

Citizen's Guide to the Case-Control Study of Childhood Cancers in Dover Township January 2003

The New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) are releasing the final report, *Case-Control Study of Childhood Cancers in Dover Township (Ocean County), New Jersey*, which completes the study of possible risk factors for childhood cancers in Dover Township. The report, which was previously released as a draft for public comment, incorporates and addresses comments received. This Citizen's Guide summarizes the design, methods and results of the study.

Part 1. Methods

What was the overall objective of the study?

The overall objective of the study was to identify possible disease risk factors that might explain why leukemia and brain and nervous system cancers were elevated among children in Dover Township, New Jersey. This exploratory epidemiologic study examined several specific questions, or hypotheses, about the relationship between these childhood cancers and certain environmental exposure pathways identified in the community, including:

- exposures to specific public drinking water supply sources;
- exposure to contaminated private wells; and,
- potential exposure to major air pollution sources.

How was the study designed to examine the proposed hypotheses?

This exploratory study used two case-control designs. In both of these case-control studies, children with cancer were compared to children without cancer in order to examine the differences in exposures to potential risk factors. One of the studies (the Interview Study) gathered information through interviews of parents. The information included residential history, parental occupation, medical history, diet, household related exposures, and demographic information. The families of all forty children identified as cases (children diagnosed with leukemia or brain and nervous system cancers before the age of twenty years during the period 1979 through 1996) participated in the study, as did 159 families of children without cancer who served as controls. The second study (the Birth Records Study) examined the birth records of children whose mothers lived in Dover Township at the time of the child's birth, and who were diagnosed with cancer while living anywhere in New Jersey or one of several other states. The Birth Records Study gathered information from each child's birth certificate, including residence, demographic factors, and pregnancy characteristics.



Why was the public water supply included in the studies, and how was exposure assessed?

Over the course of the entire study period (1962 through 1996) there was evidence that some of the public water supply wells were contaminated at various points in time. However, the nature, magnitude, and duration of contamination is not known with certainty. The Holly Street well field exhibited contamination related to Ciba-Geigy production in the mid 1960s. Volatile organic compounds were detected in some of the wells in the Parkway well field in 1986, due to the Reich Farm groundwater contamination. Water from those wells was treated to remove volatile compounds, and released into the public supply. Ten years later, semi-volatile organic compounds were also identified in these wells.

A computer model was developed by the ATSDR to estimate the proportion of water each study residence received from each well field in the public supply system over time. An electronic map of the entire system for the year 1998 was initially developed, which included the location of all distribution pipes larger than two inches in diameter, the wells, points of entry into the distribution system, storage tanks, and booster pumps. Taking into account the length, diameter and roughness of each pipe, water demand, and other factors, a model of the flow of water within the system was developed. This model was checked for accuracy against actual field measurements.

Then historic annual maps of the system were developed for the years 1962 through 1996, by removing pipes, wells, and other elements from the electronic map when those elements were not part of the water distribution system. These models provided estimates of the proportion of water from each well reaching a study participant's residence for each month from 1962 through 1996. These estimates were made without knowing whether the residence was that of a case or a control.

A water source index was created for each Interview Study participant by calculating the percentage of water each household received from each well in service on a monthly basis, for the time period of one year prior to the child's birth through the month the child or matching case was diagnosed with cancer. In this manner it was estimated whether the child had no or low, medium, or high exposure to any given public well for specific intervals in the child's life. For example, if over the course of one year, a residence received two percent of its water from the Indian Head well field, sixteen percent from the Holly Street well field and eighty-two percent from the Parkway well field, the child's water source index was low for Indian Head, medium for Holly Street, and high for Parkway. Additionally, time-specific indices were established for the Parkway and Holly well fields, based on assumptions regarding when the wells might have been contaminated. For the Birth Records Study participants, only the mother's residence at the time of the child's birth was available. It was assumed that the mother lived at the same address for nine months (the prenatal period),

and a water source index was created using only those nine months of water source data.

Finally, for Interview Study participants, not only was the water source considered, but also how much water the mother drank while pregnant or the child drank after birth. By combining these variables, drinking water source/consumption indices were developed, which indicate if exposure to a source combined with consumption was none or low, medium, or high.

How were potential exposures to water from private wells included in the studies?

Contamination of private wells has also been of concern during the study period. Ten groundwater regions of known volatile organic compound contamination were identified and their borders defined. An eleventh section, consisting of street segments with at least one contaminated private well, was also identified. These groundwater regions were mapped electronically. All Interview Study families that reported using a private well had their residence(s) included in the mapping. Birth Records Study residences were assumed to be connected to the public water supply unless there was no public distribution pipe near the residence during the year the child was born.

How were air pollution sources chosen and assessed for this study?

The Environmental and Occupational Health Sciences Institute (EOHSI) developed models to assess areas that might have been impacted by airborne contaminants. EOHSI identified the Ciba-Geigy facility as the only major emitter of hazardous air pollutants in Dover Township during the study period. The Oyster Creek Nuclear Generating Station was identified as a site of community concern. EOHSI used information on facility characteristics and detailed weather data to develop computer models of the spread of emitted pollutants. For Ciba-Geigy, information on levels of emitted pollutants was lacking, so estimates were modified based on plant production. Emissions data were available from Oyster Creek, and were used in the modeling. Monthly exposure estimates were then developed for each study residence for the two potential sources. For the Interview Study participants, indices of no/low, medium, or high exposure for the entire study, prenatal, or after birth periods were calculated. For the Birth Records Study, the eight months prior to birth and the birth month were included. The mother's residence during that nine month period was assumed to be the same as her residence at the time of the child's birth.

How were issues regarding place of residence handled in this study?

The issues examined by the NJDHSS regarding residence included proximity to known contaminated sites and the year of construction of the house.

The New Jersey Department of Environmental Protection identifies contaminated sites throughout New Jersey. The Dover Township portion of the list was reviewed, and community input was sought to identify sites requiring further consideration. Seven sites were chosen, including Ciba-Geigy, Reich Farm, the Dover Township Municipal Landfill, the Ocean County Landfill, the Ciba-Geigy pipeline, a section of the Toms River, and the Toms River Coal Gas site.

These sites were mapped, along with the study residences. Any residence that was within one-half mile from a site's border was identified. For the Interview Study, indices were developed based on the proportion of study time a child spent at the address.

Year of construction was generally not available for residences in the Interview Study. For the Birth Records Study, information on the year of construction of the birth residence was available from municipal records for 83 percent of the homes. Residences were broken into two groups: "older" (built before 1970) and "newer" (built from 1970 onward).

How was parental occupation assessed for this study?

Parental occupational information was collected as part of the Interview Study. Occupational histories were collected for both parents for the period of one year prior to the child's birth to the date of diagnosis. Parents were asked about particular job activities, such as painting, electrical and electronics, or pest control; and exposures to groups of chemicals, including solvents, metals, and paints. Lists of job activities and chemicals were given to parents before the interview.

Jobs were coded by an industrial hygienist, who assessed the intensity and duration of exposure. Occupational indices, based upon occupation, industry, and potential exposures, were then developed. Exposure categories were developed for the time periods of one year before birth, after birth to date of diagnosis, or both time periods combined.

How were the data analyzed and interpreted?

Odds ratios were calculated for different cancer types, by age group and gender. An odds ratio compares the proportion of cases exposed to the proportion of controls exposed. If the proportions are the same, there is no association between the exposure and the disease. If the proportion is higher in the cases, there is an association between exposure and disease. Once associations are found, criteria are used to interpret the meanings of those associations. The criteria used include:

- the strength of the association (the magnitude of the odds ratio),
- the consistency of findings, both within the study and when compared to other epidemiologic studies,
- apparent dose-response effect (as exposure increases, so does the risk of illness), and,
- evidence that exposure to contaminants occurred.

Part 2. Results

What results are presented and analyzed in the Case-Control Study of Childhood Cancers in Dover Township (Ocean County), New Jersey?

The final report examines the possible associations between leukemia and brain and nervous system cancers in children less than twenty years of age and the following factors: public and private drinking water sources; potential exposures to air pollution sources, including the Ciba-Geigy facility and the Oyster Creek Nuclear Generating Station; residential proximity to sites of concern; and parental occupation. The report also includes analyses of demographic, pregnancy and birth characteristics; family medical history; health, medical conditions and medical procedures; dietary factors; exposure to tobacco smoke and alcohol; and household exposures to chemicals, animals, and household appliance electromagnetic fields. The latter factors were reported in the December 1999 Interim Report and are reviewed in the Final Report. In general, analyses for most non-environmental factors did not show differences between cases and controls, and were consistent with findings from other studies.

What were the findings related to drinking water?

The study evaluated the association between childhood cancers in Dover Township and exposures to each of the ten public water well fields ever used in the system during the study period (1962 - 1996), as well as private wells in areas of known groundwater contamination.

Holly Street well field

In both the Interview and the Birth Records Studies, there did not appear to be an association with any childhood cancer grouping and the Holly Street well field. Nor was there an association with the Holly Street water supply prior to 1976 (when contamination may have been more likely), or before 1981 (when the last of the previously contaminated wells were in service).

Parkway well field

For most analyses, there was no association between childhood cancer and modeled potential exposure to Parkway well field water. However, prenatal exposures to Parkway well water in the period 1982 - 1996 was about five times more common in females with leukemia than in controls. When maternal water consumption was factored in, prenatal exposure to Parkway well water in this time period was six times more common among female leukemia cases than controls. The Birth Records Study showed a slight elevation in the odds ratio for females with leukemia

All other public supply wells

For the Interview Study, there was no association seen with childhood cancer and water from any of the other water sources in the public water supply: Brookside, Indian Head, Route 70, Anchorage, Berkeley, Silver Bay, South Toms River and Windsor well fields. For most analyses, there was no association between childhood cancers and other public supply source in the Birth Records Study.

Private wells

There were few case or control families living in an area of groundwater contamination that had private wells. Among Interview Study participants, odds ratios for leukemia were elevated among children who lived in a residence with a private well after birth. No association was seen in the Birth Records Study.

What were the findings related to air emissions?

Modeled potential exposures to Ciba-Geigy air emissions did not appear to be associated with childhood cancers when both males and females were considered together. However, among Interview Study participants, there was an elevation in leukemia among females less than five years of age with medium or high exposures in the prenatal and postnatal periods. In the Birth Records Study (which considered only the prenatal time period and assumed that the mother's residence throughout her pregnancy was the same as her residence at birth), the same elevation in leukemia among females diagnosed before the age of five years was found.

Potential exposure to air emissions from the Oyster Creek Nuclear Generating Station did not appear to be associated with any childhood cancer groupings in either the Interview or the Birth Records Study.

What were the findings related to other sites of concern and age of housing?

Among Interview Study participants, there was an association between leukemia in females and residence within one-half mile of the Ciba-Geigy pipeline. However, residential distance to the entire pipeline is a crude estimate of potential exposure. A more refined index was developed which considered exposures to study participants living within one-half mile of known pipeline breaks during or after the years of the breaks. When this was evaluated, the association was diminished. There were no associations with any of the other sites of concern in the Interview Study.

In the Birth Records Study, there was an association between cancers other than leukemia and nervous system cancers and residence within one-half mile of the pipeline. When pipeline breaks were considered, these associations also diminished.

In the Birth Records Study, older residences were not statistically significantly associated with any of the case groupings. However, more children with brain and central nervous system cancers lived in older residences at birth than their matched controls.

What were the findings related to parental occupation?

Parental occupation was evaluated for Interview Study participants only. Fathers were more likely than mothers to have had exposure to solvents, plastics, and petroleum products. Fathers were also more likely to have had jobs in electrical, metal, or motor vehicle work.

The findings in this study are generally consistent with other epidemiologic studies. Associations with paternal exposures were found for: dyes or pigments and leukemia and nervous system cancers; and petroleum products and leukemia.

An association was found between maternal exposures to ionizing or low frequency radiation and leukemia and nervous system cancers.

What do the NJDHSS and ATSDR conclude about childhood cancer and environmental concerns in Dover Township?

The results of the final report must be interpreted cautiously because of the relatively small number of study subjects. However, based on a combination of evaluation criteria for the risk factors and their association with cancers, the NJDHSS and ATSDR conclude the following:

- several environmental factors were found to be associated with leukemia in female children, specifically for the prenatal period. These associations were not found in male children, and include the following:
 - an association was seen with prenatal exposures to the Parkway well field in the years 1982 - 1996 and leukemia in female children of all ages.
 - an association was seen in the Interview and the Birth Records studies between prenatal exposure to Ciba-Geigy ambient air and leukemia in female children diagnosed before the age of five years.
- No associations were seen between exposure to the Holly Street well field water and any cancer groupings.
- The use of private wells for drinking water in any area with a history of groundwater contamination was rare. Odds ratios for leukemia were elevated among children who lived in a residence with a private well after birth. Risk for prenatal exposures could not be calculated.
- Although no completed exposure pathways associated with the Ciba-Geigy pipeline were identified, an association was observed during the prenatal and postnatal periods for residential distance from the pipeline and leukemia in female children. There was no association seen when documented pipeline breaks were considered.
- No consistent patterns of association were seen between the environmental factors of primary concern and any cancer groupings during the postnatal exposure period.

What are the recommendations of the report?

- The NJDHSS should analyze cancer incidence statistics when an additional five years of complete cancer incidence data (1996 - 2000) are available, in order to determine if there are any changes in childhood cancer incidence rates or time trends in Dover Township. (This analysis has been completed and is being released in a separate report.)
- Efforts should continue to reduce or cease exposure to hazardous substances, including:
 - ensure that the remaining wells of the Parkway well field are not affected by Reich Farm contamination;
 - maintain private well restriction zones;
 - contain and remove contaminants in the groundwater at Ciba-Geigy.

It is important to note that, through remedial activities by State and federal environmental agencies, all known exposures to the community from these sites have been interrupted.

- Continue educational efforts for health care providers, teachers and children in schools, and the community at large.

Where can I get a copy of this report?

For a copy of the *Case-Control Study of Childhood Cancers in Dover Township (Ocean County), New Jersey*, please call the NJDHSS at (609) 588-3120. The report is also available on the NJDHSS website at [http:// www.state.nj.us/health](http://www.state.nj.us/health)