Chemical Contaminants in Breast Milk and Their Impacts on Children's Health: An Overview

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**Human milk is the best source of nutrition for infants. Breast milk contains the optimal balance of fats, carbohydrates, and proteins for developing babies, and it provides a range of benefits for growth, immunity, and development. Unfortunately, breast milk is not pristine. Contamination of human milk is widespread and is the consequence of decades of inadequately controlled pollution of the environment by toxic chemicals. The finding of toxic chemicals in breast milk raises important issues for pediatric practice, for the practice of public health, and for the environmental health research community. It also illuminates gaps in current knowledge including *a*) insufficient information on the nature and levels of contaminants in breast milk; *b*) lack of consistent protocols for collecting and analyzing breast milk samples; *c*) lack of toxicokinetic data; and *d*) lack of data on health outcomes that may be produced in infants by exposure to chemicals in breast milk. These gaps in information impede risk assessment and make difficult the formulation of evidence-based health guidance. To address these issues, there is a need for a carefully planned and conducted national breast milk monitoring effort in the United States. Additionally, to assess health outcomes of toxic exposures via breast milk, it will be necessary to examine children prospectively over many years in longitudinal epidemiologic studies that use standardized examination protocols that specifically assess breast milk exposures. Finally, current risk assessment methods need to be expanded to include consideration of the potential risks posed to infants and children by exposures to chemical residues in breast milk. *Key words:* breast milk, breast-feeding, children's health, chemical contaminants. *Environ Health Perspect* 110:A313–A315 (2002). [Online 13 May 2002] *http://ehpnet1.niehs.nih.gov/docs/2002/110pA313-A315landrigan/abstract.html*

Human milk is, without question, the best source of nutrition for infants. Breast milk contains the optimal balance of fats, carbohydrates, and proteins for developing babies, and it provides a range of benefits for growth, immunity, and development (*1*). Breast milk contains powerful immune factors that help infants fight infections (*2*), and it contains growth factors that appear to influence brain development and increase resistance to chronic diseases such as asthma, allergies, and diabetes. Breast-feeding builds a powerful bond between a mother and her child, and this bond enhances health and well-being across the generations. Recognition of the manifold benefits of breast milk has led to the adoption of breast-feeding policies by numerous health and professional organizations (*3–9*) and stimulated development of the recent "Blueprint for Action on Breastfeeding" by the U.S. Department of Health and Human Services (*10*).

Unfortunately, breast milk is not pristine. Contamination of human milk is widespread and is the consequence of decades of inadequately controlled pollution of the environment by toxic chemicals. Polychlorinated biphenyls (PCBs), DDT and its metabolites, dioxins, dibenzofurans, polybrominated diphenyl ethers (PBDEs), and heavy metals are among the toxic chemicals most often found in breast milk (*11,12*). These compounds are encountered to varying extents among women in industrially developed as well as in developing nations. Some of the highest levels of contaminants are seen among women in agricultural areas of the developing world that are extensively treated with pesticides (*13*) and among women in remote areas, such as the Canadian Inuit, who eat a diet rich in seal, whale, and other species high on the marine food chain that accumulate heavy burdens of persistent organic pollutants (POPs) (*14*).

The finding of toxic chemicals in breast milk raises a series of important issues for pediatric practice, for the practice of public health, and for the environmental health research community.

Lack of data on contaminants. Although much information has been generated on the types of chemicals likely to be found in breast milk, this database is scattered and incomplete. Data have been collected on only a limited number of chemicals, from small samples of women in relatively few geographic locations (*15*). Major need exists for more data on exposure patterns, levels of contamination, and trends.

Lack of consistent protocols. No standardized methodology has been developed in the United States for collecting and analyzing breast milk samples. This makes it difficult to compare data from study to study. Although more data are available in other nations, again, standardized protocols do not exist. Methodologic shortcomings of published studies include inconsistent sampling and analysis protocols, incomplete descriptions of sampling methods, nonrepresentative sampling (in regard to geography, parity, age), limited duration of sampling, small numbers of study participants, and limited number and types of chemicals analyzed (*16*).

Lack of toxicokinetic data. Women may be exposed to lipophilic chemicals from various sources including air, food, water, and occupational and household environments.

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This article is an introduction to the Mini-Monograph on "Chemical Contaminants in Breast Milk." The series of articles in this mini-monograph were developed from ideas developed at the conference on "Chemical Contaminants in Breast Milk: Impacts on Children's Health."

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Lipophilic chemicals can be stored and accumulated over time in body fat and can then be mobilized into milk during lactation. Generally, chemicals enter breast milk by passive transfer from plasma, and their concentration in milk is proportional to their solubility and lipophilicity (*17*). Twenty percent or more of maternal body burden of some persistent pollutants, such as PCBs, can be transferred during 6 months of lactation (*18*). Information on the toxicokinetics of chemicals in breast milk is incomplete.

Lack of data on health outcomes. There are scant data on the health outcomes that may be produced in infants by exposures to chemicals via breast-feeding. Thus far, effects on the nursing child have been seen primarily in high-dose poisonings where the mother was clinically ill (*19*). The prospective epidemiologic studies that are needed to assess chronic outcomes that may occur at lower levels of exposure have been undertaken for only a few chemical contaminants, most notably PCBs. Few data exist on long-term effects or on interactions among chemicals.

Lack of evidence-based health standards. Although most breast-feeding mothers have detectable levels of several environmental agents in their milk, there are no established normal or abnormal values for clinical interpretation that are derived from toxicologic or epidemiologic studies; therefore, evidence-based guidance cannot be provided.

To examine these emerging issues and to chart a course for the future, the Mount Sinai Center for Children's Health and the Environment convened a conference on 5 October 2001 titled "Chemical Contaminants in Breast Milk: Impacts on Children's Health." The stimulus for this conference was a desire to confront the issue of nursing infants' exposure to chemicals in breast milk and to assess the hazards to health and development that may result from those exposures. A group of scientists and clinicians came together to examine what we know and do not know about patterns and trends in infants' exposure to chemicals in breast milk, toxicokinetics, possible health outcomes, research needs, and implications for risk assessment. The following are the major findings and recommendations of this conference.

Breast Milk Monitoring

The conferees agreed unanimously that a need exists for a carefully planned and conducted national breast milk monitoring effort in the United States. A few countries, mainly Sweden and Germany, have systematic breast milk monitoring programs that have tested considerable numbers of women over time using consistent sampling methods (*15*). However, most countries have done little monitoring for pesticides, metals, or industrial chemicals in breast milk. To be nationally representative, such an effort would need to include women of various socioeconomic backgrounds and geographic locations.

Comprehensive breast milk monitoring with standardized protocols for specimen collection and analysis must be expanded worldwide. Only with more reliable and better standardized approaches to selection of subjects, milk sampling and collection, and analytical methods can conclusions be drawn about global patterns of contamination, trends over time, and emerging hazards. Good data on time trends and geographic patterns would aid in generating hypotheses and would lead to more definitive studies. Such information would also provide a sound basis for evidence-based public health policies. Without such data, it is difficult to provide advice to health care professionals and to new mothers on the potential risks and benefits of breast-feeding.

Another need is to study lactating women prospectively to determine rates of decrease in concentrations of chemicals over the course of lactation. It has been recommended that women should donate milk samples on a monthly basis (or more frequently in the first 2 months) and then every 2–3 months if lactation continues (*16*).

It will also be necessary to develop data that will permit comparison of breast milk contamination levels with contaminant levels associated with other infant food sources, such as formula and cow's milk. Such data will permit us to compare the risks associated with each source of infant nutrition. Use of formula feeding does not necessarily result in a child being protected from chemicals in the environment because formula can be diluted with water that is polluted (*15*). Infant formula has been found to be contaminated with toxic metals, bacteria, and other environmental toxicants. Pesticide residues and bovine growth hormone can be found in cow's milk.

Health Outcomes

The conferees agreed that to assess the effects of contaminants in breast milk on child health and development, it will be necessary to examine children prospectively over many years in longitudinal epidemiologic studies that use standardized examination protocols and that specifically assess exposures to environmental contaminants via breast milk. This is the study design envisioned for the National Children's Study, a major prospective epidemiologic study now being planned under the direction of the National Institute of Child Health and Human Development in collaboration with the National Institute of Environmental Health Sciences, the Centers for Disease Control and Prevention, and the U.S. Environmental Protection Agency. The goal of this study will be to examine the influences of multiple exposures—environmental, behavioral, socioeconomic, and genetic—on child and adult health. It will follow as many as 100,000 children in all regions of the United States, from *in utero* to at least 21 years of age (*20*). Companion studies are under development in Canada and possibly in Mexico. The choice of which exposures to measure, which outcomes to assess, what data infrastructure to build, what specimens to store, and what ethical safeguards to impose will be critical to the National Children's Study.

Risk Assessment

The conferees agreed that current risk assessment methods generally do not consider chemical exposures to infants via mother's milk and therefore need to be expanded. In traditional risk assessment, assessment of risk is normally based on adult body weights and food consumption data (*11*).

The level of risk to infants and children of exposure to chemical residues in human milk depends on each mother's food consumption patterns, the nature and levels of chemical residues in her milk, and the toxicologic potency of those chemicals. A comprehensive analysis of the potential health risks to infants and children exposed to chemicals from breast milk will require consideration of all these factors as well as of the unique vulnerabilities of infants and children.

Infants and children may exhibit unique susceptibilities to the toxic effects of chemicals because they are undergoing rapid tissue growth and development (*21*). Infants and children also consume much greater quantities of milk fat and certain foods than do adults on a body weight basis, and thus they may be subjected to proportionately higher levels of exposure to certain chemicals. These exposures occurring earlier in life may predispose infants and children to a greater risk of chronic toxic effects than exposure occurring later in life (*22*). Traditional approaches to health risk assessment need to be expanded to encompass those factors and to adequately protect infants and children. Furthermore, it must be recognized that there are only limited data on the residue levels of chemicals in milk and food consumption patterns of infants and children that are appropriate for use in risk assessment.

Another source of exposure of infants to chemicals that must be considered in risk assessment is drinking water and the water used for mixing formulas. Although water intake is considered in current risk assessment, neither nondietary exposures nor exposures in drinking water are considered in deriving risk estimates for total chemical exposure in infants' milk. Because of these limitations, burden of total exposures to infants and children may be underestimated.

Stockholm Convention

The conference concluded by noting that there is some encouraging news for nursing mothers. On 22 May 2001, the United States and 119 other nations signed an international treaty in Stockholm to phase out use and production of 12 POPs worldwide and established a procedure to add additional chemicals to the list of banned pollutants (*15*). The treaty also promotes action to minimize the release of biologically persistent industrial byproducts such as dioxins and furans. Over the last several decades, individual nations have banned certain chemicals, effectively reducing the threat that these chemicals pose. For example, the United States has banned DDT and PCBs. Countries that have banned certain POPs are likely to have lower levels of pollutants in mother's milk. However, even with the signing of the treaty, newly emerging hazards such as PBDEs and nonyl phenols must be monitored (*12*). Breast milk remains the best source of nutrition for babies, but constant vigilance is needed to keep it pure.

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