Use of Biomonitoring to Assess Human Exposure to Environmental Contaminants

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Biomonitoring California

Symposium: Bioaccumulation in California
Dec 17, 2012  Richmond, CA
Overview

• Biomonitoring California
• Background
  – Environmental sampling vs biomonitoring
• Basics of biomonitoring
• Biomonitoring for environmental contaminants
  – Mercury
  – Bioaccumulative contaminants
    • Polychlorinated biphenyls (PCBs)
    • Organochlorine pesticides
    • Polybrominated diphenyl ethers (PBDEs)
• Providing information to study participants
Biomonitoring California

- Established by the State Legislature (SB 1379) in 2006
- Tri-departmental program
  - California Department of Public Health (CDPH) Health and Human Services
  - Office of Environmental Health Hazard Assessment (OEHHA) California EPA
  - Department of Toxic Substances Control (DTSC) California-EPA
- Scientific Guidance Panel
- Public Involvement

www.biomonitoring.ca.gov
Biomonitoring California Goals

• Determine levels of environmental contaminants in California residents
• Examine trends in contaminant levels over time
• Help assess and inform regulatory programs & public health efforts

www.biomonitoring.ca.gov
Traditional Environmental Monitoring Framework

Directly measure chemicals in environmental media

Chemical Source

- air
- water
- sediment
- plants
- animals
- indoor environment

Mathematical Modeling (Lots of assumptions)
- Dose
- Pharmacokinetics

Predicted chemical levels in people
What is biomonitoring?

Collect blood, urine, or other biological specimens

Directly measure levels of environmental contaminants
Biomonitoring Environmental Contaminants – Factors to Consider

• Is the chemical absorbed into the human body?
• How fast is it eliminated and by what route (e.g., urine, feces)?
• Is there a biomarker (target chemical analyzed) specific to the contaminant?
  – Parent compound
  – Metabolite
  – Environmental breakdown product
• Can the chemical be measured in blood, urine or other biological matrices?
Bioaccumulative contaminants

• Absorption – generally well-absorbed

• Elimination - In general, slow elimination. Generally poorly metabolized and stored in adipose tissue.

• Biomarker specific to the contaminant
  – Parent compound – most likely
  – Metabolite – may be present at low levels, but sometimes analyzed
  – Environmental breakdown product (e.g., DDE)

• Commonly measured in blood
  – Also, breast milk and adipose tissue
Non-persistent contaminants

• Many metabolized and excreted quickly
  – Single or intermittent exposures can be hard to detect

• “Pseudo-persistent” chemicals
  – Non-persistent contaminants with ongoing exposures
  – Examples include BPA and phthalates

• Biomarker: often metabolite

• Commonly measured in urine
Mercury Contamination in Fish

- Methylmercury
  - Formed by action of bacteria in water, soil and sediment
  - Biomagnifies up the food chain

- Biomonitoring for mercury
  - blood: total mercury
    - Usually dominated by organic mercury compounds, primarily methylmercury
    - Generally, elevated total blood mercury reflects methylmercury exposure
  - urine: inorganic mercury
Examples of Mercury Findings from Biomonitoring California Studies

Firefighter Occupational Exposures Study (FOX)

Maternal Infant Environmental Exposure Project (MIEEP)
FOX Project Overview

• Collaboration with UC Irvine

• 101 firefighters in Orange County participated

• Blood & urine samples collected Oct 2010 - Feb 2011

• Contaminants measured include:
  – Some heavy metals
  – PBDEs
  – PCBs
  – Perfluorinated chemicals (e.g., PFOA, PFOS)
  – Pesticides
  – Phthalates
  – Polycyclic aromatic hydrocarbons (PAHs)

• Laboratory analyses in progress
FOX Project: Blood mercury findings

• Average blood mercury was higher in FOX participants compared to levels reported in the National Health and Nutrition Survey (NHANES).
  – NHANES 2009-2010: median blood level, 0.98 µg/L
  – FOX: ~ 3 times higher than NHANES

• Blood mercury has been shown to be higher in individuals living in coastal regions.
  – Associated with higher fish consumption
Blood mercury levels:
Studies in coastal and general populations*

- Korea coastal (n=293)
- British Columbia coastal (n=61)
- NYC (n=1811)
- USA coastal women (n=2603)
- Korea (n=1749)
- USA (n=2784)
- Canada (n=2678)
- Germany (n=709)

* Blood mercury values are for adult men and women, except for: US coastal adult women and Canadian population (includes ages 6-79).
Maternal Infant Environmental Exposures Project (MIEEP)

• Collaboration with UCSF and UC Berkeley

• 92 pregnant women, mainly Latina
  – Maternal urine & blood, umbilical cord blood

• Elevated mercury levels in one mother-infant pair

  Maternal blood: 15.16 µg/L  Cord blood: 7.43 µg/L

  – Both were higher than the CDC early reporting threshold of 5.8 µg/L for women of childbearing age and children.

  – High mercury levels were found to be the result of exposure to face cream imported from Mexico.

  – Blood mercury level was unrelated to fish consumption.
Bioaccumulative contaminants: PCBs

• Multiple sources of PCBs in environment
  – Diet is likely the primary source of exposure (e.g., fatty fish; and some high-fat meat and dairy products)
  – Other possible sources include old caulk, paint, floor finish, fluorescent light ballasts

• Biomonitoring has demonstrated declining levels in people

• However, PCBs are still commonly detected
  – Selected detection frequencies from Biomonitoring California collaborations*

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<th>Detection Frequency</th>
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<td>PCB-118</td>
<td>237</td>
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<td>PCB 138</td>
<td>237</td>
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<td>PCB 153</td>
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<td>96%</td>
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<tr>
<td>PCB 180</td>
<td>226</td>
<td>96%</td>
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*Presented at November 8, 2012 Biomonitoring California Scientific Guidance Panel meeting
Bioaccumulative contaminants: Organochlorine pesticides

- Organochlorine pesticides (OCPs) that Biomonitoring California is measuring are no longer used in the U.S.
- OCPs are still found in some fatty fish, and some high-fat meat and dairy products.
- Biomonitoring has demonstrated declining levels in people.
  - Selected detection frequencies from Biomonitoring California collaborations*

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<tr>
<td>DDT</td>
<td>199</td>
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<td>DDE</td>
<td>212</td>
<td>99.5%</td>
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<tr>
<td>Hexachlorobenzene</td>
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<td>98%</td>
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<tr>
<td>Oxychlordane</td>
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<tr>
<td>trans-Nonachlor</td>
<td>136</td>
<td>88%</td>
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Bioaccumulative contaminants: PBDEs

- Indoor dust is currently the primary source of exposure
- Exposure is greater in California
- PBDE blood levels in Californians are among the highest in the world
  - Selected detection frequencies from Biomonitoring California collaborations*

<table>
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<tr>
<th>BDE</th>
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<td>BDE-209</td>
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<td>38%</td>
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Other bioaccumulative contaminants

Biomonitoring California is also measuring

- Perfluorinated compounds (PFCs), such as:
  - PFOA
  - PFOS
  - Perfluorohexane sulfonic acid
  - Perfluorononanoic acid
  - Perfluorobutane sulfonic acid
Biomonitoring California Fact Sheets

Each chemical fact sheet describes

• Where the chemical is found
  – e.g., consumer products, food, dust
• Possible health effects
• Possible ways to reduce exposure
• Links for more information

Chemical fact sheets will be posted on the Biomonitoring California website (www.biomonitoring.ca.gov), in early 2013
## Frequently Asked Questions about Mercury

### Where is mercury found?
- Certain types of fish and seafood – this is the most common source of exposure to mercury
- Some imported face creams used for skin lightening, anti-aging, or acne
- Silver-colored dental fillings
- Glass thermometers, older barometers, and blood pressure gauges
- Fluorescent lights, including compact fluorescent light (CFL) bulbs

### What are possible health concerns?
Mercury:
- Can affect brain development and cause learning and behavior problems in infants and children who were exposed in the womb.
- Can harm the nervous system and kidneys.
- May affect the heart.

### What are possible ways to reduce exposure?
- Choose fish that are lower in mercury, such as salmon, tilapia, trout, canned light tuna, sardines, anchovies, and oysters.
- Avoid fish that are high in mercury, such as shark, swordfish, orange roughy, bluefin, and bigeye tuna.
- Do not use imported skin lightening, acne treatment, or anti-aging creams unless you are certain that they do not contain mercury.
- Properly clean up broken thermometers, CFL bulbs, and other items containing mercury. Do not let children play with silver liquid from items like mercury thermometers.

### For more information:
- Advice on mercury in fish that you catch: [www.oehha.ca.gov/fish/hg/index.html](http://www.oehha.ca.gov/fish/hg/index.html) or call (510) 622-3218
- Concerns about mercury exposure – contact the California Poison Action Line: [www.calpoison.org/home.html](http://www.calpoison.org/home.html) or 1-800-222-1222
- Cleaning up mercury spills, such as from broken thermometers or CFL bulbs: [http://www.epa.gov/mercury/spills/](http://www.epa.gov/mercury/spills/)
Biomonitoring supports public health action

Measure selected chemicals in California residents

Identify chemical exposures of concern

Inform environmental and health policies to reduce exposure to toxic chemicals