National Institute of Environmental Health Sciences | **Superfund Basic Research Program**

RESEARCH BRIEF 125

Epidemiologic Research on Environmental Pollution and the Risk of Disease

In the 1980's, an unusually high incidence of cancers was observed in the upper Cape Cod region of Massachusetts. Possible environmental risk factors were identified including proximity to the Massachusetts Military Reservation, pesticide applications to cranberry bogs and forests, and tetrachloroethylene contamination of drinking water. Led by Dr. Ann Aschengrau, epidemiologists at the Boston University SBRP are using traditional and new tools to test hypotheses concerning associations between these exposures and cancers, reproductive disorders, and developmental disorders.

From 1968 through 1980, families in eight Cape Cod towns were exposed to tetrachloroethylene (also called perchloroethylene, PCE) when the solvent leached into drinking water from the inner vinyl lining of certain asbestos cement water distribution pipes. In 1997, Dr. Aschengrau initiated a population-based case-control study to investigate the association between PCE exposure from public drinking water and breast cancer. The study involved 672 cases with breast cancer and 616 controls. Dr. Aschengrau's research team estimated the relative delivered dose (RDD) of PCE to which each subject was exposed. The RDD is the mass of PCE (in milligrams) that entered a house as a drinking water solute during a specified time period. It is based on a mathematical model for the leaching rate of PCE from the vinyl liner of the water distribution pipes, and takes into account the age of the pipe, its length, diameter and the upstream load. The results of this SBRP-funded study refined and confirmed Dr. Aschengrau's earlier findings that women with the highest PCE exposure levels have a small to moderate increased risk of breast cancer.

To control for additional factors, Dr. Aschengrau's research team devised a method to re-evaluate the data. The RDD quantifies the amount of PCE in the drinking water that enters a home, but does not consider exposure from inhalation, dermal absorption, or ingestion. PCE is a volatile organic compound and daily indoor inhalation exposure to contaminated water from showering can be up to six times greater than exposure from ingestion. Using personal exposure variables on tap water consumption and bathing habits obtained from surveys, Dr. Aschengrau's research team constructed a dose model to quantify the relative amount of PCE taken in by each participant – referred to as the personal delivered dose (PDD).

Overall, the risks calculated from the PDD analysis differed only slightly from the RDD analysis. The study showed that the impact of variations in personal habits was small in comparison to variations in characteristics of the drinking water distribution system. However, Dr. Aschengrau believes that it remains important to assess exposure as accurately as practical in an epidemiological investigation.

Dr. Aschengrau's research team has also developed an innovative exposure assessment method to model complex interconnected geometries for a town's entire water distribution system. They are using EPANET, an EPA software package that simulates hydraulic and water quality characteristics within pressurized pipe networks. Using the Geographic Information System (GIS) developed for associated studies, they produced digital maps for each study town that identify the subjects' residences and water pipe network and are able to calculate the yearly PCE concentration at each subject's residence.

Dr. Aschengrau is currently analyzing data from a population-based retrospective cohort study including approximately 2,000 Cape Cod children and their families who were exposed to PCE-contaminated drinking water and a comparable group of 2,000 unexposed children and their families. This study tests the hypothesis that PCE found in the public drinking water supplies in Cape Cod is associated with

reproductive and developmental outcome such as menstrual abnormalities, spontaneous abortion, low birth weight, intrauterine growth retardation, pre-term delivery, congenital malformations, and developmental disorders of learning and attention.

As an alternative method to assess historical exposures to banned and current-use pesticides, Dr. Aschengrau's group has also collaborated with Silent Spring Institute (Newton, Massachusetts) in a population-based case-control study of 1,165 women residing in Cape Cod who were diagnosed with breast cancer in 1988-1995 and 1,006 controls. They assessed exposure by historical reconstruction back to 1948 and GIS-based modeling of pesticide applications for tree pests (e.g., gypsy moths), cranberry bogs, other agriculture, and mosquito control. Relative exposure intensities were calculated for six wide-area pesticide uses, based on modeling of drift and deposition. This approach has several strengths compared with other exposure assessment techniques such as self-report, which is prone to error and recall bias, and biologic or environmental sampling, which is expensive, limited in the number of agents that can be measured, and typically limited to single and recent samples available for testing.

While the researchers did not find an overall pattern of association between pesticide use and breast cancer, they did identify modest increases in risk associated with aerial application of persistent pesticides on cranberry bogs and less persistent pesticides applied for tree pests or agriculture. This novel use of GIS-based methods allows researchers to assess exposures to mixtures of many chemicals from multiple types of use over many years.

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To learn more about this research, please refer to:

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