Biomonitoring: A public health and public interest perspective

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finding the ways that work
Why do we need to do more extensive biomonitoring?

- Hazard testing of most chemicals is grossly inadequate
- Exposure modeling is faulty at best
- "Ground truth" is essential for prioritization of resources
- Temporal trends of epidemics suggest environmental causes
Figure 1. Prevalence of overweight among children and adolescents ages 6-19 years

Percent

Age in years

<table>
<thead>
<tr>
<th></th>
<th>6-11</th>
<th>12-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963-70</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>1971-74</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>1976-80</td>
<td>7</td>
<td>5</td>
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<tr>
<td>1988-94</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>1999-02</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>


SOURCE: CDC/NCHS, NHES and NHANES
Percentage of children with asthma

Measure D1

Children ever diagnosed with asthma
Children who currently have asthma
Children ever diagnosed with asthma and having an asthma attack in the past 12 months


DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey

Note: The survey questions for asthma changed in 1997; data before 1997 cannot be directly compared to data in 1997 and later.
Autism on the Rise (Figure 1)

Over the last decade, the number of students diagnosed with autism in America’s schools has increased more than fivefold.

Growth in the Number of Autistic Students Served under the Individuals with Disabilities Education Act

<table>
<thead>
<tr>
<th>School Year</th>
<th># of Autistic Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-93</td>
<td>20,000</td>
</tr>
<tr>
<td>1993-94</td>
<td>25,000</td>
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<tr>
<td>1994-95</td>
<td>30,000</td>
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<tr>
<td>1995-96</td>
<td>35,000</td>
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<td>1996-97</td>
<td>40,000</td>
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<td>1997-98</td>
<td>45,000</td>
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<td>1998-99</td>
<td>50,000</td>
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<tr>
<td>1999-00</td>
<td>55,000</td>
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<tr>
<td>2000-01</td>
<td>60,000</td>
</tr>
<tr>
<td>2001-02</td>
<td>65,000</td>
</tr>
</tbody>
</table>

SOURCE: U.S. Department of Education
Kids, cars, blood lead
The smoking tailpipe...
NHANES III (1988-1994) Showed Blood Lead Levels Continued to Decrease as Gasoline Levels Declined
Blood Lead Level of Concern

Historic Perspective

Year

Blood Lead Level (µg/dL)

http://www.chicagolead.org/EducationalTools/LevelOfConcern.gif
Lessons from Lead

• Surprise ubiquity
• Clear hazard at high dose
• Data allowed study of low dose effects
• Biomonitoring provided the "smoking gun"
The “Kehoe” Paradigm

“If it is shown ... that an actual danger to the public is had as a result of treatment of gasoline with lead, the distribution of gasoline with lead in it will be discontinued”

Robert Kehoe, M.D. (1925)
The smoking rocket ship
Estimated Perchlorate Exposure based on Urine Concentrations

n=1532 Individuals,
Blount et al. 2007b
Infants in Boston Exposed to Perchlorate above “Safe” Levels

Estimated Perchlorate Dose to Infants based on human milk concentrations from 49 volunteers, Pearce et al. 2007
Perchlorate affects thyroid function in women with low iodine intake well below "safe dose"

adapted from Blount et al. 2007a

Change in Thyroid Hormones

Change in T4, ug/dL
Change in TSH, IU/L
The smoking armchair?
FIGURE 1. Total PBDE concentrations (ΣPBDE) in human blood, milk, and tissue (in ng/g lipid) shown as a function of the year in which the samples were taken; see Table 2. The three symbol types indicate the location from which the samples were collected. The overall regression is shown.
Figure 1. Daily PBDE dietary intake of U.S. population by age and food group (pg/kg body weight) as shown in Table 5. Abbreviations: F, female; M, male.
The Smoking Water Bottle?
Bisphenol A Exposure

Adapted from Calafat et al. 2005
The function of the pancreatic β-cell is the storage and release of insulin, the main hormone involved in blood glucose homeostasis. The results in this article show that the widespread environmental contaminant bisphenol-A (BPA) imitates 17β-estradiol (E2) effects in vivo on blood glucose homeostasis through genomic and nongenomic pathways. The exposure of adult mice to a single low dose (10 μg/kg) of either E2 or BPA induces a rapid decrease in glycemia that correlates with a rise of plasma insulin. Longer exposures to E2 and BPA induce an increase in pancreatic β-cell insulin content in an estrogen-receptor–dependent manner. This effect is visible after 2 days of treatment and starting at doses as low as 10 μg/kg/day. After 4 days of treatment with either E2 or BPA, these mice developed chronic hyperinsulinemia, and their glucose and insulin tolerance tests were altered. These experiments unveil the link between environmental estrogens and insulin resistance. Therefore, either abnormal levels of endogenous estrogens or environmental estrogen exposure enhances the risk of developing type 2 diabetes mellitus, hypertension, and dyslipidemia. Key words: bisphenol A, diabetes, endocrine disruptors, estradiol, estrogen receptor, insulin, islet of Langerhans, nongenomic, xenoestrogens. Environ Health Perspect 114:106–112 (2006). doi:10.1289/ehp.8451 available via http://dx.doi.org/ [Online 20 September 2005]
Is bisphenol A the next health risk to be uncovered through biomonitoring?

- Ubiquity
- Laboratory evidence of hazard at higher dose
- Nascent biomonitoring program

Overall, the available biomonitoring data indicates that actual human exposure to bisphenol A is far below levels that could cause adverse health effects and supports the conclusion that exposure to bisphenol A from all sources poses no known risk to human health.

What is the future for biomonitoring?
Disincentives for data generation and disclosure

- TSCA does not require base set of toxicity data for new chemicals
  - Less than 2% existing chemicals scrutinized

- "Confidentiality of sensitive business information is the lifeblood of many chemical companies." - SOCMA "TSCA Compliance Fundamentals Workshop" Oct. 2004
Increasing coordination of state and federal activity

- Expansion of CDC and state laboratories
- CDC funding of state biomonitoring programs
- State legislation for biomonitoring programs
CDC funded programs

- **New York**
  - POPs, PAHs, VOCs, Hg
- **New Hampshire**
  - As, Hg, phthalates, PBDEs
- **Rocky Mountain consortium**
  - 6 mining states
  - Heavy metals and arsenic
California Environmental Contaminant Biomonitoring Program

- Plan initiated in 2003; state not funded by CDC
- S.B. 1379 passed in 2006
  - Designed to assess geospatial localization as well as subpopulations
- Scientific Guidance Panel created summer 2007
Minnesota: “Tracking Toxins” bill

• Passed May, 2007
• Provides $2 million to state DHS to set up EH tracking and biomonitoring program
  – Pilot for As, Hg, and perfluorinated compounds
The Coordinated Environmental Public Health Network Act of 2007

- Sponsored by Senator Clinton (D-NY)
- Expands biomass monitoring data collection to allow analysis by geographic area and subpopulation
What is needed

• More robust data collection
  – Finer geospatial resolution
  – Individual level information relevant to exposure and risk

• Enhanced research and monitoring program on cumulative risk, including chemical stressors

• Enhanced coordination of state and federal health and environmental surveillance

• Increased research on social issues, including privacy, perception, communication

• Exploratory analyses of pooled samples
  – Focus on vulnerable subpopulations like fetuses, children
Thank You

www.environmentaldefense.org