Biomonitoring: Making a Difference

Flash Presentation Transcript

The information contained in this document has been taken from a Flash format presentation on the topic of biomonitoring available on the National Biomonitoring Program's Website at:

http://www.cdc.gov/biomonitoring/biomonitoring_presentation.html

It has been divided into eight sections, each containing one or more subsections which correspond to the original presentation.

Section 1: Introduction

The Centers for Disease Control and Prevention (CDC) is recognized as the lead federal agency for protecting the health and safety of people – at home and abroad, providing credible information to enhance health decisions, and promoting health through strong partnerships. CDC serves as the national focus for developing and applying disease prevention and control, environmental health, and health promotion and education activities designed to improve the health of the people of the United States.

Section 2: Overview

Subsection: Biomonitoring

These days, it's virtually impossible for people not to come into contact with hundreds of chemicals each day—whether those chemicals are in our food, air, water, soil, dust, or the products we use. And it's even more difficult for people to know if those chemicals are harmful to their health or not. That's why the work being done at CDC's Environmental Health Laboratory is so important.

For at least three decades, scientists here have been determining which environmental chemicals people have been exposed to and how much of those chemicals actually gets into their bodies. This technique is known as biomonitoring. Biomonitoring measurements are the most health-relevant assessments of exposure because they measure the amount of the chemical that actually gets into people, not the amount that may get into people.

Our laboratory operates CDC's National Biomonitoring Program, which specializes in biomonitoring. The measurements we make support these essential steps to prevent disease or death caused by people's exposure to toxic substances:

Detect and monitor exposures.
Assess people's health risk as a result of exposure.
Develop and implement interventions that reduce exposure.
Evaluate how effective those interventions are.

Subsection: How Biomonitoring Works

So…how does biomonitoring work?

Right now, we can reliably measure more than 300 chemicals in people. We use methods that measure even very low levels of these chemicals in small amounts of people's blood or urine. And our scientists use the best instruments in the world to make these measurements.

Subsection: Goals of CDC's National Biomonitoring Program

Which environmental chemicals actually get into people? How much exposure does each person have? Are there particular population groups, such as minorities, the elderly, children, or women of childbearing age who are at higher risk for exposure than others and who might become ill as a result of their exposure to certain chemicals?

Goals of CDC's National Biomonitoring Program

- Find out which environmental chemicals actually get into people
- Measure how much exposure a person has
- Assess exposure for health studies of certain groups of people such as children or women of childbearing age.
- Determine which population groups, such as minorities, people with low incomes, children, or the elderly, are at high risk for exposure and adverse health effects.
- Assess the effectiveness of public health interventions.
- Monitor trends in exposure levels over time.

CDC's Biomonitoring Program helps answer these questions. Besides measuring exposure, we also monitor exposure levels over time, assess human health risks resulting from exposure, and provide accurate information that helps public health officials put in place the right public health interventions and then assess their effectiveness.

Subsection: Who We Work With

CDC's Biomonitoring Program analyzes levels of specific chemicals in the U.S. population, but we don't do testing for individuals. We also work with many different groups, including state health departments, to provide exposure information for public health investigations or emergencies as well as for about 60 to 70 exposure studies each year.

Health officials need biomonitoring information to help them make the best decisions that will benefit the health of the American public.

Our scientists collaborate with U.S. government agencies, state and local health departments, universities, community organizations, and international organizations on national studies of general population exposure and studies of specific exposed populations such as children.

Subsection: Difference Between Environmental Modeling and Biomonitoring

Biomonitoring is a way of measuring exposure to chemicals that is different from environmental modeling to gauge exposure. Environmental modeling is a way to monitor exposure to chemicals by measuring levels of that chemical in air, water, soil, or food, then estimating the amount of air one breathes, the food one eats and the skin contact one has with the chemical, then estimating amounts absorbed in the blood from these sources and finally making assumptions about a person's behavior and adding genetic factors into the mix.

Predicting levels of chemicals in people using environmental modeling is difficult. As a result, predicted levels of chemicals in people exposure may be very different from actual levels in their bodies.

Subsection: The Model - Biomonitoring

With biomonitoring, we can get actual measurements of the levels of environmental chemicals in people, making it the most health relevant way of assessing exposure.

Biomonitoring avoids errors resulting from the inaccuracy of interpreting environmental levels (that are measured in air, soil, water, or food) and personal recall as a way to estimate exposure. There are limits to the use of biomonitoring. It provides a snapshot in time of a person's exposure to environmental chemicals. But because of differences in individual genetic makeup, the nature of the chemical that gets into the body, and other factors, the metabolism and excretion of environmental chemicals vary from person to person.

It's also important to know that just because people have an environmental chemical in their blood or urine does not mean that the chemical causes disease. There's an old saying that "the dose makes the poison." We know that small amounts of some chemicals may be of no health consequence, but larger amounts may cause disease. For some chemicals, such as lead, research studies have given us a good understanding of health risks associated with different levels of lead in blood. But for most chemicals, we have more questions than answers. That's why more research is needed to determine whether exposure to chemicals at the levels we measure in the U.S. population are cause for concern.

Section 3: Public Health Impact

Subsection: Report Overview

Biomonitoring has taken the guesswork out of assessing the people's exposure to environmental chemicals. Every 2 years, CDC's National Biomonitoring Program also assesses the exposure of the U.S. population to specific environmental chemicals. From people who take part in CDC's National Health and Nutrition Examination Survey (also called N-HANES), our scientists analyze their blood or urine for environmental chemicals. We measure levels in the U.S. population as a whole as well as in groups divided by age, sex, and race or ethnicity. We publish this exposure information in CDC's National Report on Human Exposure to Environmental Chemicals.

As the largest study ever done on human exposure to environmental chemicals, it is an excellent snapshot of the exposure of the U.S. population to specific chemicals, including metals, pesticides, and tobacco smoke.

The Report also will help assess the effectiveness of public health efforts to reduce people's exposure to these chemicals and to set priorities for research on the effects of the chemicals on people's health.

- National Report on Human Exposure to Environmental Chemicals
- Which chemicals get into Americans
- Which people have chemicals above levels known to be toxic
    - Minorities
    - Children
    - Vulnerable Groups
- Assess the effectiveness of public health efforts
- Set priorities for research on human health effects.

Subsection: National Report on Human Exposure to Environmental Chemicals

The first National Report on Human Exposure to Environmental Chemicals was issued in March 2001 and presented exposure data for 27 chemicals. The Second Report, released in January 2003, presented biomonitoring exposure data for 116 environmental chemicals (including the 27 in the first Report) for the U.S. population over the 2-year period 1999-2000.

Chemicals in the Second National Report on Human Exposure to Environmental Chemicals

- Lead
- Mercury
- Cadmium
- Other Metals
- Pesticides
- Cotinine (Tobacco Smoke)
- Phthalates
- Polycyclic aromatic hydrocarbons (PAHs)
- Dioxins, furans, and coplanar polychlorinated biphenyls (PCBs)
- Non-coplanar PCBs
- Phytoestrogens
- Selected organophosphate pesticides
- Organochlorine pesticides
- Carbamate pesticides
- Herbicides
- Pest repellents and disinfectants

Section 4: Making a Difference

Subsection: Biomonitoring in Action

Chemicals are part of the everyday modern world. From the shampoo we use to the pan we cook in and the computer we work on, we are exposed to hundreds of chemicals every day. They can enter our body through drinking .. eating .. breathing… even through contact with our skin. Some of these chemicals may not make us sick or cause disease, but others can cause serious health problems.

The biomonitoring work being done at CDC's Environmental Health Laboratory plays an important role in understanding this exposure and what part these chemicals play in our nation's health. Let's look at some examples of biomonitoring in action….

Subsection: A Decline in Lead Use

CDC's Environmental Health Laboratory has been measuring lead levels in the population for many years. Lead poisoning can affect nearly every system in the body. It can cause learning disabilities, behavioral problems, and, at very high levels, seizures, coma, and even death.

Our information about lead levels in the U.S. population resulted in the rapid removal of lead from gasoline in the United States and prompted research that showed similar relationships of gasoline lead to blood lead levels in other countries. This information also resulted in the removal of lead in gasoline in almost every industrialized nation.

Subsection: What Biomonitoring Found

From 1976 through 1980, overall use of lead in gasoline declined as a result of the introduction of unleaded gasoline. Unleaded gasoline was introduced because lead interfered with the operation of catalytic converters in automobiles. In 1981, the U.S. Environmental Protection Agency, or EPA, was considering regulatory changes that would allow increasing the amount of lead in leaded gasoline because lead was an inexpensive octane booster.

Environmental monitoring data and modeling predicted that leaded gasoline had little effect on blood lead levels in people. But results of CDC's second national survey, covering the years 1976 through 1980, showed that declines in actual blood lead levels measured in people matched declines in levels of lead in gasoline, 10 times more than predicted from environmental modeling.

This critical finding was a major consideration in EPA's decision to further restrict the use of leaded gasoline. As remaining lead was removed from gasoline, lead levels continued to decline. By 1999, blood lead levels in children one to five years old had fallen to historic lows.

Gasoline lead levels continued to decline through 1991. Biomonitoring measurements taken from 1988 through 1991 showed blood lead levels continued to decrease as gasoline levels declined.

Subsection: U.S. Children 1-5 Years of Age with High Blood Lead Levels

Now that lead is out of gasoline, the most common source of children's exposure to lead is dust from older homes that contain lead-based paint. Lead-based paints were banned for use in housing in 1978. However, about 24 million homes in the United States still contain leaded paint and lead-contaminated house dust.

Children are particularly susceptible to lead exposure because of normal hand to mouth activity. The Report showed that 2.2% of children between 1 to 5 years old had blood lead levels that were of concern. This figure is down from the 4.4% in the early 1990s and dramatically lower than the 88% of children who had unacceptable blood lead levels in the late 1970s.

Subsection: U.S. Children 1-5 Years of Age with High Blood Lead Levels

Biomonitoring has been an essential tool in helping public health officials identify exposure to lead, track lead levels over time, determine groups at highest risk for lead poisoning, and assess how well programs aimed at reducing or eliminating exposure to lead actually work. The data collected through biomonitoring gave the EPA the crucial scientific human evidence it needed to accelerate the removal of lead from gasoline.

Biomonitoring continues to arm public health officials with the information they need to focus prevention efforts on children who are at high risk for lead exposure.

Biomonitoring enables public health officials to:

- Identify exposure to lead
- Track lead levels over time
- Determine groups at highest risk for lead poisoning
- Assess the effectiveness of intervention programs

Complete data on blood lead levels are available in CDC’s Second National Report on Human Exposure to Environmental Chemicals.

Subsection: Biomonitoring and Smoking

Cotinine is a "metabolite" -- or breakdown product -- of nicotine. It forms in the body when a person is exposed to nicotine. Nicotine gets into people's bodies if they smoke or chew tobacco, if they are involved in tobacco production and must handle tobacco, or if they are exposed to secondhand tobacco smoke--also called environmental tobacco smoke, or ETS. Levels of cotinine in the body track the amount of exposure a person has to tobacco smoke.

Subsection: Tracking Exposure to Environmental Tobacco Smoke

When CDC developed a method for measuring very low levels of cotinine in the U.S. population, it found that 88% of the non-smoking population was exposed to tobacco smoke.

Data were unavailable to document that people who thought they were exposed to environmental tobacco smoke in the workplace actually had such exposure. CDC showed that people who reported more exposure to environmental tobacco smoke in the workplace had measurably higher levels of cotinine, indicating higher actual exposure. These unique data provided important justification for establishing regulations restricting smoking in public buildings.

Subsection: What Biomonitoring Found

When cotinine levels in the U.S. population were measured again in 1999 and 2000, average cotinine levels among non-smoking people aged 3 years and older had decreased at least 70%. This dramatic reduction is an important public health success; however, because approximately half of all American youth are still exposed, and because children's levels are still twice those of adults, exposure to environmental tobacco smoke remains a major public health concern.

Subsection: Biomonitoring and Smoking -- Summary

Biomontoring enables public health officials to:

- Identify exposure to environmental tobacco smoke
- Track exposure of nonsmokers to environmental tobacco smoke over time
- Determine groups at highest risk for exposure to environmental tobacco smoke
- Assess the effectiveness of smoking-intervention programs
- Identify exposure of smokers and nonsmokers to other chemical risk factors

Complete data on serum cotinine levels are reported in CDC’s National Report on Human Exposure to Environmental Chemicals.

Section 5: Making a Difference

Subsection: Responding to Public Health Emergencies

Local public health officials serve on the frontlines in responding to public health emergencies. When an emergency arises, biomonitoring is a useful tool to monitor people's exposure to contaminants quickly and accurately.

Responding to a known or suspected excessive exposure takes three steps:

- First, identify the exposure and the people who are affected
- Second, assess the health risks of the exposure
- And third, treat those who are exposed and prevent further exposure

Subsection: Investigating a Possible Mercury Exposure

In January 2004, CDC researchers and laboratory scientists assisted Nevada health officials in assessing the exposure of 280 children, faculty, and staff to a large amount of liquid mercury at a rural middle school. A student had brought the elemental mercury to the school after finding it on a nearby estate, unaware that it was dangerous. Mercury is a naturally occurring metal that has many forms. Short-term exposure to high levels of metallic mercury vapors may cause lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

Scientists at CDC's National Biomonitoring Program measured mercury levels in the urine of the people most likely exposed and those who thought that they might have been exposed. They found that only one person—the child who had brought the mercury to school—had a mercury level that was slightly above levels in the general U.S. population. And the highest levels measured were still well below the level of mercury toxicity.

Subsection: Investigating a Cancer Cluster

A cancer cluster is a greater-than-expected number of cases of cancer that occur within a group of people in a geographic area over a defined period of time. In Churchill County, Nevada, health officials reported a significant increase in the number of children with leukemia. By the end of 2001, the disease had been diagnosed in 15 children.

Churchill County is in a geologically rich area where environmental chemicals are present from mining, agriculture, and a nearby military base. The potential for toxic levels of a chemical in the environment was present. But more information was needed. In 2001, the State of Nevada contacted CDC for help investigating the cases.

CDC's Environmental Health Laboratory analyzed blood and urine samples from 69 families in the Fallon, Nevada area of Churchill County for more than 100 chemicals. To date, no link has been established between exposure to any of the chemicals measured and the occurrence of leukemia. But the laboratory scientists did find differences in exposure to arsenic and tungsten for the Churchill County community as a whole when community-wide levels were compared with levels found in the general U.S. population. The arsenic finding confirmed an ongoing environmental concern for the community. This naturally-occurring element was prevalent in the Churchill County water supply.

Because of the tungsten finding, the National Institutes of Health is currently planning a study of tungsten as a priority chemical for toxicologic research. Biomonitoring made it possible to pinpoint areas of further research and give the people who were tested accurate information about chemicals in their environment and bodies at the time of the study.

Section 6: Chemical Terrorism

Subsection: Introduction

The attacks on September 11th and the subsequent anthrax scare made all of us aware that other kinds of terrorist attacks, including those involving chemical agents, could occur. The possibility of chemical attacks by terrorists underscored the need for a quick and reliable way to determine the identity of a chemical agent … who has been exposed … and the extent of their exposure. Health officials will need to make urgent decisions, and biomonitoring can provide valuable information reliably and quickly to help them make these decisions.

Subsection: CDC's Rapid Toxic Screen

The Rapid Toxic Screen is a series of tests that can identify up to 150 chemical agents in people's blood or urine. In the event of a terrorist incident involving chemicals, CDC's Environmental Health Laboratory would use the Rapid Toxic Screen to determine which chemical agents were used, who and who was not exposed, and the extent of exposure. This information is indispensable to medical and public health personnel managing the care of people in the terrorists' path as well as those who might believe they were exposed to a deadly chemical agent. This information also may help security and law enforcement agencies track the production or use of chemical-terrorism agents.

CDC's Environmental Health Laboratory maintains a select Laboratory Response Team that is available 24 hours a day, seven days a week to respond to a chemical terrorism event anywhere in the country. This Team will support the collection of clinical samples in hospitals and trauma centers to help ensure that proper testing can be done to assess people's exposure to chemical agents.

Subsection: Collaborating with State & Local Public Health Laboratories

CDC's Environmental Health Laboratory is also working with public health laboratories in states, territories, cities, and counties to assist them in preparing and responding to chemical terrorism incidents or other emergencies involving chemicals. They need the laboratory staff and equipment to conduct their own routine biomonitoring studies as well as special studies in case of industrial accidents or suspected chemical terrorism.

To help states build their own biomonitoring programs, CDC's environmental health laboratory provided funds to public health laboratories through cooperative agreements. CDC is also funding state and local laboratories to measure chemicals that may be used in terrorist events.

Subsection: Summary

With biomonitoring, CDC's Environmental Health Laboratory and public health laboratories that are part of a nationwide laboratory network can produce timely and accurate results of tests following a chemical terrorism event. And the advantage of having a common reporting system means that we are able to centralize the critical exposure information from multiple laboratories. Vital information gets back quickly to health officials, hospital emergency teams, and first responders, so they can manage the care of people in the terrorists' path as well as those who may believe that they were exposed to a deadly chemical agent.

Biomonitoring essentials:

- Timeliness in producing accurate results
- Capacity to deal with large or multiple events
- For multiple laboratories, a common reporting system

Section 7: Summary

As we have seen, biomonitoring has played a major role in key decisions that have had a positive and lasting effect on the health of people just like you. It is the most reliable and accurate way of getting science-based information about which chemicals and how much of them actually get into people’s bodies. But as useful as biomonitoring is, it must be used responsibly. Just because we can measure chemicals in people doesn’t mean the chemicals cause disease. As a result, more research is being done to help scientists not only to make the connections between exposure and the occurrence of disease but also to show where there is no link. Biomonitoring provides the solid human data needed to make sound public health decisions.

Section 8: Links & Resources

Subsection: Information on Chemical Exposure

The National Report on Human Exposure to Environmental Chemicals is available at http://www.cdc.gov/exposurereport/.

Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles are available at http://www.atsdr.cdc.gov/toxpro2.html.

Subsection: Lead

A fact sheet on lead is available at http://www.cdc.gov/exposurereport/Lead_FactSheet.html.

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Subsection: Cotinine

A fact sheet on cotinine is available at http://www.cdc.gov/exposurereport/Cotinine_FactSheet.html.

CDC's Office on Smoking and Health is available at http://www.cdc.gov/tobacco/.

Subsection: Public Health Emergencies

CDC's Emergency Response and Preparedness Web site is available at http://www.bt.cdc.gov/.

Subsection: Partners

The Association of Public Health Laboratories Web site is available at http://www.aphl.org/.