Chemicals in Breast Milk

Little Data to Date

Breast milk offers infants unparalleled nutrition to fuel their growth and development. It also provides a host of immune factors that can increase their resistance to common infections. Additionally, breast-fed infants may have a reduced risk of developing chronic diseases such as diabetes, allergies, and asthma. By breast-feeding her infant, a mother herself receives several health benefits, including less postpartum bleeding, a quicker return to prepregnancy weight, and a potentially decreased risk of ovarian and breast cancers. However, some new mothers hesitate to breast-feed due to concern about environmental chemicals in their breast milk. Although the benefits of breast-feeding outweigh the risks of low-level chemical exposures, more information is necessary to dispel concerns.

In a review of the literature on environmental chemicals in breast milk, Judy S. LaKind and colleagues from the Pennsylvania State University College of Medicine and the Johns Hopkins University Department of Mathematical Sciences demonstrate that the data, particularly in the United States, are sparse [*EHP* 109:75–88]. Their review focuses on two aspects of exposure: chemical concentrations in breast milk and their trends over time.

Environmental contaminants such as polychlorinated dioxins and furans, polychlorinated biphenyls, and chlorinated organic pesticides have been detected at low concentrations in breast milk throughout the world. Among other risks, these chemicals are suspected of subtly damaging the immune system, causing developmental delays, and increasing an exposed person's lifetime cancer risk. The chemicals, which accumulate in body fat over the course of a person's life, are mobilized during lactation and excreted in breast milk.

Consuming questions. A review of the literature shows that data on chemicals in breast milk are limited at best.

LaKind and her associates identify several problems that impede the forming of general conclusions. In the United States, there are uncertainties regarding whether breast milk samples have been collected in a way that allows for comparison from one study to another, and the data that exist pertain only to a limited number of women from specific locations. Data from other nations, particularly in Europe, are more thorough, but, as with the data from the United States, cross-study comparisons are difficult because of inconsistent protocols and nonreported information. One variable that is particularly overlooked is depuration (the elimination of environmental chemicals from the mother's body through breast milk) over the course of lactation. Among other factors, depuration may be influenced by a mother's age, how many children she's had, and how much milk her infant consumes. One-time samples therefore do not account for changes in breast milk concentrations over the course of lactation.

The reviewers suggest that the inadequacies of current data could be addressed through a carefully planned and coordinated breast milk monitoring effort. Such a monitoring program could include women from throughout the United States and could represent diverse socioeconomic and demographic groups. Data collection could build on earlier studies by including both previously studied chemicals as well as other environmental contaminants such as heavy metals.

To control for depuration differences, milk samples could be collected longitudinally. Finally, to extract the maximum information from the data, sampling and testing methods would have to be in harmony across different studies. According to LaKind and her colleagues, a well-planned monitoring program would provide reliable information to doctors, nurses, and lactation specialists, and help them communicate the benefits of breast-feeding to new mothers.

It is also necessary, the reviewers say, to assess the concentrations of environmental contaminants in other infant food sources, such as formula, in order to compare the risks and benefits associated with all sources of infant nutrition. **–Julia R. Barrett**

A Toxic Form of Expression

Different Agents Affect Different Genes

Toxicogenomics is a topic of great current interest. A quick scan of the contents of any scientific journal is likely to turn up several articles on the closely related topics of expression profiling, proteomics, toxicogenomics, and bioinformatics. Toxicologists are intensely interested in expression profiling—monitoring and comparing the expression of hundreds or thousands of genes simultaneously—because this approach, once fully developed and validated, could provide an alternative to traditional toxicologic animal bioassays that would be much faster, less costly, more sensitive and informative, and nonanimal-based.

A study in this month's issue examines gene expression in mouse liver using a DNA microarray that includes 148 mouse genes presumed to play a role in response to environmental exposure [*EHP* 109:71–74]. These genes play roles in phase I and phase II metabolism, DNA repair, stress response, cell signaling, and housekeeping. Led by Matthew Bartosiewicz, a graduate student in the molecular biology laboratory of Alan Buckpitt at the University of California at Davis, a team of researchers analyzed the transcriptional profile of mice exposed to a range of doses of cadmium chloride, benzo(*a*)pyrene, or trichloroethylene, three environmental/occupational contaminants that fall into distinct chemical classes. The goal was to test the hypothesis that chemicals of different classes have distinct profiles to determine how useful the technique might be in

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future toxicology testing. The authors chose a small subset of mouse genes and a small number of compounds because they consider this study to be a "proof of principle" experiment.

The group's results clearly show that a distinct set of genes is induced and/or repressed in mice exposed to these three agents. A statistically significant change in expression was observed for 16 of the 148 genes in the DNA microarray. The authors believe their findings provide proof that "these three environmental contaminants . . . elicit unique patterns of gene expression over the doses tested in an *in vivo* model."

This *in vivo* work confirms several earlier, comprehensive DNA microarray studies that have been carried out based on the complete genome sequence of *Saccharomyces cerevisiae*, which have established that DNA microarray technology can provide quantitative information on changes in gene expression due to altered cellular environment, disease, and/or exposure to stress. The present study by Bartosiewicz and colleagues is a promising demonstration that environmentally important agents can be monitored using DNA microarray technology in an *in vivo* mammalian system. Due to these efforts, the groundwork is steadily being laid for future use of expression profiling in toxicology testing.

Although the patterns of gene induction in this study largely agree with those found in earlier studies, there were some differences for genes that had previously been up-regulated in association with benzo(*a*)pyrene. Future work will determine if these differences are due to differences between *in vivo* and *in vitro* experimental systems, or tissue or dose specificity. **–Miriam Sander**

Empty Nets?

Fishing for Hard Facts on *Pfiesteria*

Pfiesteria piscicida and related toxic dinoflagellates were implicated in numerous fish kills in Atlantic coast estuaries in the 1990s, raising concerns about possible threats to public health. In 1997, Maryland watermen reported health effects from environmental exposure to toxic *Pfiesteria*, including memory loss and confusion. North Carolina also recorded many *Pfiesteria*-related fish kills, but researchers there had not systematically studied health effects among people who were exposed to waterways where *Pfiesteria* and related toxic dinoflagellates could occur.

In this issue, Marian Swinker of the East Carolina University School of Medicine and colleagues report on the first comprehensive examination in North Carolina of people with long-term contact with waterways where they may encounter *Pfiesteria* [*EHP* 106:21–26]. Conducted at the request of the state health agency in November 1997, the study found no pattern of abnormalities that could be attributed to possible exposure to *Pfiesteria* and related dinoflagellates.

It is difficult to assess whether someone has experienced contact with *Pfiesteria*. This dinoflagellate, which inhabits estuaries, spends nearly all of its time in nontoxic life stages. Moreover, the dinoflagellate attacks fish suddenly and then retreats, returning quickly to a nontoxic form on the estuary bottom. To confuse the issue, toxic algae such as *Pfiesteria* are not the primary cause of fish kills in estuarine waters; instead, low oxygen concentrations commonly kill large numbers of fish in shallow estuaries during warm months. As a consequence of these factors, biologists have had difficulty tracking the dinoflagellate and determining whether it actually is the cause of many fish kills, even in places where the organism has been found.

In their study, the North Carolina team used the 1997 Centers for Disease Control and Prevention case description for estuary-associated syndrome (EAS). This case description covers anyone who complains of persistent health effects such as memory loss, confusion, or acute skin burning after recent or remote contact with fish kills, fish with lesions, or affected waterways. For the North Carolina study, the term "affected waterways" could mean one of three things: any estuarine areas with conditions conducive to a *Pfiesteria* outbreak, any area where diseased fish were reported from June to September 1997, or any area where *Pfiesteria* had been seen in the past.

The team examined 22 licensed commercial fishermen and state employees who had worked in such waterways. Seventeen of the fishermen in this group reported exposure to a fish kill or to fish with lesions—possibly, but not conclusively, caused by *Pfiesteria*. For controls, the team examined 21 watermen and state employees who worked in the ocean, where *Pfiesteria* cannot survive. Eleven of those in the control group reported exposure to a fish kill or to fish with lesions that could not have been caused by *Pfiesteria*.

The team's examinations included a medical, occupational, and environmental history; general medical, dermatologic, and neurologic examinations; vision testing; and neuropsychologic evaluations. One subject in each group had had symptoms of EAS in the past, but neither subject had significant and current neuropsychologic impairment when examined.

The team found no pattern of abnormalities in these evaluations, with one exception. Watermen who worked on affected waterways had a significant reduction in a visual contrast sensitivity test—a measurement of the ability to detect visual patterns. Neurotoxins can affect vision, including the ability to detect visual patterns. But certain chemicals, drugs, alcohol, and several developmental and degenerative conditions can have the same effect. Moreover, scientists have not determined whether visual contrast sensitivity is affected by known dinoflagellate toxins. The researchers point out that there is no evidence that a relationship exists between potential environmental exposure to *Pfiesteria* or related toxic dinoflagellates and a reduction in visual contrast sensitivity, but that such reduced sensitivity should be considered in future studies to assess whether it might act as a marker of toxic dinoflagellate exposure. **–John Tibbetts**

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Casting about for answers. A North Carolina study found no link between health effects and exposure to toxic *Pfiesteria*.