

## **Biological and Environmental Monitoring Brief**

*Developed by GBPSR, October 2002*

*Exposure to chemicals can be hard to quantify, yet it is a critical piece of the toxics puzzle. It is also a particularly difficult piece, because there are so many points along the path from chemical production to a target tissue where relevant information may be gathered, and each point along the path provides only a limited snapshot of information.*

“Human Exposures to Reproductive Toxicants” in Schettler T, Solomon G, Valenti M and Huddle A, Generations at Risk: Reproductive Health and the Environment, MIT Press, Cambridge, MA, 1999.

### **Routes of Exposure to Toxic Chemicals**

Human health can be harmed by acute or chronic exposures to toxic chemicals through various routes of exposure. The *In Harm's Way* program primarily addresses the health effects of chronic or low-level exposures, especially during fetal and early childhood development.

- Direct exposures can occur when chemicals in food, air, water, and dust are taken into the body by eating, breathing, drinking and skin absorption;
- Indirect exposures can occur through:
  - maternal intake of toxicants during pregnancy which are then transferred to the developing fetus;
  - release of chemicals stored in the mother's body to the fetus during pregnancy, or through breast-milk;
  - male and female exposures prior to parenthood that can alter the hormonal system, reproductive system, or genes, potentially affecting future offspring.

Exposures to toxic chemicals can cause acute health effects such as allergic reactions, skin rashes, gastrointestinal symptoms or even death, and chronic and long-term health effects, such as neurodevelopmental disabilities, which are often delayed in onset. High-level or ongoing, lower level exposures may result in delayed, subtle impacts that are often difficult to link to earlier exposures. New scientific information has taught us that the old adage "the dose makes the poison" is not necessarily so unless the timing of exposure is taken into consideration. Small exposures to particular toxins during critical windows of vulnerability can cause lifelong or even intergenerational effects. In addition, low-level cumulative exposures over long periods of time can also cause harmful health effects. Multiple exposures to many different chemicals each day also add to the complexity, as we do not know how most of these chemicals interact, and if that interaction may cause a more toxic affect than the single chemical alone.

The opportunity for exposure can occur if there is an environmental release of a toxicant into the air, water, or soil. Some toxicants enter the food chain and are transformed into a more harmful form of the chemical (such as the transformation of inorganic mercury into organic mercury, which then contaminates dietary fish at levels of concern). Some toxicants magnify in concentration as they move higher in the food chain (such as certain pesticides, dioxins, PCBs,

and methylmercury). Exposures can also occur during chemical production and use in the workplace, and from product use.

Both environmental monitoring (monitoring releases of toxic chemicals into the air, water and soil), environmental testing (of food, water, air), and biomonitoring (testing human blood, urine, hair, exhaled air, etc.), can provide important information about potential exposures as well as actual human exposures to toxicants.

### **Environmental Monitoring and Testing**

The U.S has many programs or activities for monitoring production, use and release of chemicals, as well as chemical presence in environmental media, food, and the human body.

Data may be collected on a regular or periodic basis under the following programs.

- The Toxics Release Inventory requires certain companies to report annually on releases of more than 650 chemicals each year to air, water, and land. The TRI has expanded since its inception in 1986 to include more types of companies that must report, more chemicals that must be reported, and lower thresholds for many of the more dangerous chemicals such as dioxins, mercury and PCBs. All of the data, by state and in the aggregate for the U.S., can be accessed via the EPA web site at [www.epa.gov/tri](http://www.epa.gov/tri), and can provide a valuable snapshot of the potential for exposures on a geographic basis.

- The National Center for Food and Agricultural Policy (NCFAP) is a private non-profit non-advocacy organization funded by the government and also industry. Its national report NCFAP National Pesticide Use Database is issued periodically and estimates total U.S. use of pesticides (including insecticides, herbicides, fungicides and fumigants). It includes state-specific data and again, can provide important information on potential exposure to pesticides. The most recent update is for 1997. The NCFAP National Pesticide Use Database contains 20,886 individual records that quantify the use of 235 active ingredients on 87 crops in the 48 contiguous states. Access it at: <http://www.ncfap.org/database/default.php>

Beyond the reporting of what is produced, used and released into the environment, there are a number of programs to test for the presence of toxicants in food, air and water. These include such programs as the U.S. Geological Survey for water testing, and the Total Diet Study Pesticide Data program.

- The U.S. Geological Survey (USGS) National Water Quality Assessment Program (NAWQA) began in 1991 with the purpose of producing a long-term assessment of the status of and trends in the quality of the nation's water resources. Although pesticides are one of the highest-priority issues for NAWQA, VOCs are also monitored. Monitoring is done in more than 50 major river basins and aquifers covering nearly all 50 states. Access at: <http://water.usgs.gov/nawqa/>

Locally, communities are now required, as part of the Safe Drinking Water Act revisions, to prepare an annual water quality “report card” and disseminate it to all citizens. Although it is not perfect, it is a step toward flagging potential exposure problems for community residents and health professionals. These can be obtained at the local Department of Water or Public Works, or from the Board of Health.

- The Food and Drug Administration's FDA's Total Diet Study (TDS) has provided data on dietary intake of food contaminants for almost 40 years. Since its inception in 1961 as a program to monitor for radioactive contamination of foods following atmospheric nuclear testing, TDS has grown to encompass residues of pesticides, industrial chemicals, toxic and nutritional elements, vitamins, and radionuclides. In all instances, analyses have been performed on foods prepared for consumption. Access at: <http://www.cfsan.fda.gov/~comm/tds-toc.html>

There is a useful resource entitled "Available Information on Assessing Exposure Pesticides in Food", USEPA Office of Pesticide Programs, 2000, available at:  
<http://www.epa.gov/fedrgstr/EPA-PEST/2000/July/Day-12/6061.pdf>

### **Biomonitoring and Testing**

The environmental presence of a chemical provides the potential for human exposure, but that does not necessarily mean there has been an exposure or health risk. Biological sampling of, for example, blood, urine, hair, breast milk, or exhaled air may be used to document that an exposure has occurred and to give some indication of the level of exposure. Depending on the chemical of interest, choices are made among the various biomonitoring options in order to gather the data most relevant for determining health risks. For example, some heavy metals like mercury can be measured in hair as an indication of exposure levels over time. Lead is preferentially stored in bone, and blood levels of lead only give an approximation of relatively recent exposures and a less useful indication of exposures in the past. Some chemicals are not stored in the body at all and are rapidly excreted so that biological testing must occur immediately after exposure in order to estimate the magnitude of exposure.

As a result, most biomonitoring programs concentrate on those chemicals that are stored in the body and that can be most easily measured in blood or urine. Less information is available for breast milk contaminants, and even less for those chemicals that are rapidly excreted.

Major U.S. biomonitoring programs include:

- NHEXAS - The National Human Exposure Assessment Survey (NHEXAS) was developed by the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency (EPA) early in the 1990s to provide critical information about multipathway (air, water, soil, house dust, food and beverage), multimedia population exposure distribution to chemical classes. Chemicals are measured on skin and in urine and blood. Chemicals known or suspected to be major environmental health risks include metals such as lead, cadmium, arsenic; pesticides such as diazinon and chlorpyrifos, VOCs, PAHs. The first phase consisted of three pilot studies involving 550 people - several hundred Arizona residents, several hundred in EPA Region IV north central U.S., and 60 people in Maryland. Two more phases are envisioned - special studies and a broader national population survey. Access at:  
<http://www.epa.gov/nerl/research/nhexas/nhexas.htm>

- NHANES - The National Health and Nutrition Examination Survey (NHANES) is a periodic national health study in the U.S. population with a subset of exposure to environmental chemicals.

In July 2005, using data gathered through NHANES, the CDC released the *National Report on Human Exposure to Environmental Chemicals*. The *Report* is the third in a series of publications that provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals using biomonitoring. It is the most extensive

assessment ever made of the exposure of the U.S. population to chemicals in our environment. For more information: Call 1-866-670-6052, or access the web at <http://www.cdc.gov/exposurereport/>.

### **Health Outcome Monitoring and Tracking**

Although there are registries for cancer and some for birth defects, there is no national chronic disease monitoring and tracking program. Such a program has been proposed at the national level and is currently being considered by Congress. There have also been calls to establish a nationwide breast milk monitoring program as an indicator of environmental pollution that is entering the human body, and particularly for fetal exposures. PSR National has led an effort on national monitoring and tracking of chronic health problems such as developmental disabilities and asthma.

Access: PSR National at [www.psr.org](http://www.psr.org)

### **At the Clinical Level**

At the clinical level, you can also test for the presence of chemicals if you believe an exposure has occurred. “Primer for the Clinician,” Page 302, Figure 10.1 “Biological Monitoring for Exposure to Potential Reproductive Toxicants” (in the Resource section of the binder), lists the biological monitoring test that would be used for 29 chemicals and substances including metals, solvents, and pesticides. More detailed recommendations can be obtained from standard textbooks of occupational or environmental medicine.

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Resources in binder to refer to:

Refer to Slide 43 of PPT presentation, “Factory to Fetus”

Refer to Slide 28 of PPT, “Bioconcentration”

Refer to “Primer for the Clinician”, Page 302, Figure 10.1 “Biological Monitoring for Exposure to Potential Reproductive Toxicants”

Health Care Provider Fact Sheet

Creating a Healthy Environment for Your Child’s Development Fact Sheet

Why Breast-Feeding is Still Best for Baby Fact Sheet