PBDEs in Breast Milk

Levels Higher in United States than in Europe

The commercial flame retardants that manufacturers add to electrical appliances and building materials undoubtedly save lives. However, mounting evidence shows that these chemicals—which bioaccumulate in the tissues of fish, animals, and humans—can be toxic and potentially carcinogenic. Of particular concern are polybrominated diphenyl ethers (PBDEs), a class of chemicals that make up roughly 37% of the worldwide market for flame retardants. In the current issue, researchers led by Arnold Schecter of the University of Texas Health Sciences Center in Dallas provide the first published data set of PBDEs in breast milk samples obtained from women in the United States, revealing that U.S. women have the highest PBDE concentrations detected in the world to date [***EHP* 111:1723–1729**].

Schechter and colleagues analyzed a total of 47 samples from white, black, and Hispanic nursing mothers aged 20–41. Of these, 24 were obtained from the Austin Mother's Milk Bank, a Texas-based nonprofit organization, and 23 were obtained from the University of Texas Southwestern Medical Center in Dallas. The researchers confined their analyses to 13 PBDE chemical structures known as congeners.

The researchers found every sample to be contaminated with PBDEs to some extent. Further, their results indicate that PBDE concentrations in these breast milk samples were 10–100 times higher than those detected in breast milk from women who lived in Europe, and in fact were the highest detected in the world. The lowest concentration in an individual U.S. sample, expressed as the sum of all detected congeners in breast milk lipids, was 6.2 parts per billion (ppb), and the highest was 419.0 ppb. The median was 34.0 ppb, and the mean was 73.9 ppb. Neither the duration of lactation nor the number of children each mother had ever nursed was associated with PBDE levels in breast milk.

Schecter and colleagues do not recommend that mothers not nurse, but do suggest that the detection of these compounds in breast milk raises concerns for nursing infants, who are more susceptible than adults to the effects of exogenous chemicals. Toxicity data for PBDEs are rare, but limited studies in animals have linked the chemicals to possible endocrine, hepatic, reproductive, and neurodevelopmental effects, in addition to cancer.

A baby's concern. Elevated concentrations in U.S. breast milk samples of chemicals found in flame retardants suggest that some American babies may be at risk for adverse health effects.

It is unclear how humans are exposed to these compounds. Possible sources include ingestion of contaminated food and inhalation of airborne PBDEs at home or in occupational settings within the electronics and computer industries, the authors say. However, Schecter and colleagues also found high levels in women with no known occupational exposure. These findings suggest the need for studies that investigate animal fat as a primary source of exposure within the U.S. population, the authors write.

Based on their established toxicity, two classes of PBDEs—penta-BDEs and octa-BDEs—will be officially banned by the European Union in 2004, although most European manufacturers have already voluntarily ceased production of these chemicals. Large quantities of deca-BDEs are still produced in both the United States and Europe. These compounds, being large and bulky, cross the cell membrane with difficulty, rendering them less toxic than their penta- and octa-brominated counterparts. However, deca-BDEs may degrade in the environment to lesser-brominated forms, thus creating another potential source of human exposure. Schecter and colleagues suggest that more data are needed to determine the levels and distribution of PBDEs in the environment, routes of intake, and health effects. **–Charles W. Schmidt**

Ethics in Environmental Health

A Mini-Monograph

Environmental health science is by nature an applied endeavor. Scientists who study environmental toxicology or cancer epidemiology arrive at conclusions that frequently have a direct and immediately apparent relevance to human health. Moreover, their findings attract the attention of regulators, politicians, private industry, and the general public. Thus, environmental health science has ethical, legal, and social implications that go far beyond the confines of the laboratory. In a mini-monograph in this issue, six writers explore this largely uncharted territory linking science and society [***EHP* 111:1786–1818**].

Bioethicist Richard Sharp, of the Baylor College of Medicine, introduces the mini-monograph with an overview of the myriad ethical and social issues that arise in environmental health science, from the choice of which toxicants to study, to the interpretation of data, to the communication of results to the public. When scientific conclusions have the potential to directly impact human health, Sharp concludes, they carry unique "moral force."

Epidemiologist Steve Wing, of the University of North Carolina School of Public Health, starts his paper on objectivity and ethics in environmental health science with the thesis that "knowledge is shaped by its social context." Beginning with Thomas Kuhn's 1970 book *The Structure of Scientific Revolutions*, historians and philosophers of science have insisted that scientific tools and methods are products of their time and place, rendering scientific objectivity vulnerable to social influence. But Wing argues that candid discussion about external forces in science can actually improve scientific rigor, and that to do good science, scientists must "take into account [their discipline's] history, conceptual foundations, preconceptions, taboos, and other social forces that shape its content and application."

Wing cites the example of cancer studies on residents from around Three Mile Island, site of the infamous 1979 nuclear accident. Although a study of cancer incidence in the area found more cancers in locations that received higher radiation exposures, radiation was dismissed as the cause because the official estimate of the amount of radiation released was too small to have had such an effect. Wing, however, disputed that interpretation, arguing that widespread reports of acute radiation poisoning symptoms including metallic taste and hair loss contradicted those estimates. His point is that scientists must make judgments when interpreting a body of evidence, and these judgments may be influenced by personal beliefs

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and nonscientific considerations, such as the trustworthiness of official exposure estimates.

The first reports of unusual symptoms around Three Mile Island came from a small household survey conducted by local volunteers. So-called popular epidemiology has played an important role in the early characterization of health hazards in other cases as well. In his paper on qualitative methods in environmental health research, sociologist Phil Brown of Brown University advocates for greater use of such methods as a way to invite community participation in research. Alternative data sources, such as in-depth personal interviews, court records, and media reports, can provide valuable information about a community's response to a health threat that cannot be captured within a large-scale quantitative epidemiologic study. Qualitative research methods, Brown says, "give voice to individuals and community-based organizations, as well as characterize the community in a full and complex fashion."

Moving beyond discussion. Five articles in this issue discuss how ethical considerations are increasingly at the heart of questions regarding how society uses environmental health research and information.

At the same time, qualitative research and community participation bring unique challenges. Qualitative research relies on extensive personal contact for data collection, so perhaps more than with any other type of research, scientists conducting such studies must win the trust and support of the people they are studying. Brown writes, "I am convinced that—and this is so spectacularly obvious—deep empathy is necessary in order to adequately study contaminated communities." But does this relationship introduce bias into the results? Brown, who refers to himself as an "advocacy sociologist," admits that the field of environmental sociology is "tinged with a pro-community ethos."

Some scientists object that scientific advocacy as practiced by Brown and Wing is inconsistent with the quest for scientific truth. Among epidemiologists, for example, a rift has divided the discipline into two camps. One cohort insists that, in order to maintain an aura of objectivity, epidemiologists should restrict themselves to doing rigorous science. The other side maintains that epidemiologists have an obligation to communicate their findings to policy makers and to ensure that their work benefits society.

Epidemiologists Douglas Weed, of the National Cancer Institute, and Robert McKeown, of the Norman J. Arnold School of Public Health of the University of South Carolina, are squarely in the latter camp. According to Weed and McKeown, the choice to practice epidemiology as a profession requires a moral commitment to "the primary goals of public health," namely disease prevention and health promotion. Epidemiologists, of course, are not required to take a formal professional oath. Nevertheless, write Weed and McKeown in their paper on science and social responsibility in public health, "epidemiologists, by virtue of their special training and experience, have a special responsibility to participate in public health action" above and beyond that of the average citizen.

But putting that maxim into practice is no easy matter. How do decision makers decide when evidence of a potential health hazard warrants preventive action? In January 1998, an international group of 32 scientists, government officials, lawyers, and labor and grassroots environmental activists met to address this question, concluding that "when an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically." Their recommendation, dubbed "the precautionary principle" and described by Arizona State University law professor Gary Marchant in his paper in the mini-monograph, seems relatively innocuous as a general rule of thumb. However, the principle has gained the force of law in the European Union and in several international environmental agreements. The precautionary principle appears in the environmental section of the Treaty of Europe and has also been applied by European authorities in issues of food safety.

This legal codification is where the trouble begins, explains Marchant. The principle's ambiguity leaves it vulnerable to manipulation in the service of vested interests; Marchant objects that "it can potentially be deployed as an outcome-determinative wild card at any time." Indeed, the precautionary principle has seen some dubious applications, Marchant says. He cites the government of Norway's invocation of the principle to ban Kellogg's Corn Flakes on the grounds that the vitamins added to the cereal might constitute a health hazard when eaten in unforeseen amounts (the decision was later overturned by a court of the European Free Trade Association).

So what is the alternative? Marchant admits that "some degree of precaution is appropriate for most risks," but that the definition of precaution must be clarified. For example, when do the potential harms associated with an activity outweigh its potential benefits? When is a risk acceptable for the public? These questions cannot be answered by science alone, of course. As the papers in the mini-monograph illustrate, environmental health science raises ethical and social issues that are outside the reach of the scientific method. Nevertheless, all of these authors agree that, when it comes time to make such choices, environmental health scientists cannot remain on the sidelines. **–Mark J. Parascandola**

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