

# Dover Township

## Childhood Cancer Investigation

April 2003

### Findings of the Case-Control Study of Childhood Cancers in Dover Township (Ocean County), New Jersey

**Background:** The New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) have released the final *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. A draft of the study was previously released for public comment, and this final release reflects comments received and the changes made as a result of those comments. Simultaneously, the NJDHSS released the *Childhood Cancer Incidence Update: A Review and Analysis of Cancer Registry Data, 1979-2000, for Dover Township (Ocean County), New Jersey*, which evaluated five additional years of childhood cancer data since an earlier report in 1997. This Health Care Provider Update summarizes the results of each of these reports.

#### Report 1. Case-Control Study of Childhood Cancers in Dover Township

sources.

#### Study Design

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

#### Methods

##### Study Objective

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 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

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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.

### ***Public Water Supply Exposure Assessment***

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. A digital 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.

Historic annual maps of the system then 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. Models based on these maps 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, while pregnant, 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 indicated if exposure to a source combined with consumption was none or low, medium, or high.

### ***Private Well Exposure Assessment***

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.

### ***Air Pollution Exposure Assessment***

New Jersey's Environmental and Occupational Health Sciences Institute (EOHSI) developed computer 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.

### ***Place of Residence Assessment***

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).

### ***Parental Occupation Assessment***

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.

### ***Data Interpretation and Analyses***

*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 proportions are different, 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.

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## **Results**

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.

### ***Drinking Water Results***

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, in the Interview Study, 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.

**Air Emissions Results**

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, especially in the prenatal period. 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.

**Other Sites of Concern and Age of Housing Results**

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.

**Parental Occupation Results**

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.

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.

The findings in this study are generally consistent with other epidemiologic studies.

## Conclusions

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 (when wells were most likely to be contaminated) and leukemia in female children.
  - 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.

## Recommendations

- 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 was released in a separate report. See page 7 of this Update.)
- 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.

## Report 2. Updated Childhood Cancer Incidence Analysis

### Background

In September 1997 the New Jersey Department of Health and Senior Services (NJDHSS) released a report that reviewed all available childhood cancer incidence data for Dover Township (Ocean County), New Jersey. Those data, which covered the time period 1979 through 1995, indicated that there were significantly higher rates of certain childhood cancers than expected in Dover Township and the Toms River section of the township. This led the NJDHSS and the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct a case-control study to attempt to define what environmental exposures might be associated with those increases. This study, summarized in the previous section of this Update, is provided in the January 2003 report, *Case-Control Study of Childhood Cancers in Dover Township (Ocean County), New Jersey*. The case-control study report also recommended that the 1997 report be updated when an additional five years of childhood cancer incidence data are available.

### Purpose

The update report provides analysis and interpretation of the full twenty-two years (1979 through 2000) of childhood cancer incidence data for Dover Township and Toms River, including recent (1996-2000) data not in the earlier report. It was developed in order to determine if there have been any changes in incidence rates, or if there are any time trends in incidence, in Dover Township and Toms River.

### Cases Evaluated

Cancers evaluated in this update, as well as the earlier report, include: all cancers combined, brain and central nervous system cancers, sympathetic nervous system tumors, Wilms'

tumor, malignant bone cancer, soft tissue sarcomas, leukemias and lymphomas. Cases were included in the evaluation if the person was less than twenty years of age, and a resident of Dover Township, at the time of diagnosis.

### Results

#### *Changes of Previous Data*

The NJDHSS found that the total number of childhood cancer cases during the period 1979 through 1995 was 87, not 90 as originally reported. Four cases were found to be not eligible for the study, and one case was identified more recently and not included in the earlier analyses. Additionally, with the release of year 2000 U.S. census data, population estimates were revised. However, these changes did not affect any of the original conclusions. For the period 1979 through 1995, the rates of total cancers and leukemia in females in Dover Township were significantly elevated when compared to state rates.

#### *Recent Data Indications*

There were 25 new childhood cancer cases diagnosed in Dover Township between 1996 and 2000. For Dover Township, the average annual number of cases was similar in the 1979-1995 and the 1996-2000 time periods. The percentage of children less than five years of age newly diagnosed with cancer decreased from 26 percent of the total to 16 percent. In Toms River there was a more noticeable decrease in the average annual number of cases among all children. This is primarily due to a drop in the percentage of young children with cancer, from 50 percent of the total in the earlier time period to zero in the more recent five years.

When compared to New Jersey rates for the 1996-2000 time period, rates remain higher than expected in Dover Township for several cancers, including brain and central nervous system cancers and leukemia in females. However, there are no statistically significant elevated rates of any of the cancers studied in Dover

Township or Toms River. In Toms River, leukemia is elevated when compared to state rates; however, no child under age five was diagnosed with cancer in the 1996-2000 time period.

### **Time Trends**

Time trends are difficult to interpret. For all cancers combined, Dover Township rates rose above state rates from the mid-1980s through the mid-1990s, and again in the late 1990s. Toms River rates were more variable, with defined peaks above state rates in the mid to late 1980s, mid-1990s, and the late 1990s.

### **Conclusions**

The conclusions reached in the earlier study remain valid regarding the significant elevations in certain childhood cancers in Dover Township and Toms River in the time period 1979 through 1995. During the more recent study period of 1996 through 2000, rates of some cancers remain higher than expected, although there were no significantly increased rates of cancer in children in both Dover Township and Toms River. Cancer rates may be declining since no cases of cancer occurred in children less than five years of age in Toms River in the more recent time period. There were also fewer cases than expected in Dover Township among children less than five years of age.

### **Recommendations**

The NJDHSS recommends that it continue its childhood cancer surveillance in Dover Township, updating this report when an additional five years of cancer incidence data are available from the New Jersey State Cancer Registry. The NJDHSS and ATSDR should also continue their educational and outreach efforts in Dover Township.

## **For copies of the reports**

For a copy of the *Case-Control Study of Childhood Cancers in Dover Township (Ocean County), New Jersey*, or the *Childhood Cancer Incidence Update: A Review and Analysis of Cancer Registry Data, 1979-2000; Dover Township (Ocean County), New Jersey* please call the NJDHSS at (609) 588-3120. The reports are also available on the NJDHSS website at [http:// www.state.nj.us/health](http://www.state.nj.us/health)

### **Highlights of this update**

Several environmental factors were found to be associated with leukemia in female children, especially for prenatal exposures.

Prenatal exposures to Parkway well field water during the period 1982-1996 was five times more common in females with leukemia than controls.

There were elevations in leukemia among females less than five years of age with medium or high exposures to Ciba-Geigy air emissions, especially in the prenatal period.

There were no other associations found between drinking water sources and childhood cancer.

Between 1996 and 2000 there were 25 additional childhood cancer cases diagnosed in Dover Township. Rates remain higher than NJ rates for brain/CNS cancers and leukemia in females.

Childhood cancer rates may be declining in Dover Township. Between 1996 and 2000 there were fewer than expected cases of cancer in children under age five, and no child under age 5 was diagnosed with cancer in Toms River.



