Communicating Biomonitoring Data that Impacts Public Health
Moderator:
Kristin Dortch, MS
Centers for Disease Control and Prevention

Speakers:
Marc Nascarella, Ph.D., MPH
Massachusetts Department of Public Health

Fuyuen Yip, Ph.D., MPH
Centers for Disease Control and Prevention

Christine Bean, Ph.D., MBA
New Hampshire Public Health Laboratories
Communicating Biomonitoring Data that Impacts Public Health

Polling Questions

What is your primary use for biomonitoring data?
Do you use the Environmental Health Tracking portal?
Do you have direct access to the legislators in your state?
Communicating Biomonitoring Results to Promote Environmental Health Interventions

Presented June 4, 2019 at the APHL Annual Meeting in St. Louis, MO

Marc A. Nascarella, MS, PhD, CPH
Bureau of Environmental Health
Massachusetts Department of Public Health
Preparing Individual Reports

Environmental Chemicals

Environmental chemicals are in the air, water, food, soil, and some products you may buy. Everyone is exposed (comes into contact with) environmental chemicals every day. Because you are exposed to environmental chemicals all the time, it is normal for them to be in your body.

Cadmium (kadm-uh-um)

Cadmium is naturally in rocks and soil. Cadmium is also used to make batteries, pigments, plastics, and other materials. Cadmium can travel long distances in the air and settle on water or soil. It can enter the environment from industrial activities, mining, or burning coal or waste. Cadmium can then enter the environment from industrial activities and mining.

How does cadmium enter and leave my body?

Some chemicals are naturally in the environment, while others enter the environment from industrial or human activity. Cadmium is naturally in rocks and soil. Cadmium can also enter the body when you breathe air containing cadmium vapors or smoke or by eating food that contains cadmium. Cadmium can be found in the air, soil, and water. It can also enter food during the growing process.

An environmental chemical may enter your body if you inhale (breathe in) it or if you eat or drink food that contains it. If the chemical is in the air, it enters your body through your mouth or nose. If the chemical is in the water, it enters your body when you drink water or bathe. If the chemical is in soil, it enters the body when you eat food that contains it.

How does cadmium enter and leave my body?

Cadmium enters the body through the digestive system. Cadmium is absorbed through the skin or in the mouth. Cadmium is also absorbed through the lungs. Cadmium may enter your body through the skin when you bathe or shower. Cadmium can enter your body if you eat food that contains it.

Cadmium leaves the body in different ways. Cadmium can be excreted through the urine or feces. Cadmium can also be excreted through the skin or in the breath. Cadmium can be removed from the body by the kidneys and liver.

Your Cadmium Results

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Test Type</th>
<th>Test Result</th>
<th>Typical Result</th>
<th>Upper-end Result</th>
<th>Health Reference Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>Urine</td>
<td>0.962</td>
<td>0.150</td>
<td>0.807</td>
<td>2.0</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Blood</td>
<td>0.024</td>
<td>0.239</td>
<td>1.25</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Your Results Compared to the Upper-end Level in U.S. Non-Hispanic Whites

<table>
<thead>
<tr>
<th>Chemical</th>
<th>U.S. Non-Hispanic Whites</th>
<th>Your Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.2</td>
<td>0.10</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.2</td>
<td>0.962</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0.2</td>
<td>0.024</td>
</tr>
<tr>
<td>Copper</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Iodine</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Lead</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Thallium</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Tin</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Uranium</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Vanadium</td>
<td>0.2</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Note: Times Higher than Upper-end Level
Discussing Individual Results

- Spot-collected specimens are a "snap-shot"
- Do not reflect total exposure or source
- May not be typical exposure for an individual
Population-Based Values VS. Health-Based Values

Urine Level (μg/g creatinine)

- ≥ HRL
- ≥ US_95th
- ≥ Geomean
- ≤ Geomean
- ≤ RL

Clinical Intervention

Environmental Intervention
Biomonitoring Data for Public Health Surveillance

APHL Annual Meeting
June 4, 2019
St Louis, MO
Biomonitoring Data on the Tracking Network

- **Potential Uses**
  - Track concentrations of analytes in US population over time
  - Serve as reference levels: compare with individual-level or state/local population-level data
  - Allow users to easily access and interact with NHANES data through a user-friendly interface

- **Potential Challenges**
  - Different methods used: populations, laboratory, sampling
Epidemiological Study Design Guidance for Biomonitoring Studies

- Make data from these studies useful for public health surveillance
- Share examples of probability sampling
- Complement other guidance documents provided by APHL and CSTE

Example: Minnesota East Metro PFAS Biomonitoring Projects - Two-stage cluster sample enrolling randomly-selected adults likely to be exposed to PFAS and from a PFAS-affected community.


Online link: http://www.health.state.mn.us/divs/hpcc/tracking/biomonitoring/projects/emetro-landing.html

Methods:
- Study location is a community with known PFAS exposures.
- Sampling frames (2 communities included):
  - People on community water: billing addresses of all households receiving municipal water service from city of Oakdale prior to January 1, 2005 (prior to the remediation)
  - People on private wells: private well sampling results for all households with PFOS or PFOA above trace levels
- Sent a household survey to a random sample of people on water billing records, and to all homes with contaminated private wells.
- Asked households to enumerate all eligible adults who lived there. (Restricted eligibility to those who lived in Oakdale prior to January 1, 2005.)
- Identified sample size for study. (Sample size determined by state legislation in this case.)
- Randomly selected eligible adults from the list to fit selected sample size. For anyone who declined, selected replacements.

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
<th>Recommendations for use or/and modifications suggested for use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population-based sample.</td>
<td>Results are limited to those from the same communities and not the general population.</td>
<td>Community outreach key to make residents familiar with issue/study and likely to participate.</td>
</tr>
<tr>
<td>Results can be applied to others from the same communities (those not tested).</td>
<td>Renters/non-homeowners are underrepresented on water billing lists, so may be missing important, possibly vulnerable sub-populations. (We addressed this in 3rd study by including a group of renters, but it was difficult to find a sampling frame and participation rates were lower.)</td>
<td>Important to consider health equity issues and alternate ways to include renters/non-homeowners.</td>
</tr>
<tr>
<td>Using an existing list as sampling frame was an economically efficient means of recruitment.</td>
<td></td>
<td>Don't have to restrict residence length.</td>
</tr>
<tr>
<td>With extensive prior agency outreach and community interest, participation rates can be high.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>These sampling frames work especially well when water is the source of exposure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Able to assess some differences between participants and refusals.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Working with Legislators to Influence Public Health and Environmental Health Policy

Christine Bean, PhD, MBA, MT(ASCP)
Laboratory Director
NH Public Health Laboratories
June 4, 2019
Environmental Health Commissions-
- HB511-Establishing a Commission to study environmentally-triggered chronic illness
- HB736/737/SB85-Reestablishing this commission

Environmental Health Bills
- HB661- Relative to a private right of action for toxin exposure
- SB81-DHHS authorization to hire ten EH personnel
- HB1356-Relative to data sharing between DES and DHHS
- HB691-Relative to blood testing for individuals exposed to perfluorinated chemicals in water supplies
- HB522, HB614, HB494, HB257
HB1592-2018
Requiring the commissioner of DES to review ambient groundwater standards for As

HB261- 2019
Lowers ambient groundwater quality standard for As to a value not to exceed 5 ug/L. (lowered from 10)
Effective July 1, 2021
Results and Reporting

Targeted Arsenic and Uranium Public Health Study

Your Personal Test Results

Targeted Arsenic and Uranium Public Health Study

Summary Report

What is biomonitoring?

Biomonitoring is the assessment of chemicals or their breakdown products in human specimens such as urine, blood, or tissue. The biomonitoring sciences are important because they give information on how people come into contact with chemicals from their environment, such as from their work, the foods and beverages they consume, or the products they use. The Targeted Arsenic and Uranium Public Health Study was a biomonitoring project designed to measure the levels of arsenic and uranium in New Hampshire (NH) residents. These metals were selected because NH residents are at risk of coming into contact with these naturally occurring contaminants if they consume contaminated groundwater.

Summary of the Targeted Arsenic and Uranium Public Health Study

Arsenic and uranium occur naturally in the granite that lies deep beneath NH soils. Approximately 85% of NH residents rely on private wells for their home water source and many of these wells are drilled deep into the granite bedrock in order to access the groundwater. Metals like arsenic and uranium can exit the bedrock and enter the groundwater, potentially creating unsafe levels in drinking water. These unsafe levels can cause health effects such as cancer, cardiovascular and respiratory disease, and effect brain development and kidney function. There is no NH law requiring a well owner to test their water or to treat their water if unsafe levels of contaminants have been found. Biomonitoring New Hampshire conducted this study to see if there are unsafe levels of arsenic and uranium in the well water of NH residents and (2) whether those metals are getting into people's bodies. This was done by testing both well water and urine for these metals.

The left image shows the probability of arsenic contamination in groundwater above the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) in NH groundwater. Previous studies suggest that arsenic is found in bedrock, uranium may also be found. The image below shows the targeted area (well owners) in light green and the comparison area (public water users) in dark green.
State Health Improvement Priorities

- Asthma
- Cancer
- Healthy mothers and babies
- Heart disease and stroke

State Initiatives

- NH Environmental Public Health Tracking Program
- Biomonitoring New Hampshire
- Per- and Polyfluoroalkyl Substances (PFAS) Blood Testing and Community Exposure
- Health Equity
- NH Youth Risk Behavior
- Occupational Health Surveillance Program
The Biomonitoring New Hampshire Program evaluates exposure to environmental chemicals by testing human specimens such as blood, serum, or urine for those chemicals or their metabolites. These chemicals may be natural, such as arsenic and uranium from groundwater, or they may be man-made, such as pesticides from agriculture. The program’s objectives are:

- To identify which groups of people are most at risk for coming into contact with chemicals from the environment.
- To educate NH residents on ways to reduce and/or eliminate their exposure to environmental chemicals.
- To build the capacity and capability of the NH Public Health Laboratories to conduct high-quality biomonitoring science.
- To communicate and reduce health risks from environmental chemicals by collaborating with public health professionals and legislators.

Financial and technical assistance is being provided through cooperative agreement with the Centers for Disease Control and Prevention (CDC) Division of Laboratory Sciences at the National Center for Environmental Health RFA EH14140202. The contents of these pages do not necessarily represent the official views of the CDC.

CDC National Biomonitoring Program
Targeted Arsenic and Uranium Study

Arsenic and uranium occur naturally in the granite that lies deep beneath New Hampshire (NH) soils. Metals like arsenic and uranium can leach from the bedrock into the groundwater, potentially creating unsafe levels of these contaminants in drinking water. These unsafe levels can cause health effects such as cancer, cardiovascular and respiratory disease, and affect brain development and kidney function. Biomonitoring New Hampshire conducted this study to see (1) if there are unsafe levels of arsenic and uranium in the well water of NH residents and (2) whether those metals are getting into people’s bodies. This was done by testing both well water and urine for these metals.

From August 2016 to September 2018, residents with private wells from 27 targeted NH towns were invited to participate in this study. A total of 515 participants from 258 households were recruited from the targeted area, as well as 31 participants from 35 households in a comparison area on a public water supply (see map below). All participants completed an exposure survey to assess whether they had contact with arsenic and uranium in ways other than their drinking water, such as from work, recreational activities, or consumption of certain food and beverages. They then collected a urine sample and household water samples, which were tested at the NH Public Health Laboratories.

The cities and towns in NH that comprise the “target area” for this study include those with groundwater containing arsenic above the Environmental Protection Agency’s maximum contaminant level. Bedrock aquifer mapping data from the U.S. Geological Survey shows that 515 residents who received their water from private wells participated in this study, while the comparison area, where public water is shown in red, is shown in green.
How Do Total Arsenic and Uranium Concentrations Vary Across Targeted Participants?

<table>
<thead>
<tr>
<th>U.S. Population (2015-2016) Percentile</th>
<th>Total Arsenic</th>
<th>Uranium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urinary Total Arsenic Concentration [µg/L]</td>
<td>Number of Participants (Percent)</td>
</tr>
<tr>
<td>&lt; 50th</td>
<td>&lt; 5.41</td>
<td>93 (10.1%)</td>
</tr>
<tr>
<td>50th to &lt; 75th</td>
<td>5.41 to 11.1</td>
<td>167 (32.4%)</td>
</tr>
<tr>
<td>75th to &lt; 95th</td>
<td>11.1 to &lt; 44.9</td>
<td>194 (37.7%)</td>
</tr>
<tr>
<td>≥ 95th</td>
<td>≥ 44.9</td>
<td>61 (11.8%)</td>
</tr>
</tbody>
</table>

- About 12% of the Targeted Participants had urinary total arsenic levels above the U.S. population 95th percentile whereas only 5% of the U.S. population were above this value.
- About 6% of Targeted Participants had urinary uranium levels above the U.S. population 95th percentile whereas only 5% of the U.S. population were above this value.

Source: wisdom.dhs.gov

How Do Total Arsenic and Uranium Concentrations of Targeted Participants Vary by Age and Sex?

<table>
<thead>
<tr>
<th>Targeted Participants</th>
<th>Number of Participants</th>
<th>Urinary Total Arsenic Geometric Mean [µg/L]</th>
<th>Uranium Geometric Mean [µg/L]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>512</td>
<td>12.8</td>
<td>0.058</td>
</tr>
<tr>
<td>Females</td>
<td>254</td>
<td>12.8</td>
<td>0.058</td>
</tr>
<tr>
<td>Ages 0-19</td>
<td>201</td>
<td>12.2</td>
<td>0.077</td>
</tr>
<tr>
<td>Ages 20-39</td>
<td>89</td>
<td>11.5</td>
<td>0.086</td>
</tr>
<tr>
<td>Ages 40-59</td>
<td>46</td>
<td>9.63</td>
<td>0.096</td>
</tr>
<tr>
<td>Ages 60+</td>
<td>202</td>
<td>12.9</td>
<td>0.066</td>
</tr>
<tr>
<td>Ages 60+</td>
<td>175</td>
<td>13.8</td>
<td>0.065</td>
</tr>
</tbody>
</table>

- The average urinary total arsenic and uranium concentrations did not vary significantly among male and female Targeted Participants or between the different age groups of Targeted Participants.

Source: wisdom.dhs.gov

Arsenic Speciation Testing Subset

Overall Urinary Arsenic and Uranium Concentrations in Study Participants

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Number of Participants</th>
<th>Statistics</th>
<th>Total Arsenic [µg/L]</th>
<th>Uranium [µg/L]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted Participants</td>
<td>515</td>
<td>Median</td>
<td>10.9</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geometric Mean</td>
<td>12.5</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5th Percentile</td>
<td>2.56 Below limit of detection</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95th Percentile</td>
<td>53.7</td>
<td>0.064</td>
</tr>
<tr>
<td>Comparison Participants (Concord, NH)</td>
<td>51</td>
<td>Geometric Mean</td>
<td>0.94</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95th Percentile</td>
<td>3.8</td>
<td>0.020</td>
</tr>
<tr>
<td>U.S. Population (USP) (2015-2016)</td>
<td>3901</td>
<td>Geometric Mean</td>
<td>5.96</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50th Percentile</td>
<td>5.41</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75th Percentile</td>
<td>11.1</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95th Percentile</td>
<td>44.6</td>
<td>0.021</td>
</tr>
</tbody>
</table>

- The study was designed to focus on an area of NH that is more likely to have arsenic and uranium in the groundwater.
- Because of this, it is not surprising that the Targeted Participants have a higher amount of total arsenic than the other populations in the table.

Source: wisdom.dhs.gov