CDC’s
Fourth National Report on Human Exposure to Environmental Chemicals

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National Center for Environmental Health
Public Health Mission

To prevent disease due to environmental chemicals, we must:

- Detect exposure, markers, or disease
- Assess health risks based on scientific evidence
- Implement interventions
- Assure those interventions are effective
Biomonitoring
-the measurement of chemicals in blood and urine-
can help meet public health goals
Traditional Exposure Estimation

“Dose or Intake”

- Water levels
- Soil/dust levels
- Food levels
- Air levels
- Fraction absorbed (lung, GI, skin)
- Frequency, duration
- Nutritional status
- Behavioral factors
- Other factors

Estimate “Dose”

Compare to toxic doses (animals)

Predict effects in people
Exposure-Effect Paradigm

Sources of Variability

- Dose
- Concentration in blood
- Concentration at the target site
- Target Effect
- Observed effect

Exposure Estimate:
- Multi-Routes
- Multi-measures
- Freq, Duration
- Behaviors
- Absorption *

Kinetics*:
- Time
- Absorption
- Distribution
- Elimination
- Metabolism

Dynamics:
- Equilibrium
- Physiologic state
- Receptor status
- Nutrition
- Disease/drugs/chemicals

Homeostasis:
- Physiologic antagonism
- Repair
- Metabolic compensation
- Receptor regulation
Attributes of Biomonitoring

• Exposure assessment
  – A more direct indicator of internal exposure than traditional “dose” estimation (intake)
    • Measured - not estimated or modeled
    • Person specific - not averaged
    • Inclusive of multiple exposure routes

• Risk and effect assessment
  – Can be better related to site of action than estimated intakes
    • Fewer intervening sources of variability (more precise)
  – Can be a measurable benchmark of risk or effects
## Blood Lead

- Effects are Benchmarked to Levels -

<table>
<thead>
<tr>
<th>Blood Lead Concentration (chronic and equilibrated)</th>
<th>Clinical</th>
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</thead>
<tbody>
<tr>
<td>Neuropathy</td>
<td>80+</td>
</tr>
<tr>
<td>Nephropathy</td>
<td>60-80</td>
</tr>
<tr>
<td>Encephalopathy</td>
<td></td>
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<tr>
<td>Colic, Anemia</td>
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</table>

### Subclinical

- Proteinuria, ↓GFR: 30-40
- Nerve conduction: 25
- ↑Protoporphyrin: 20
- ↑Blood Pressure: 10

### Risk

- ↓Vit. D metabolism
- ↓Hgb synthesis
- ↓Neurodevelopment
Biomonitoring Applications

• In Public Health
  • Epi-investigations
    – Prevalence of excess exposure
    – Case confirmation/tracking
  • Surveillance of the public’s exposure

• In Worksite Monitoring
  • BEIs, BATs – several metals and solvents
Biomonitoring Applications

• In Research
  • Better exposure assignments
  • Determinants of exposure
  • Observational associations
  • Concentration-effect relationships

• In Risk Estimation
  • Dose validation:
    – Direct dose-concentration relationships
    – Forward and reverse dosimetry
  • Animal to human extrapolation:
    – Level-to-level vs. dose-to-dose
  • Direct benchmarking of effects
Biomonitoring Program at CDC
Division of Laboratory Sciences

- **Methods**
  - Selection of techniques
  - Validation
  - Quality Assurance
  - Best practices

- 50+ studies per year
  - Collaborative research; epi-investigations; best practices

- Biomonitoring planning and funding to States

- Surveillance of the Public’s Exposure
  - *National Report on Human Exposure to Environmental Chemicals*
National Report on Human Exposure to Environmental Chemicals
Surveillance of the Public’s Exposure

- Who is exposed?  How much?
- Which chemicals?
- Time trends and interventions
- Establish reference values
- Prevalence above thresholds
- Set new research goals
National Exposure Report
NCHS

• National Health and Nutrition Examination Survey (NHANES, run by NCHS)
  – Stratified, multistage, national probability sample
  – 8000 people every 2 years
  – 30 localities via mobile trailers

• Data collected
  – Extensive questionnaire on demographics and health behaviors
  – Physical exam
  – Medical and nutritional lab tests
National Exposure Report
NCEH

• Blood or urine sampled from NHANES participants
  – A random 1/3rd subsample (most chemicals)
  – Sample size ~ 2500 per 2 yr period
  – Over 500,000 high-quality analyses

• Descriptive data
  – Geometric means, percentiles and confidence intervals
  – Age, gender, race/ethnicity

• General text on:
  – Uses, sources, biologic fate and effects
  – Comparisons to other biomonitoring studies
### Chemicals in the Reports

#### 148 Chemicals in 3rd Report
- Metals
- Polychlorinated biphenyls, dioxins and furans
- Organochlorine pesticides
- Carbamate pesticides
- Organophosphate pesticides
- Herbicides
- Polycyclic aromatic hydrocarbons
- Phthalates
- Phytoestrogens
- Pest repellants
- Cotinine

#### Added Chemicals in 4th Report
- Speciated arsenic
- Polybrominated diphenyl ethers
- Environmental phenols
- Perfluorinated chemicals
- Volatile organic compounds
- Perchlorate
- Acrylamide

**Better exposure information helps make better decisions to protect public health**
Fourth Report, 2009

- 212 chemicals
  - Searchable HTML
  - Downloadable PDF
- 470 tables, 1000 references
- 75 new chemicals
  - Early publications in scientific literature
- Cumulative data
  - 99-00, 01-02, 03-04
- Most extensive evaluation of U.S. exposures

www.cdc.gov/exposurereport
Website for the Report

The Fourth National Report on Human Exposure to Environmental Chemicals

The Fourth National Report on Human Exposure to Environmental Chemicals is the most comprehensive assessment to date of the exposure of the U.S. population to chemicals in our environment. CDC has measured 212 chemicals in people’s blood or urine – 75 of which have never before been measured in the U.S. population. The new chemicals include acrylamide, arsenic, environmental phenols, including bisphenol A and triclosan, and perchlorate.

The blood and urine samples were collected from participants in CDC’s National Health and Nutrition Examination Survey (NHANES), which is an ongoing survey that samples the U.S. population every two years. Each two year sample consists of about 2400 persons. The Fourth Report includes findings from national samples for 1999-2000, 2001-2002, and 2003-2004. The data are analyzed separately by age, sex and race/ethnicity groups.

Download the Fourth Report

Full Report [PDF - 8MB]
Chemicals in the Fourth Report [PDF - 50KB] This list provides the 212 chemicals and chemical metabolites included in the Report

Explore the Fourth Report

- Introduction
- Data Tables by Chemical Group
- Appendices

Additional Resources

- Peer-Reviewed Biomonitoring Articles
- Fact Sheets
- Chemical Nomination Process

National Biomonitoring Program

Environmental Health Laboratory
## Urinary Perchlorate

Geometric mean and selected percentiles of urine concentrations (in μg/L) for the U.S. population from the National Health and Nutrition Examination Survey.

<table>
<thead>
<tr>
<th>Survey years</th>
<th>Geometric mean (95% conf. interval)</th>
<th>50th (95% confidence interval)</th>
<th>75th (95% confidence interval)</th>
<th>90th (95% confidence interval)</th>
<th>95th (95% confidence interval)</th>
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<tr>
<td>01-02</td>
<td>3.54 (3.29-3.81)</td>
<td>3.70 (3.50-4.00)</td>
<td>6.30 (5.80-6.90)</td>
<td>10.0 (9.10-11.0)</td>
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<tr>
<td>03-04</td>
<td>3.22 (2.93-3.55)</td>
<td>3.30 (2.90-3.80)</td>
<td>5.50 (5.00-6.40)</td>
<td>9.50 (8.40-11.0)</td>
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<td>01-02</td>
<td>4.93 (4.22-5.76)</td>
<td>5.20 (4.40-6.40)</td>
<td>8.10 (6.90-9.80)</td>
<td>12.0 (9.30-19.0)</td>
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<td>11.0 (9.10-12.0)</td>
<td>15.0 (12.0-17.0)</td>
<td>617</td>
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</table>
Several Highlights
Widespread Exposure to Certain Industrial Chemicals

- **Perfluorochemicals**: PFOS, PFOA
  - Used to synthesize heat and stain resistant coatings
- **Polybrominated diphenyl ethers**: BDE47
  - Used as fire retardants in rugs, appliance casings
- **Bisphenol A**
  - BPA epoxy resins and polycarbonates
- **Perchlorate**
  - Used in solid rocket fuels, explosives, fireworks
Perchlorate

- Inorganic anion
- Uses/Sources:
  - Solid rocket fuel, fireworks, minor industrial uses
  - Some naturally occurring
- Exposure:
  - Water, milk, plant foods with high water content
- Goitrogen at high doses:
  - Blocks iodine uptake into thyroid
- Universal exposure in NHANES participants
  - Most less than Urinary equivalent of EPA RfD
Urinary Perchlorate

NHANES 2003-2004

Urine Perchlorate, ug/g creatinine
Impact of Biomonitoring

• Dose estimates and risk assessments:
  • Hg, perchlorate, dioxins, phthalates, PFOA, pesticides

• Animal research at human levels:
  • Phthalates, perchlorate

• Trends: Pb, ETS, OC pesticides, Hg, PFCs

• Comparisons to other populations
  • Epi-investigations
  • Occupational exposures
  • Regional pesticide exposure studies
  • Other surveys: Germany, NYC
Biomonitoring Summary

• Complementary approach to estimating exposure or to benchmarking health effects
  • Reduced variability in exposure and risk estimates

• National Report on Human Exposure to Environmental Chemicals
  • Prevalence, trends, reference values, risk assessment, scientific direction

• Division of Laboratory Sciences Biomonitoring Program
  • Definitive methods, expansion to State PHL, research on biomonitoring
Thank You