Biomonitoring at the Minnesota Department of Health

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Minnesota Biomonitoring Legislation

- 2007
  - MN statutes 144.995-144.998
  - Created Environmental Health Tracking and Biomonitoring (EHTB) program

- Directed MDH to:
  - Develop tracking program to collect, integrate, analyze, and disseminate exposure data
  - Develop pilot biomonitoring program
  - Create EHTB advisory panel
  - Provide annual reports to legislature
Legislative directives
Biomonitoring Pilot Program

- Develop program guidelines to address biomonitoring
- Conduct 4 biomonitoring pilot studies
- Develop and implement a base biomonitoring program based on findings of pilot studies
Legislative directives

Biomonitoring Pilot Program

MN Statutes specify:

- NHANES protocols
- Community outreach
- Data privacy
- Informed consent
- Individual counseling
- Communications
Legislative directives
Biomonitoring Pilot Program

• Three chemicals specified by legislature
  – Arsenic
  – Mercury
  – Perfluorinated chemicals (PFCs)
• Fourth chemical to be selected by MDH in collaboration with advisory panel
• Funding provided, $500k/year for 2 years
  – Expires July 2009
Background
Minneapolis Children's Arsenic Study

• Soil contamination discovered in south Minneapolis in 1994
  – Company produced and stored arsenic-containing pesticides
• High levels of arsenic found in soil and in groundwater underneath site
• Manufacturing site clean-up completed in 2005
**Background**

Minneapolis Children's Arsenic Study

- In 2004 EPA determined that soil with arsenic levels above 95 ppm should be removed
  - 3,775 residential sites sampled
  - 196 sites with >95 ppm arsenic
  - Clean up completed in 2008
- In 2007 the site was listed on the National List of Priorities ("Superfund"),
  - additional funds to clean up lower levels of arsenic in soil that could be a concern over many years of exposure
Minneapolis Children's Arsenic Study

- Recruitment goals
  - 100 children, ages 3-10
  - residents of households in South Minneapolis where EPA testing has measured arsenic in soil

- Biospecimen
  - 2 first morning urine samples

- Analysis
  - Total urinary arsenic at MDH-PHL
  - Speciation if total arsenic > 15 μg/g creatinine
    - Separates organic from inorganic arsenic
Analytical methods

Minneapolis Children’s Arsenic Study

Inductively Coupled Plasma-Mass Spectrometry

- Low detection limits
- High Selectivity
- Fast

ICP-DRC-MS

- Dynamic reduction cell
- Removes carrier gas interferences (e.g. ArCl)
- Allows for sensitive arsenic measurements
Analytical methods
Minneapolis Children’s Arsenic Study

Liquid Chromatography – ICP-MS

- Separates compounds based on chemical properties
- Can separate \( \geq 6 \) arsenic species
Quality Control Sample
Purchased Standards

AC: Arsenocholine, *diet*
AB: Arsenobetaine, *diet*
As3: Arsenous (III) acid
DMA: Dimethylarsinic acid
MMA: Monomethylarsonic acid
As5: Arsenic (V) acid
Status

Minneapolis Children's Arsenic Study

- Initial goal to recruit 100 children residing on properties with soil arsenic >20 ppm
- Recruitment more difficult than expected
  - Vacant homes (12%)
  - No children in household (61%)
- Study was expanded to include households with any measurable soil arsenic level
- 65 children enrolled in study
Minneapolis Children’s Arsenic Study
23 of the 65 Samples were selected for Speciation

Total arsenic concentration in 23 samples was >15 μg/g creatinine
Study Results
Arsenic Species Measured in 23 of 65 Samples
Minneapolis Children’s Arsenic Study

• Values of arsenic substantially below clinical values
• Concentrations of total and inorganic arsenic in the study group slightly higher than NHANES, reason may be
  – Different age range (3-10 y vs 6-12 y)
  – Population exposure
• No relationship between soil and urinary arsenic values
• Results communicated to community this spring
Background

Perfluorochemicals (PFCs) in Minnesota

- PFCs were used widely in 3M commercial products
- 3M has manufacturing operations in the Twin Cities metro area
- PFCs are persistent in the environment and in people
Many private wells and public wells in the Twin Cities metro area have measurable levels of PFCs.

PFBA, PFOS, and PFOA are the most prevalent PFCs.
East Metro Perfluorochemicals (PFC) Project

• Recruitment goals
  – 200 Adults, age 20 or older, living in one of the two pilot project communities
    • Households served by Oakdale municipal water supply
    • Households with private wells that contain PFCs in Lake Elmo and Cottage Grove

• Biospecimen
  – Blood/seri,

• Analysis
  – Analyze at MDH-PHL for the seven PFCs Measured in the east metro water
Analytical method

East Metro PFC Biomonitoring Pilot

LC-MS/MS

<table>
<thead>
<tr>
<th>Compound</th>
<th>MDH Report Level (ng/mL)</th>
<th>Average level (ng/mL)*</th>
<th>Range (ng/ml)*</th>
<th>10th-95th percentile</th>
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</thead>
<tbody>
<tr>
<td>PFBA</td>
<td>0.1</td>
<td>na</td>
<td>na</td>
<td>na</td>
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<tr>
<td>PFPeA</td>
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<td>na</td>
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<td>PFHxA</td>
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<tr>
<td>PFOA</td>
<td>0.1</td>
<td>3.9</td>
<td>1.9 – 9.8</td>
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<tr>
<td>PFBS</td>
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<td>na</td>
<td>na</td>
</tr>
<tr>
<td>PFHxS</td>
<td>0.1</td>
<td>1.9</td>
<td>0.7 – 8.3</td>
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</tr>
<tr>
<td>PFOS</td>
<td>0.1</td>
<td>20.7</td>
<td>9.8 – 54.6</td>
<td></td>
</tr>
</tbody>
</table>

*results from National Health and Nutrition Examination Survey 2003-2004
Recruitment goals met
- 98 individuals from each community (196 total) completed blood draw and questionnaire

MDH-PHL has analyzed all 196 samples for PFCs

Participants have received individual results and summary analysis is underway
Background
Lake Superior Mercury Biomonitoring Study

- Initially begun as a collaborative effort with state newborn screening programs in Wisconsin and Michigan
- Funded primarily by a grant from the U.S. Environmental Protection Agency
- Target population includes persons who live within the Lake Superior Basin identified by ZIP code areas that drain water into Lake Superior
Study design
Lake Superior Mercury Biomonitoring Study

• ~2100 residual blood spots from 3 states
• Informed consent from MN participants
  – Samples anonymized for testing
  – Information retained
    • State of mother’s residence
    • Urban or non-urban based on ZIP code
    • Gender
    • Month of birth
Analytical methods

Lake Superior Mercury Biomonitoring Study

- Study enabled by method to measure mercury in residual blood spots (RBS) developed by Utah PHL
- Eluant protocol developed by MDH allows for speciation
- Method involves acid extraction followed by ICP-MS
Status
Lake Superior Mercury Biomonitoring Study

• Legislators agreed that study could be used to satisfy mercury biomonitoring pilot even though individual results will not be communicated
• MN began recruitment in Nov, 2008
  – Informed consent for 74 participants
  – Local public health assisting with consent process
• WI began enrollment in Feb, 2009
• MI currently unable to provide samples
  – Change in storage of specimens
  – Will likely require informed consent
Background
Riverside Prenatal Biomonitoring Study

- Conducted as an ancillary study to research project at University of Minnesota
- Study will measure pregnant women’s exposure to
  - Environmental phenols including bisphenol A
  - Cotinine, indicator of exposure to secondhand smoke
- Chemicals selected because of concerns that they may affect fetal development
Study design

Riverside Prenatal Biomonitoring Study

- Recruitment goals
  - 90 pregnant women from 3 ethnic groups
- Biospecimen
  - Urine
- Analysis
  - Analyzed for suite of environmental phenols at MDH-PHL
  - Analyzed for cotinine at commercial laboratory
Status
Riverside Prenatal Biomonitoring Study

- IRB approval obtained from U of MN
  - Stipulated that individual results not be returned to study participants
  - Aggregate community results will be provided
- Legislators notified of alternative approach
- Study materials completed
- Methods for evaluating environmental phenols using CDC methods are being implemented and validated
Strategic Planning

- MDH is engaged in a strategic planning process
  - Statement of vision and purpose
  - Best practices, strategies and methods
  - Criteria and a process for chemical selection for future studies
Lessons Learned
Recruitment

- Recruitment
  - Unexpected challenges
    - Not enough participants
    - Too many interested participants
  - Resource intensive
    - Multiple visits and communication methods needed
    - Costly
Study Design

• Lack of consensus on need/advisability of reporting individual results back to study participants
  – Legislators
  – Epidemiologists/Scientists
  – IRB
  – Community

• Determination of chemicals to be evaluated and study goals and design
  – Diversity of opinions
  – Political considerations
  – Interpretation of Results
Resource Limitations

- Led to creative approaches to designing pilot studies
- But convenience samples may not be so convenient
  - Addition of informed consent required additional resources for mercury study
    - ~30% participation after multiple contacts
  - U of MN IRB would not allow reporting of results back to individuals
Analytical Challenges

• Methods were in various stages of development at the start of the project
  – Required staff time for development and validation
  – Collaboration with other states and CDC was critical
• State funding was not enough to cover development costs
Funding for Analytical Method Development

- State biomonitoring funds
  - Covered lab analysis, no development funding
  - Needed to leverage other resources
- ATSDR grant for arsenic (1998-99)
- EPA grant for LSB mercury biomonitoring
- CDC PHEP (Level 2, 2003-2006, Level 1, 2007-present)
  - Build instrument capacity
  - Hire and train PhD scientists
Partnerships are Vital

- Program staff
  - laboratory scientists
  - toxicologists
  - environmental epidemiologists
  - statisticians
  - community health educators
- Health Agency steering committee
- Scientific advisory panel
- Key legislators
- Clinical and academic partners
- Communities
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