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Hazardous Substances & Public Health

Healthy People in a Healthy Environment

Polychlorinated Biphenyls

This issue of *Hazardous Substances and Public Health* is devoted to polychlorinated biphenyls (PCBs). Future issues of the newsletter will also focus on a single topic, chemical, or hazardous substance. For example, the fall 2001 issue will be devoted to asbestos.

PCBs are a group of manufactured organic chemicals that contain 209 congeners. Congeners are individual chlorinated chemicals. Some commercial mixtures of PCBs are known by their industrial trade name, Aroclor. In the past, PCBs have been used as coolants and lubricants in electrical equipment such as transformers and capacitors. The manufacture of PCBs was banned in the United States in 1977 because of evidence that they build up in the environment and cause harmful effects in humans and in wildlife.

PCB exposure can occur if you

- Eat food, including fish, meat, and dairy products, that is contaminated by PCBs
- Drink PCB-contaminated water
- Breathe air near hazardous waste sites that contain PCBs
- Use old fluorescent lighting fixtures and old appliances such as television sets and refrigerators (small amounts of PCBs might leak into the air)
- Repair or maintain transformers that use PCBs.

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Case Studies in Environmental Medicine

ATSDR's *Case Studies in Environmental Medicine: Polychlorinated Biphenyl (PCB) Toxicity* is being updated. It will be available on the Internet at www.atsdr.cdc.gov/HEC/CSEM/ and in print (see contact information, page 2).

The case studies series is a key part of the agency's health professional education strategy. They are available at no cost to educate and inform health professionals and the general public about hazardous substances. The case studies are accredited and offer continuing education credits.

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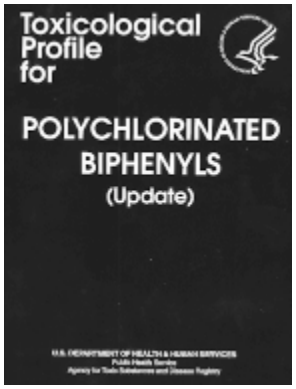
For a print version of the revised PCB case study when it becomes available, write to or fax the continuing education coordinator (Continuing Education Coordinator, DHEP, ATSDR, 1600 Clifton Road, NE (MS E-33), Atlanta, GA 30333, or 404-498-0061).

The Revised PCB Toxicological Profile

Obaid M. Faroon, PhD, DVM, Division of Toxicology, Agency for Toxic Substances and Disease Registry

ATSDR prepares toxicological profiles on the hazardous substances most commonly found at National Priorities List sites and on those substances that pose the most significant potential threat to human health. ATSDR reviews the profiles every 3 years to determine if revisions and updates are warranted. The overall goal in updating the profiles is to enhance the risk assessment process to the greatest possible extent.

The *Toxicological Profile for Polychlorinated Biphenyls* was updated extensively in 2000, from 450 pages to more than 900 pages, and it has been reformatted for easier use. The profile is organized by health end points, includes a running title and an index, and is hardbound. Following is a summary of the new information included in the updated profile.



Neurodevelopmental Studies

Recent findings from the Michigan Mother-Child Study, the Oswego Newborn and Infant Development Project, the Lake Michigan Aging Population Study, the Dutch Mother-Child Study, and the European Background PCB Study were summarized, representing over 10 articles. The studies found that background exposure levels to PCB, as measured by cord and/or maternal serum levels, induced neurobehavioral alterations in newborns.

Immunologic Studies

The Dutch Mother-Child and the Inuit Infant Studies found that infants born to PCB-exposed mothers had an increased number of middle ear and respiratory infections at a PCB level of 0.45 parts per billion (ppb) in cord plasma and/or at a PCB level of 620 ppb in breast milk (fat basis).

New Intermediate Oral Minimal Risk Level

The dose of 7.5 micrograms per kilogram per day was identified as the lowest observable adverse effect level in infant monkeys after a 20-week exposure to a PCB mixture simulating 80% of the congeners mostly found in the breast milk of Canadian women. The infant monkeys had decreased learning and performing abilities.

New Endocrine Disruption Section

New research and health discussions have focused on the potential harmful effects of endocrine disruptors, which are able to mimic, block, and modify the normal function of the endocrine system. Some scientists believe that these chemicals have potential adverse health effects in humans and animals. The endocrine disruption section outlines the effects of PCBs on breast cancer, estrogenic and antiestrogenic activity, the reproductive system, and thyroid glands.

New Child Health Section

Many studies indicate that children can have different susceptibilities to toxic chemicals than adults. These differences are probably due to behavior, pharmacokinetics, developmental stages, and body fat content. Information on neurobehavioral deficits, reduction in immunity, and endocrine effects of PCBs in children are discussed in sections 1.6 (How Can PCBs Affect Children?), 1.7 (How Can Families Reduce the Risk of Exposure to PCBs?), 2.7 (Children's Susceptibility), and 5.6 (Exposure of Children).

Requests for Toxicological Profile

ATSDR's *Toxicological Profile for Polychlorinated Biphenyls* is now available. If you qualify for a free copy,* contact ATSDR, Division of Toxicology, 1600 Clifton Road, NE (MS E-29), Atlanta, GA 30333 (telephone: 1-888-42-ATSDR or 1-888-422-8737; fax: 404-498-0057; e-mail: atsdric@cdc.gov).

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If you do not qualify for a free copy, you can purchase one from the National Technical Information Service (NTIS). Contact NTIS at 5285 Port Royal Road, Springfield, VA 22161 (telephone: 1-800-553-6847 or 703-605-6000; NTIS Web site: www.ntis.gov).

*Congress requires ATSDR to (1) provide toxicological profiles to state health and environmental agencies and (2) make them available to other interested parties.

A Tale of Two Cities: PCBs in Rome and Anniston

Howard Frumkin, MD, DrPH, Professor and Chair, Environmental and Occupational Health; Director, Southeast Pediatric Environmental Health Specialty Unit; Rollins School of Public Health of Emory University, Atlanta, Georgia

Pediatric Environmental Health Specialty Units (PEHSUs) are supported by ATSDR, the Association of Occupational and Environmental Clinics, and the U.S. Environmental Protection Agency. PEHSUs are a national resource for pediatricians, other health care providers, and communities. The program is designed to reduce environmental health threats to children, improve access to expertise in pediatric environmental medicine, and strengthen public health prevention capacity.

The key focus areas of the PEHSUs are medical education and training, clinical consultation, and clinical specialty referral for children who may have been exposed to hazardous substances in the environment. Eleven PEHSUs are now in operation. For more information about the PEHSU program, contact Chris Rosheim (cxr5@cdc.gov).

The Southeast PEHSU at Emory University recently worked with two PCB-contaminated communities. This article will (a) introduce the two communities, (b) compare and contrast them, (c) describe our activities in each community, and (d) offer conclusions about the value of PEHSU involvement at the community level.

Anniston

Anniston is the county seat of Calhoun County, Alabama. Although there is some industry and agriculture in the area, and a medical center serving the northeast part of the state, Anniston's economy has been heavily dependent on two large military bases. (One of these, Fort McClellan, recently closed; the Anniston Army Depot is still operational.) From 1929 to 1971, the Monsanto (now known as Solutia Inc.) plant manufactured PCBs (one of two U.S. facilities that did so). The plant is on the west side of Anniston in a low-income, mixed-race area. Considerable environmental PCB contamination has been documented near the plant. Since the early 1990s, community-based environmental justice groups have been active in Anniston, pursuing environmental sampling, public education, research by government agencies, litigation, and other initiatives.

Rome

Rome is the county seat of Floyd County, Georgia. It has a diversified economy, with sizeable manufacturers of container board and other paper products, wire, aluminum products, carpets, poultry products, and machine tools; a regional medical center; and three small colleges. From the 1950s until the 1990s, General Electric (GE) operated a medium transformer manufacturing facility in Rome. The facility used PCBs until the 1970s. The plant is on the northern side of Rome, in an area of light industry and predominantly white, middle-class neighborhoods. In the 1970s, PCB contamination was discovered on the GE site and in nearby waterways. The Georgia Environmental Protection Division issued fish advisories and began regulating the facility's waste stream. Environmental levels of PCBs began to decline. In 2000, the citizens' group, Citizens Action Network (CAN), was formed, and it has focused considerable public attention on PCB contamination since its formation.

Similarities and Differences

In some ways the Rome and Anniston areas are similar. In other ways they are quite different. Among these differences are duration of community concern and activism, history of litigation, profile of "key players," medical infrastructure, and data

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available on both environmental contamination and human levels of PCBs.

Widespread community attention to PCBs has a 10-year history in Anniston; in Rome it is more recent. As a result, Anniston has defined the problem in greater detail, and has pursued a range of remedies. In Rome, agency officials and citizens are still assessing the extent of the problem.

In Anniston, much litigation has occurred and is ongoing. Two large settlements have been reached; one included the relocation of several families. In Rome, no major litigation has been launched.

Key players in each city include community and environmental organizations; local, state, and federal health and environmental agencies; the facilities themselves; the medical community; the business community; local and county elected officials; school systems; and others. (A full analysis of each city, and a comparison of the two, are beyond the scope of this article.)

The medical infrastructures of the two cities are similar. Anniston's medical community is centered at the 372-bed Northeast Alabama Regional Medical Center; a smaller hospital (Stringfellow Memorial, with 125 beds) and numerous small private medical practices also exist. Rome has two hospitals, Floyd Medical Center (304 beds) and Redmond Regional Medical Center (201 beds), and several large multispecialty practices. Both cities are regional medical centers for their parts of the state, and both have family practice residencies. The Anniston medical community has remained largely detached from the PCB issue, whereas the Rome medical community has been eager to address patient concerns and to learn more about PCBs in continuing medical education sessions. The reasons for this difference are unclear.

Extensive environmental sampling in Anniston has defined the areas of contamination, and blood testing of almost 3,000 people—most by plaintiffs' attorneys, and the remainder by ATSDR—has documented the community's biological uptake. In Rome, in contrast, most available environmental sampling is from the plant site itself, and results from off-site properties are only now becoming available. Biological monitoring has yet to be conducted.

PEHSU Involvement

This brief comparison provides a partial picture of the communities encountered when PEHSU became involved with the sites. PEHSU was asked to become involved in Anniston by the U.S. Environmental Protection Agency's Region IV office and in Rome by the Georgia Environmental Protection Division. In Anniston, the primary focus was physician education; in Rome, it included both physician education and health information for the community. However, in both communities, PEHSU initiated dialogue with community and environmental groups, local officials, and others, in an attempt to understand the situations more fully and to provide more responsive, relevant information. PEHSU offered itself as an impartial, health-oriented resource in both communities.

In Anniston, the major health concern was child development and behavior. Both physicians and members of the community believed that too many children were hyperactive, inattentive, withdrawn, and/or had behavioral and learning difficulties. PEHSU therefore suggested addressing this concern directly, with a program of early detection of developmental and learning difficulties and early intervention. Although it is virtually impossible to prove that a child's learning difficulties have been caused by PCB exposure, it is possible to develop early intervention programs in a city where PCB exposure is common and where children might, as a group, be at risk. Discussions about this program—how to design, implement, and fund it—are underway with the school systems, community groups, the medical community, and others in Anniston. Because of its expertise in developmental pediatrics, PEHSU is assisting in these discussions.

In contrast to health concerns in Anniston, what emerged in Rome was a need for fuller information on PCB contamination. Although there is reason to suspect excessive levels of PCBs in the soil and waterways of Rome, environmental sampling data remain fairly limited, and biological data are unavailable. Accordingly, PEHSU suggested a program of blood testing to determine whether citizens in Rome have elevated body levels of PCBs. If some levels are elevated, PEHSU will attempt to identify the risk factors, such as a history of employment in the GE facility, residence near the plant, or residence near

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waterways that drain the plant area. In particular, elevated levels among children could indicate ongoing absorption of PCBs long after the cessation of PCB use at the GE plant. Discussion of the blood testing program—how to design and implement it, who should be screened, which laboratory should be used, and how to fund it—are underway, led by a broad coalition of local elected officials, the health department, CAN, and the business and medical communities.

Summary

Several conclusions can be drawn from these two projects.

- Careful "diagnosis" of the community—including a thorough history, a physical examination (multiple visits to the community, time spent with key people, and visits to the sites of contamination), and a review of laboratory data—is essential. This time-consuming process is necessary because no two communities are alike.
- Trust-building is essential, both to be able to elicit a complete history of the community and to be credible when offering solutions.
- Appreciating underlying tensions and needs is essential. Just as a patient who presents with hypertension may be struggling with family, job, and social problems that need to be addressed, a community presenting with chemical exposure may be struggling with economic challenges, discrimination, and marginalization. Without appreciating and addressing these issues, it is difficult to "treat" the presenting problem effectively. Moreover, when these underlying tensions and needs erupt in a noisy public forum, a tense private meeting, or an off-target newspaper article, that is as much a part of the process as an emotional interaction with a physician—something to be respected and handled sensitively, not feared or avoided.
- Just as a primary care physician must do the difficult work of remaining in contact with a variety of specialists on a complicated case, physicians who want to help at the community level must communicate regularly with numerous agencies, officials, and organizations to contribute to effective solutions rather than contradictory recommendations and even chaos.

In both Anniston and Rome, many professionals, mostly from government agencies and the manufacturers, had been active before PEHSU involvement began. Nevertheless, many doors were opened to PEHSU. We believe this resulted from our impartial medical input, the link with an academic medical center, and the technical expertise without a vested interest or local history. We believe PEHSU is "part of the solution" in both Anniston and Rome, and that these projects provide a model for PEHSU activity throughout the region.

Anniston Site Activities

Clement J. Welsh, PhD, MPH, Division of Health Assessment and Consultation, Agency for Toxic Substances and Disease Registry

Background

PCBs were manufactured in Anniston, Alabama, between the late 1920s and the early 1970s. The Anniston manufacturing plant was a primary producer of PCBs used in the United States. During the 40 years PCBs were made in Anniston, PCB waste materials were buried on-site and PCBs were released into the environment. In early investigations, PCBs were discovered in fish in an Anniston-area watershed. Follow-up investigations showed that releases of PCBs to surface waters contaminated banks and sediments of downstream ditches, creeks, and rivers in the Anniston area. In November 1993, the State of Alabama issued a "no consumption" fish advisory for the PCB-contaminated waters in the Anniston area.

Cooperative Efforts

Investigations conducted in the mid- to late-1990s shed more light on the extent of PCB contamination, as well as on human exposures to PCBs in the Anniston area. These investigations were a cooperative effort among ATSDR, the U.S. Environmental Protection Agency (EPA), the Alabama Department of Public Health, and the Alabama Department of Environmental Management. The investigations found that PCB contamination is attributable to operations at the former Monsanto PCB production facility (now known as Solutia Inc.).

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In 1996, the Alabama Department of Public Health released the results of an exposure investigation that concluded that the PCB levels in some residential soils were a public health hazard. Also in 1996, Monsanto instituted a property buy-out program that allowed residents to sell their contaminated properties to the company. In 1998, community groups collected soil samples from area properties and almost 3,000 blood samples from area residents. ATSDR evaluated the soil and blood data in 1999 and concluded that, although almost half of those tested had no detectable levels of blood PCBs, more than 500 persons did have elevated levels (draft document, released for public comment in February 2001). The soil samples indicated that PCB levels in some residential yards were a public health hazard.

Exposure Investigations

During the summer of 2000, ATSDR conducted an exposure investigation of 18 Anniston families living near the former Monsanto facility (draft document, released for public comment in October 2000). The primary aim of the investigation was to evaluate current exposures to children, who are a particularly sensitive population. The exposure investigation did not find unusual exposures in the children tested, but it did find that a substantial percentage of adults tested had elevated levels of blood PCBs.

Other Activities

During the summer of 2000, ATSDR also examined data from samples of PCB-contaminated soil at an Anniston-area softball complex. Data review and follow-up activities resulted in a significant soil clean-up project that was conducted over the winter of 2001. Hundreds of cubic yards of PCB-contaminated soil were removed. This action eliminates potential exposures to parkgoers when the park opens for the 2001 spring season.

ATSDR is finalizing reports of the studies previously mentioned and is preparing a health consultation assessing the potential hazard associated with an air exposure pathway in Anniston. In addition, the Alabama Department of Public Health finalized an earlier public health assessment that addressed the area near the former Monsanto facility.

Future Activities

ATSDR is involved in several ongoing and planned education and data evaluation activities in the Anniston area. These activities include general community involvement work, general exposure prevention education, specific exposure prevention education for area gardeners, education of health care delivery professionals, evaluation of on-site landfills, and evaluation of EPA's recently collected soil data. These activities are expected to lead to a more complete conceptual model of the Anniston area PCB site, and they will strengthen the public health recommendations as they relate to site-specific conditions.

Anniston PCB Health Education

Theresa L. NeSmith, BS, REHS, Division of Health Education and Promotion, Agency for Toxic Substances and Disease Registry

ATSDR is working on two activities related to PCBs in Anniston: general education regarding PCBs and gardening assessment and education. ATSDR is working with representatives from the Oak Ridge Institute for Science and Education in Oak Ridge, Tennessee, to develop and implement a gardening education program for Anniston residents. As part of this effort, we are meeting with community members and agency representatives to gather information about the gardening practices in Anniston and to discuss the best methods for communicating information to residents. Information gathered during the meetings and other discussions will be used to develop the gardening education program.

We developed a fact sheet and poster about safe gardening that will be distributed to agencies and community groups throughout Anniston. We also plan to participate in some upcoming community events that focus on gardening and work with community members and other agencies to promote safe gardening.

We also are developing health education materials for the community. These materials will describe PCBs and provide steps that people can take to reduce their potential exposure.

Great Lakes Human Health Effects Research Program

Heraline E. Hicks, PhD, Division of Toxicology, Agency for Toxic Substances and Disease Registry

Toxic substances in the Great Lakes basin present a significant public health concern. In the United States, some 80,000 commercial and industrial compounds are now in use, and more than 30,000 have been found in the basin. The International Joint Commission (IJC) has identified 11 of the most persistent and ubiquitous substances as "critical Great Lakes pollutants." These substances include polycyclic aromatic hydrocarbons, heavy metals, and organochlorine compounds, such as PCBs. These persistent toxic substances (PTSs) can bioaccumulate in sediment and organisms, biomagnify in food webs, and persist at high levels. Exposure to PTSs has caused toxic effects in wildlife, partly because of the persistence and ubiquitous presence of PTSs in the Great Lakes environment. Results from early epidemiologic investigations suggest the potential for adverse human health effects from exposure to PTSs (*1*).

Because of the implications of an association between pollutants in the Great Lakes and the potential for adverse human health outcomes, Congress amended the Great Lakes Critical Programs Act in 1990 and, in 1992, ATSDR received funds to initiate the Great Lakes Human Health Effects Research Program (GLHHERP). GLHHERP was designed to characterize exposure to PTSs via consumption of Great Lakes fish and to investigate the potential for short- and long-term adverse health effects to these pollutants by route of exposure.

Research Focus

From the onset, ATSDR focused its program on several human populations at particular risk from exposure to Great Lakes pollutants via fish consumption. These vulnerable or susceptible populations include subsistence anglers, American Indians, African Americans, Asian Americans, non-English–speaking populations, pregnant women, fetuses, nursing infants of mothers who consume contaminated Great Lakes sport fish (GLSF), young children, the elderly, the urban poor, and those with compromised immune functions. ATSDR has also identified sensitive and specific human health end points to assess in these populations. These end points include developmental, reproductive, endocrinologic, and immunologic measures.

Research Findings

Since 1992, ATSDR's GLHHERP has supported 10 studies of vulnerable communities in the Great Lakes states. The following GLHHERP findings focus on PCBs.

Exposure

- Fish consumption appears to be the major pathway of exposure to PCBs.
- Body burdens of PCBs among these community members are two to four times higher than among the general U.S. population. There is a significant trend of increasing body burden associated with increased fish consumption.
- In these communities, men eat more fish than women do; men and women eat GLSF during most of their reproductive years. Consumption of GLSF by women of childbearing age increases the risk for prenatal exposure to the most heavily chlorinated PCBs.

Demographics and Sociobehavioral Data

- A recent survey of adult residents of the eight Great Lakes states estimated that 4.7 million people eat GLSF in a given year; 43.9% of the respondents were women.
- Eighty percent of minorities who had eaten GLSF were unaware of fish advisories. Awareness of the advisories was especially low among women.

Health Effects

- Conception rate and the incidence of live births are lower among some women who eat sport-caught fish.
- Women who reported eating more than one meal per month of contaminated GLSF had significant menstrual cycle reductions.
- In the Oswego Newborn and Infant Development Study, neurobehavioral and developmental deficits have been observed in newborns (12 to 24 hours after birth and again 25 to 48 hours after birth) of mothers who had eaten approximately

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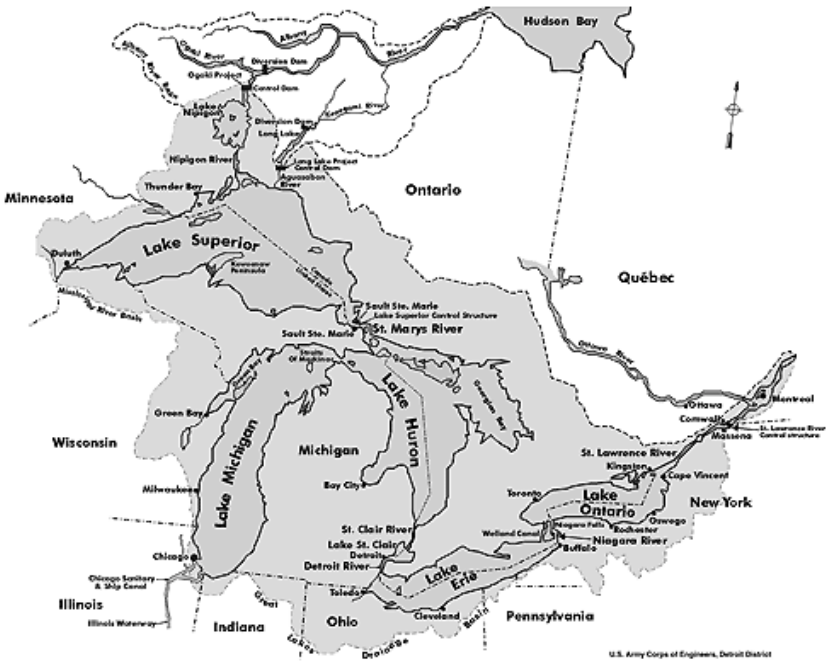
2.3 PCB-contaminated fish meals per month over their lifetime. The relationship between prenatal exposure to PCBs and performance on the Neonatal Behavioral Assessment Scale was assessed. The relationship between PCBs and performance impairment at 25–48 hours after birth was significant. Newborns were tested again at 6 and 12 months of age using the Fagan Test of Infant Intelligence. Test results indicated a significant relationship between exposure to PCBs and poor performance on the test. These cognitive deficits persist in these children at 36 months of age.

- PCBs and dichlorodiphenyl dichloroethene (DDE) were markedly elevated in an adult fish-eating cohort. Exposure to PCBs, not DDE, was associated with lower scores on several measures of memory and learning.
- Because of high consumption patterns in a population of American Indians, self-reported liver disease, diabetes, and muscle/joint pain may be associated with exposure to PCBs and other contaminants in fish. Elevated body burden levels of PCBs were significantly associated with poor scores on the pegboard performance test, which evaluates visual motor coordination and spatial orientation (*2*).

Impact of the Great Lakes Program

GLHHERP has made significant progress in reporting and evaluating findings that address public health concerns about exposure to contaminants in the basin. One reason for this progress is that the program has focused its research efforts on assessing health outcomes in vulnerable populations. ATSDR has been proactive, on the basis of these recent research findings, in providing support to develop culturally appropriate fish advisories and risk communication messages for susceptible populations. For example, regional maps have been developed in coordination with American Indians; the maps indicate which lakes, rivers, and/or streams to avoid or from which to limit their fish consumption. GLHHERP has held clinics in areas with large minority populations to ensure that these populations can identify which fish are discussed in the advisories. In addition, classes were held to discuss cleaning and preparation of fish



Map of the Great Lakes system.

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and to describe cooking practices that reduce exposure to contaminants. These and other activities have helped to reduce elevated body burden levels in these populations to levels at or near background.

In addition, the research findings from GLHHERP have influenced public health policy. For example, the establishment of a health protection value for PCBs in the *Uniform Great Lakes Sport Fish Advisory* (*3*) was based on other studies that showed neurologic effects in newborns. GLHHERP findings substantiated the use of neurologic effects in newborns as a sensitive human health end point. Great Lakes states are now targeting their fish advisories at vulnerable populations such as women and children. ATSDR's research findings formed the basis for 32 recommendations by IJC for negotiations of the Great Lakes Water Quality Agreement between the United States and Canada. Most importantly, this program provides answers to questions long asked by Great Lakes area residents about potential adverse health effects from exposure to toxic substances.

References

1. Hicks HE. 1996. The Great Lakes: a historical overview. Toxicol Ind Health 12:303–13.
2. Hicks HE, Cibulas W, De Rosa C. 2000. The impact of environmental epidemiology/toxicology and public health practice in the Great Lakes. Environ Epidemol Toxicol 2:8–12.
3. Anderson HA, Amrhein JF, Subat P, Hesse J. 1993. Protocol for a uniform Great Lakes sport fish advisory. Madison (WI): Department of Health and Social Services, Great Lakes Sport Fish Advisory Task Force.

Fish Advisories

Stephen R. Blackwell, RS, MPH, Division of Health Education and Promotion, Agency for Toxic Substances and Disease Registry

ATSDR, through an interagency agreement funded by the U.S. Environmental Protection Agency (EPA), developed a strategy for communicating information about the health risks associated with exposure to contaminants, including PCBs, in noncommercial fish. For example, ATSDR provides advice on how people who eat sport-caught fish can reduce exposures to PCBs.

Over the last 3 years, ATSDR and EPA collaborated to keep critical agencies informed about PCBs and fish consumption. The technical paper *Public Health Implications of PCB Exposures* (ATSDR) was distributed to state and tribal health and environmental agencies who develop and issue local health advisories. An update of the paper is available at www.epa.gov/ost/fish.

In addition, EPA and ATSDR developed a brochure on the health risks associated with exposure to PCBs. The brochure, *Should I Eat the Fish I Catch? A Guide to Healthy Eating of the Fish You Catch*, contained advice and recommendations for reducing health risks associated with exposures to PCBs through eating contaminated fish. The brochure was sent to health care providers who primarily served the more susceptible target populations of women and children. It is available in several languages and can be ordered by calling 1-800-490-9198.

Information about how to prepare fish and which fish are safe to eat was also distributed to health care provider groups. Exhibits included take-home educational materials to provide information and raise awareness of the fish consumption issue in the minds of health care providers and their patients.

For more information on the latest activities and for links to all advisory programs in the United States, go to www.epa.gov/ost/fish.

EPA United States Environmental Protection Agency
Office of Water

Download free interactive software on environmental topics from the SEAHOME Web site. These programs are produced by Purdue University in cooperation with the U.S. Environmental Protection Agency.

www.epa.gov/glnpo/seahome/

EPA United States Environmental Protection Agency

Purdue University

Health Effects of PCBs*

Pascale Krumm, PhD, Office of Policy and External Affairs, Agency for Toxic Substances and Disease Registry

PCBs cause numerous adverse health effects. PCBs induce liver cancer in animals and noncancerous effects on their immune, central nervous, endocrine, and reproductive systems. Some of the human studies are inconclusive because they fail to show a link between PCBs exposure and diseases. This is largely because epidemiologic studies have limitations that affect their ability to find health effects. These limitations include the small number of persons involved in a study (making it hard to discern a pattern), difficulty in determining actual exposure levels, and multiple confounding factors (e.g., smoking, drinking, and exposure to other contaminants). However, this does not mean that PCBs are safe. In fact, studies in humans suggest that PCBs have both carcinogenic and noncarcinogenic health effects. Therefore, EPA classifies PCBs as probable human carcinogens of medium carcinogenic hazard.

PCBs have a long life and tend to accumulate in humans. All people in the industrialized world have PCBs in their bodies. People are exposed to PCBs primarily through eating contaminated foods, especially fish, meat, and poultry, and through inhalation. However, studies show that the levels of PCBs in humans have been decreasing steadily over the years.

The composition of PCB mixtures changes when they are released into the environment. The most carcinogenic components of PCBs mixtures bioaccumulate in fish and other animals and bind to sediments. In fact, the build-up of PCBs in fish can reach levels thousands of times higher than the level of PCBs in water. This means that eating PCB-contaminated fish or other animal products or coming into contact with PCB-contaminated sediments is more harmful than being exposed to PCBs through occupational exposure or through PCB releases into the environment.

Acute oral exposures of animals to PCBs are associated with damage to the liver, kidneys, and central nervous system. For humans, chronic (long-term) oral exposure to PCBs is associated with cardiovascular effects (hypertension), mild liver effects, and skin effects (acne and pigmentation). Chronic human exposure to PCBs through inhalation produces respiratory tract symptoms (cough and tightness in the chest), gastrointestinal effects (nausea, vomiting, abdominal pain, weight loss, and anorexia), mild liver effects, skin rashes, and eye irritation.

Numerous health studies have focused on the carcinogenic effects of PCBs, and have concluded that PCBs cause liver cancer in animals. Studies of workers occupationally exposed to PCBs indicate increased rates of a rare liver cancer and malignant melanoma. Studies confirming the presence of liver cancer in both humans and animals exposed to PCBs lead to the conclusion that PCBs are probable human carcinogens.

In animals, PCBs also cause a variety of noncancerous effects on the immune, central nervous, endocrine, and reproductive systems, and humans could likewise be affected. Following is a synopsis of the noncancerous health effects of PCBs.

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* This information on health effects was compiled from current research on PCBs. Sources include the ATSDR Web site (www.atsdr.cdc.gov/), U.S. Environmental Protection Agency Web site (www.epa.gov), and www.about.com.

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- *Immune effects.* The immune system fights infection and diseases, and persons with weakened immune systems are prone to pneumonias and viral infections. Studies of animals have shown that exposure to PCBs greatly affects the immune system, including significantly decreasing the size of the thymus gland and decreasing resistance to Epstein-Barr virus and other infections. Studies of humans also found that exposure to PCBs affects the immune system.
- *Neurologic effects.* Proper development of the central nervous system is critical in the early learning stages as well as in later stages of life. Animal studies have found that PCB exposure in newborn monkeys negatively affected visual recognition, short-term memory, and cognitive skills. Studies of humans suggest similar findings, including learning deficits among children.
- *Endocrine effects.* PCBs decrease thyroid hormone levels in both animals and humans. Because thyroid hormones are critical for growth and development, a change in thyroid hormone levels is of great concern.
- *Reproductive effects.* Animals exposed to PCBs had serious and long-lasting reproductive effects, such as decreases in fertility, conception, and sperm rates, and longer menstruation. Women occupationally exposed to PCBs and women eating PCB-contaminated fish had shorter gestational periods and their newborns had lower birth weights. Furthermore, PCBs can reach a fetus through the placenta or be transferred to a newborn via breast milk.

  The effects of PCBs on the male reproductive system remain inconclusive. One study of men occupationally exposed to PCBs indicated no fertility problems, while another showed an association between low sperm count and high levels of PCBs in blood.
- *Other effects.* A number of other health effects have been reported among animals and humans exposed to PCBs, including dermal and ocular effects in monkeys and humans, and liver toxicity in rodents. Humans exposed to PCBs also experience high blood pressure and elevated levels of serum triglycerides and serum cholesterol.

PCBs cause a number of serious health effects. They induce cancer and other noncancerous health effects in animals, affecting their immune, central nervous, endocrine, and reproductive systems. Studies in humans, although inconclusive, tend to support the same evidence. Human health studies indicate that PCBs (a) affect women's reproductive functions; (b) reach fetuses and newborns through the placenta and breastfeeding; (c) create neurobehavioral and developmental deficits in newborns and children exposed to PCBs in utero; (d) decrease thyroid hormone levels; (e) weaken the immune system, (f) increase cancer risks, such as liver and non-Hodgkin lymphoma; and (g) produce a number of other negative health effects.

Children and PCBs

Major sources of PCB exposure in children include eating contaminated food, drinking contaminated water, and breathing contaminated air near some hazardous waste sites or in buildings with old electrical appliances that use PCBs. PCBs accumulate in pregnant womens' bodies and are released during pregnancy, passing through the placenta, and thus exposing fetuses in utero. Infants may also be exposed through nursing; because PCBs dissolve in fat, they can accumulate in the mothers' breast milk and be transferred through breastfeeding.

Adverse effects in infants and children include

- low birth weight
- shorter gestational period
- smaller head size
- abnormal neurodevelopment (e.g., abnormal reflexes, motor immaturity, permanent learning disabilities, mental retardation, impaired cognitive skills, problems with memory, and depressed responsiveness)
- neurobehavioral deficits (e.g., increased hyperactivity)
- immunologic effects (e.g., less wheezing, fewer allergic reactions, higher prevalence of recurrent middle ear infections, and higher prevalence of chicken pox)
- problems with thyroid function

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- facial abnormalities
- birth defects

How Behavioral Effects Are Measured in Infants and Children

Some of the tests used to measure infant/child behavioral effects are the Fagan Test of Visual Recognition (also known as the Fagan Test of Infant Intelligence), Bayley Scales of Infant Development, Wechsler Intelligence Scale for Children-Revised (WISC-R), and Neonatal Behavioral Assessment Scale (NBAS).

- **The Fagan test** involves showing an infant or child two identical photos of human faces for about 20 seconds, then changing one of the photos for a new one and presenting the new combination of photos. Normal babies spend more time looking at the photo of the new face. Children with memory problems cannot remember the first two photos well enough to recognize that the second two photos are different.
- **The Bayley test** is a standardized test gauging small children's development (children aged 1 month to 3.5 years). It includes a mental development index (MDI) and a psychomotor development index (PDI). MDI measures memory, the ability to solve simple problems, and language capabilities. PDI measures body control, coordination, and fine motor movement. Both indexes are scaled like a standard intelligence quotient (IQ) test.
- **The Wechsler Intelligence Scales for Children-Revised (WISC-R)** measures verbal and nonverbal performance skills.
- **The Neonatal Behavioral Assessment Scale** measures behavioral development. The scale evaluates 28 behavioral and 18 reflex items (e.g., assessing an infant's reactions to a variety of stimuli, such as a light in the eyes, a rattle, or a moving ball).

Geometric Means for PCBs in Humans

Pascale Krumm, PhD, Office of Policy and External Affairs, Agency for Toxic Substances and Disease Registry

Table 1 shows the geometric means of serum PCBs levels found among the general population.

Because PCB production is banned or sharply curtailed throughout the world, these levels are decreasing steadily.

Table 1. PCBs in Humans

Individuals	Range (ppb)*
Occupational exposure to PCBs (workers)	12.0–119.0
Nonoccupational exposure and eat PCB-contaminated fish	2.1–56.0
Nonoccupational exposure and do not eat PCB-contaminated fish	0.9–15.0

ppb = parts per billion.

New Emergency Response Line Numbers

The joint Centers for Disease Control and Prevention (CDC)/ATSDR 24-hour emergency response line numbers have changed.

- For public health consultative support from ATSDR during chemical emergencies, call **404-498-0120**.
- For public health consultative support from CDC during natural disasters, oil spills, or biological incidents, call **770-488-7100**.
- The new fax number for ATSDR is **404-498-0056**.
- The CDC fax number remains the same (**770-488-7107**).

Environmental and Public Health Web Resources

Health Web Public Health Electronic Discussion Groups

www.lib.umich.edu/hw/public.health/e.discuss.html
Includes information about selected public health listservs

- AIDSNEWS (dissemination of AIDS-related documents from CDC and other public health agencies—includes CDC's AIDS Daily Summary)
- CLINICAL-TRIALS (clinical trials)
- EAT-DIS (eating disorders)
- EPIDEMIO-L (epidemiology and methodology)
- EPIVET-L (veterinary epidemiology)
- HEALTH-PROMOTION (health care promotion and disease prevention research)
- PREVMED (preventive medicine and public health issues for students and professionals)
- PROMED (emerging infectious diseases—global scope)
- PUBLIC-HEALTH (epidemiology and public health)
- STAT-L (statistical discussion group)

Also includes Web addresses for several Internet sites with lists of listservs on various topics of health care, including public health.

World Wide Web Virtual Library

www.ldb.org/vl/top/index.htm
Link to selected topics in public health

Partners in Public Health Access for Public Health Professionals

www.nnlm.nlm.nih.gov/partners/
A collaborative project providing public health professionals with timely, convenient access to information resources to help them improve the health of the public

Global Health: Key Resources

www.pitt.edu/HOME/GHNet/GHKR.html
Important and comprehensive resources in areas that relate to public health worldwide, including

- Global resources
- Public health guides and catalogs
- Selected resources by subject
- Comprehensive medical resource lists
- Guides to electronic publications
- Electronic publications of special interest

Healthline: Michigan's Public Health Portal

www.hline.org/
Over 400 links by the following categories:

- Assessment: resources on community health assessment
- Environmental: environmental public health issues
- Governmental: federal, state, and local agencies
- Health promotion: public health promotion and education
- Immunizations: immunization information
- Nongovernmental: nongovernmental organizations dealing with public health issues
- Personal health: information related to personal health issues
- Reference: public health references
- Resources on the Internet (libraries search)
- Research: public health research topics

Courses

Occupational Safety and Health Education and Research Center

Contact information for courses: University of North Carolina, PO Box 16218, Chapel Hill, NC 27516-7579
Phone: 1-888-235-3320 (toll-free) or 919-962-2101
Fax: 919-966-7579
E-mail: oshercww@sph.unc.edu
Web page: www.sph.unc.edu.osherc/

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Supervising Lead Abatement Programs. This course is designed for those responsible for designing, planning, or conducting lead-based paint, soil, and/or dust abatement. Emphasis will be placed on safe removal techniques for steel structures and residential and commercial buildings. 2001 Course Dates: August 28–31; Refresher Date: July 12.

Comprehensive Industrial Hygiene (CHI) Review Course. This course is designed for practicing industrial hygienists seeking a review of the field or preparing to take the American Board of Industrial Hygiene (ABIH) core/comprehensive examination. 2001 Course Dates: September 17–21.

Building Inspection and Management Planning for Asbestos. Comprehensive training required for conducting inspections for asbestos-containing materials and preparing management plans that address asbestos in public and private schools. Course meets AHERA regulations and has been granted full approval by the U.S. Environmental Protection Agency. 2001 Course Dates: October 22–26; Refresher Date: September 7.

Supervising Asbestos Abatement Projects. Comprehensive supervisor training as required by AHERA. Course developed in coordination with and approved by the U.S. Environmental Protection Agency. 2001 Course Dates: June 11–15; Refresher Date: September 6.

Asbestos Operations and Maintenance. This course is required under OSHA 29 CFR 1926.1101 (k)(9)(v) for those who perform operations, maintenance, and repair activities involving asbestos-containing materials or presumed asbestos-containing materials. This course meets training requirements for Class III operations equivalent to the 16-hour maintenance and custodial training detailed in the AHERA regulations. Hands-on workshops will be held. 2001 Refresher Date: September 19.

Sampling and Evaluating Airborne Asbestos Dust (NIOSH 582). Accurate determination of the quality of asbestos in the air is critical to the health of exposed workers. This 4.5-day course will address state-of-the-art methods for making that determination as well as the proper way to sample and analyze for airborne asbestos fibers. 2001 Course Dates: September 24–28.

24th Annual Occupational Safety and Health Summer Institute, Norfolk, Virginia, August 6–10, 2001. Thirty-six courses will be presented. To review course descriptions, visit the North Carolina Education and Research Center Web site at www.sph.unc.edu/osherc/ or call the center at 1-888-235-3320.

Sound Solutions

Contact for course: Melette Meloy by phone (678-363-9897) or e-mail (mlmeloy@mindspring.com).

Audiometric Testing and Hearing Conservation Course. CAOHC approved. Recertification course on second day. Course Dates for 2001:

September 12–14	Birmingham, AL
September 19–21	Columbia, SC
October 3–5	Mobile, AL
October 17–19	Houston, TX
October 31–November 2	Birmingham, AL
November 7–9	Detroit, MI
December 5–7	Knoxville, TN

Deep South Center for Occupational Health and Safety

Contact: Melinda Sledge, The Deep South Center for Occupational Health and Safety, University of Alabama Birmingham, School of Public Health, Birmingham, AL 35294-0022; phone: 205-934-7178; e-mail: dsc@uab.edu; home page: www.uab.edu/dsc.

Audiometric Testing and Hearing Conservation. Course content includes effects and analysis of noise, parameters of sound, anatomy and physiology, ear pathology, instrumentation, audiometric technique, hearing protection and federal and state legislation. Tuition: $495 full course; $200 second-day refresher. 2001 Course Dates: October 3–5, Ft. Walton Beach, FL; November 7–9, Birmingham, AL.

Spirometry Workshop. Objective is to teach the basics of respiratory anatomy and physiology, lung volumes, determinants of respiratory flow and explain

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how the environment affects the respiratory system. Proper techniques for obtaining valid spirometric values as defined by NIOSH will be taught. Various types of spirometers and calibration syringes will be demonstrated and used. Certificate awarded upon satisfactory completion of the examination. Tuition: $410 full course; $175 first-day refresher. 2001 Course Dates: October 1–2, Ft. Walton Beach, FL; November 5–6, Birmingham, AL.

Respirator Fit Testing Workshop. This 1-day workshop will provide a brief history of respiratory protection and standards (ANSI, OSHA, NIOSH). Emphasis is placed on respiratory fit testing, with hands-on including qualitative and quantitative fit testing procedures. Scholarships are available. Tuition: $125. 2001 Course Date: October 15, Birmingham, AL.

Fundamentals of Industrial Hygiene. This five-day program will cover the basics involved in industrial hygiene for the anticipation, recognition, evaluation, and control of potential health hazards in the worksite. This course is geared toward those with minimal formal training in industrial hygiene. Tuition: $850. 2001 Course Dates: October 1–5, Ft. Walton Beach, FL.

Air Sampling for Toxic Substances. This two and half day program provides a thorough overview on industrial hygiene air sampling. Exposure assessment, sampling strategies, measurement methods, and calibration will be covered. Participants will spend time in hands-on workshops. Scholarships are available. Tuition: $600. 2001 Course Dates: October 1–3, Fort Walton Beach, FL.

Confined Space Entry and Rescue. This course is intended to promote safe confined space operations. Compliance with confined space entry program requirements, as specified in 29 CFR 1910.146, will be emphasized. Scholarships are available. Tuition: $450. 2001 Course Dates: October 10–12, Birmingham, AL.

AHERA Refresher. This course is designed to re-accredit those who have already taken and passed an Inspection and/or Management course. Inspectors attend the first half-day. Management planners must attend full day. Tuition: $85/half day; $170/full day. 2001 Course Date: October 9, Birmingham, AL.

14th Annual Occupational Medicine Update. This offering will provide useful and applicable information on current issues in occupational medicine. Although designed for physicians practicing in occupational and environmental medicine or general and family practice, this update will have topics that should be of interest to the occupational health nurse, safety professional, industrial hygienist and anyone who has an interest in safety and health at the workplace. Tuition: $350. 2001 Course Dates: September 21–22, Destin, FL.

Calendar

September 8–11, 2001
Children's Environmental Health II: A Global Forum for Action; Georgetown University Conference Center, Washington, DC. Co-hosted by the Canadian Institute of Child Health and the U.S. Children's Environmental Health Network. Contact: Web page: www.cich.ca/global.htm; or e-mail: scall@magma.ca.

December 10–13, 2001
The EPA Region III Chemical Emergency Preparedness and Prevention Conference AND the EPA Headquarters Hazmat Spills Prevention Conference, Baltimore Marriott Waterfront, Baltimore, Maryland. Theme: 2001—The Odyssey Continues. Contact: Conference hotline: 410-676-0882 or 1-800-364-7974; Web page: www.2001conference.org.

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