling, canned, drained	<0.01
Pear, canned, drained	0.047
Prunes	
Cooked	0.064
Juice	0.014
Watermelon	0.022

Meat, poultry, fish, and shellfish

Beef, fresh, uncooked	
Flank, round, rump, sirloin, or tenderloin	<0.02
Ground	<0.02
Liver	<0.04
Lamb, fresh, uncooked	
Chop	<0.02
Leg	<0.02
Luncheon meat, big bologna	<0.02
Pork, fresh, uncooked	
Bacon	<0.04
Ham	<0.02
Liver	<0.04
Loin	<0.02
Veal, fresh, uncooked	
Round or steak	<0.02
Poultry, uncooked	
Chicken, roaster	
Dark meat	<0.02
White meat	<0.02
Turkey, roaster	
Dark meat	<0.02
White meat	<0.02
Fish and shellfish	
Crab, haddock, salmon, sockeye, sole, or tuna	<0.02
Shrimp	<0.02

Nuts

Peanuts	
Butter	<0.04
Salted, blanched	0.21
Pecans	0.67
Walnuts	0.072
Brazil nuts*	1500-3000 mg/kg

Sugars and flours

Sugar	
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Brown	<0.04
Powdered	<0.04
White	<0.04
Flour, bleached, enriched	0.072
Vegetables	
Asparagus spears, frozen, uncooked	<0.02
Beans	
Baked with pork	<0.02
Green, frozen, uncooked	0.16
Lima, baby, frozen, uncooked	0.031
Wax, canned, salt-free, drained	0.11
Beets, canned, salt-free, drained	0.26
Broccoli, frozen, uncooked	<0.02
Brussels sprouts, frozen, uncooked	<0.02
Cabbage, uncooked	<0.02
Carrots, uncooked	0.052
Cauliflower, frozen, uncooked	<0.02
Celery, fresh	<0.02
Corn, whole kernel, canned, salt-free, drained	<0.02
Cucumber	<0.02
Lettuce	<0.02
Mushrooms, stems and pieces, canned	<0.02
Onions, fresh, mature	0.053
Peas, canned, salt-free, drained	<0.02
Potato	
Fresh, uncooked	<0.02
Instant, uncooked	0.056
Pumpkin, canned	0.053
Spinach, frozen, uncooked	0.04
Squash, frozen, cooked	0.083
Sweet potatoes, canned	0.22
Tomato	
Fresh	<0.02
Juice, canned, salt-free	<0.008

* (Robinson et al., 1950; Smith, 1971a)

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