INVESTIGATION OF CHILDHOOD CANCER INCIDENCE IN THE CONNETQUOT CENTRAL SCHOOL DISTRICT, SUFFOLK COUNTY, NEW YORK

Prepared by the

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EXECUTIVE SUMMARY

In January 2015, the New York State Department of Health (NYSDOH) became aware of concerns over what a resident believed to be an unusual number of children who had been diagnosed with leukemia in 2014 and 2015. The children lived in the community of Bohemia and in other communities within the Connetquot Central School District in Suffolk County. NYSDOH reviewed information collected by the resident and confirmed that the number of school-age children in the Connetquot district who had been diagnosed with leukemia during the period reported by the resident was statistically higher than expected. Since the observed number was less than six, the exact number is not reported to protect patient confidentiality. Review of available environmental information, including information on sources of concern to the resident, showed no apparent exposures to unusual levels of environmental contaminants that would have affected childhood cancer incidence. Further investigation of the unusual occurrence of childhood leukemias was then begun.

Methods

- Diagnoses of childhood cancers in neighboring school districts and an earlier period were reviewed to investigate whether the unusual occurrence of childhood leukemias in the Connetquot school district was part of any pattern. The source of data was the New York State Cancer Registry, which contains information on all cases of cancer diagnosed or treated in New York, as required by law.
- Medical records from the time of cancer diagnosis and birth certificates for the children from the Connetquot school district with leukemia were reviewed to investigate whether the children had any exposures in common or strong individual risk factors for leukemia.
- Birth certificates of all children born in the Connetquot school district during the time when the children with leukemia were born were matched against the Cancer Registry to investigate whether children born in the district were at higher risk of cancer.

Findings

<u>Search for other unusual patterns</u>

- Other than the children who had been reported by the resident, the review did not identify any children in the Connetquot school district who had been diagnosed with leukemia between 2014 and 2016. The investigation confirmed the excess in numbers of school-age children with leukemia during this period, but this excess was only statistically significant if children reported by the resident to have links to the school district, but with official addresses outside the district (for example former residents), were included in the analysis. There were no excesses in any other type of childhood cancer, or all childhood cancers combined.
- In the school districts bordering Connetquot (Central Islip, East Islip, Hauppauge, Sachem, Sayville, and Smithtown), staff identified 38 cases of cancer diagnosed between 2014 and 2016 in the six districts combined. This number was not significantly different from the 46.1 cases that would be expected for these areas combined based on the number of children

living there. The numbers of cases of leukemia and lymphoma (another blood cancer) taken separately that were identified in the six school districts combined were also not significantly different from the numbers expected. There were no statistically significant differences between the numbers observed and the numbers expected for total childhood cancers, or leukemia or lymphoma taken separately for any of the individual school districts taken separately.

- In the time since the data analyses for this investigation using cancer cases diagnosed from 2014 through 2016 were completed, an additional three years of cancer data have become available. In 2017-2019, the numbers of leukemia cases diagnosed among children in the Connetquot school district and in the other school districts were all similar to the numbers expected.
- In the ten-year period prior to 2014, 2004-2013, there were 22 cases of all types of cancer among children in the Connetquot school district compared with about 20 cases expected. The numbers of cases of leukemia and lymphoma taken separately among children in the Connetquot school district were also similar to the numbers expected.
    - When children in 5-year age groups were examined separately, numbers of cases of total childhood cancers and leukemia were similar to expected in all age groups. The number of cases of lymphoma, however, was greater than expected for teenagers ages 15-19 years. Closer examination showed most of the teenagers to have Hodgkin lymphoma with most having the most common subtype. The teenagers lived throughout the school district with no concentration in any one section.
- In the surrounding school districts in 2004-2013, numbers of cases of all childhood cancers and of leukemia and lymphoma taken separately were similar to the numbers expected for all six districts combined and for each district taken separately for children of all ages and for each 5-year age group.

<u>Records review</u>

- Information from the medical records of the children from the Connetquot school district diagnosed with leukemia in 2014 and 2015 further confirmed the diagnosis and the reported subtype. None of the children had a pre-existing medical condition that is a strong risk factor for leukemia. About half the children had a family history of some type of cancer, including some with a family history of leukemia.
- Most of the children from the Connetquot school district diagnosed with leukemia in 2014 and 2015 lived in New York at the time of their birth, either in the Connetquot school district or elsewhere in Suffolk County. Birth certificates for the children born in New York showed that none of the mothers were over the age of 35 at the time of the child's birth, but some children had a birthweight of over 3,500 g (7.7 lbs.). These conditions have both been associated with an elevated risk of leukemia.

<u>Birth match</u>

- A total of 5,001 births was identified in the Connetquot school district between 1998 and 2009. Cancer Registry records showed that, by 2017, 12 of these children had developed some type of cancer before the age of 20. This number was similar to the 13 children that would have been expected to develop cancer. The number of children identified as having

been diagnosed with leukemia was also similar to the number expected. None of the 5,001 children were identified as having been diagnosed with lymphoma.

Discussion

- Compared to adults, cancer is rare in children. Still, about 1,000 children under the age of 20 develop cancer each year in New York State, and it is the second leading cause of death in children after injuries.
- Leukemia is the most frequently diagnosed type of cancer among children. Leukemia is a cancer of the blood cells. It is usually classified by how fast it progresses (acute or chronic), and the type of blood cell affected. ALL, a cancer of the lymphocyte type of white blood cell that progresses rapidly, is the most frequently diagnosed type of leukemia in children. Known risk factors for childhood leukemia include certain genetic syndromes, such as Down syndrome, and exposure to ionizing radiation, such as prenatal X rays. Scientists are also studying suspected risk factors including infections, conditions at the time of birth such as high birthweight (generally over 3,500-4,000 g) or an older mother (age 35 or older), and exposures the child's parents may have had. There have been many reports of clusters of childhood leukemia cases, although what may be causing them is not yet known with any certainty.
- Lymphoma is a cancer that starts in lymphocytes, infection-fighting cells that are a part of the body's immune system. The two main types of lymphoma are Hodgkin lymphoma (formerly called Hodgkin's disease) and non-Hodgkin lymphoma. Children with depressed immune systems, such as those with inherited immune disorders or HIV/AIDS, have an increased risk of getting both Hodgkin lymphoma and non-Hodgkin lymphoma. The Epstein-Barr virus, which causes infectious mononucleosis, has been associated with Hodgkin lymphoma and many types of non-Hodgkin lymphoma in children and teenagers. Having a family history of non-Hodgkin lymphoma or Hodgkin lymphoma increases one's risk of that disease.
- This study has limitations. Although there was an excess in the number of school-age children from the Connetquot school district who had been diagnosed with leukemia, this excess was only statistically significant if children with links to the school district, but official addresses outside the district (for example former residents) were included. The total number of children who had moved out of the school district was not known, so it was not possible to account for them in the computation of expected numbers of cases. Also, the actual number of children with leukemia was small (for statistical purposes). Small numbers can be affected more by chance variation, making it more difficult to draw firm conclusions. Finally, the statistical analyses of the study were designed around the characteristics of the reported cases, such as age, years of diagnosis, and area of residence. Defining the study in this way, instead of specifying a hypothesis in advance or studying predefined areas, makes it more likely that the study will have significant findings.

Conclusions

- The number of school-age children from the Connetquot school district who had been diagnosed with leukemia between 2014 and 2016 was greater than the number expected, but the difference was only statistically significant if children with leukemia who no longer resided in the school district were included. Since the observed number was less than six, the exact number is not reported to protect patient confidentiality. No larger patterns of childhood cancer occurrence were detected. The study found a significantly elevated number of cases of lymphomas, particularly Hodgkin lymphoma, in teenagers in an earlier time period, however their characteristics did not suggest that the cases were related to the cases of childhood leukemia in 2014 and 2015.
- The study did not identify any unusual exposures that the children had in common or any strong individual risk factors such as a genetic condition that might explain individual cases of childhood leukemia. Numbers of children with more common but less strong risk factors such as high birth weight were too small to conclude whether these might have played a role.
- Children born in the Connetquot school district do not appear to be at greater risk of developing leukemia or cancer in general.
- The information reviewed in this investigation does not point to any single reason that some or all of the children reported by the resident developed leukemia. The occurrence of the apparently unusual number of cancers could be the result of factors it was not possible to identify. It could also be the result of chance.

INVESTIGATION OF CHILDHOOD CANCER INCIDENCE IN THE CONNETQUOT CENTRAL SCHOOL DISTRICT, SUFFOLK COUNTY, NEW YORK

Background

In January 2015, the Suffolk County Department of Health Services received an inquiry about children living within a few blocks of each other who had recently been diagnosed with leukemia. The inquiry was from a resident of Bohemia, who was aware of additional children with leukemia in nearby communities. The Suffolk County health department referred the inquiry to the New York State Department of Health (NYSDOH). NYSDOH staff compared the cases reported by the resident with the files of the New York State Cancer Registry. NYSDOH staff confirmed cases living within four miles of each other as well as children living in other communities. The number of cases confirmed was greater than expected, but within the range that often occurs by chance. The resident was informed of these findings but later became aware of additional children, particularly from the Connetquot and Sachem school districts, who had developed leukemia. In June 2015 the data confirmed that the number of school-age children reported by the resident as living or having lived in the Connetquot district who had been diagnosed with leukemia since 2014 was statistically higher than expected. Since the observed number was less than six, the exact number is not reported to protect patient confidentiality. At which point, the resident requested an investigation.

Following receipt of the request, NYSDOH conducted an evaluation to determine whether further investigation was indicated. The evaluation involved a review of what was known about childhood leukemia cases in the area and a review of available information on potential sources of unusual exposures to environmental contaminants. These included sources of concern to the resident, including fuel dumping by aircraft on approach to the Long Island MacArthur airport, refuse and chemical disposal sites, the Ronkonkoma rail station, and a local concrete company. The cancer evaluation confirmed a statistically unusual number of school-age children reported by the resident as living or having lived in the Connetquot school district who had been diagnosed with leukemia in 2014 and 2015. The environmental evaluation identified inactive hazardous waste and brownfields sites within the school district or near school district boundaries that might have been the source of unusual exposures to contaminants in the past. Contaminants from these sites affected some nearby public water supplies prior to the birthdates of the children diagnosed with leukemia. Any potential for exposure had been eliminated long before the children with leukemia were born. No information was found specific to aircraft fuel operations at Long Island MacArthur Airport, but available information indicated that in general the potential for people on the ground to come into contact with fuel jettisoned from landing aircraft appears to be minimal. Review of the results of private and routine public water supply well testing (2000-2015), including the water supply serving the Connetquot school district, showed no evidence of exposures to chemical contaminants at levels above applicable drinking water standards. No other potential sources of unusual exposures to environmental contaminants were identified. Appendix A presents a brief summary of environmental information for this study area. It was concluded that further investigation of childhood cancer

incidence was indicated because of the apparently elevated number of childhood leukemia diagnoses.

This report describes the methods and findings of the investigation conducted by the NYSDOH. The study is in three parts: 1) an analysis of Cancer Registry data to determine if the confirmed cases were part of any larger pattern of childhood cancer incidence; 2) an examination of records on individual children with leukemia to see if there were any exposures in common or individual risk factors that may have played a role in the diagnoses; and 3) an evaluation of whether children born in the school district were at greater risk of cancer. Due to the many known and unknown possible causes of cancer, this investigation is not likely to uncover a single reason for the children developing leukemia. It can, however, obtain information on the conditions under which the childhood leukemias occurred.

Search for other unusual childhood cancer patterns

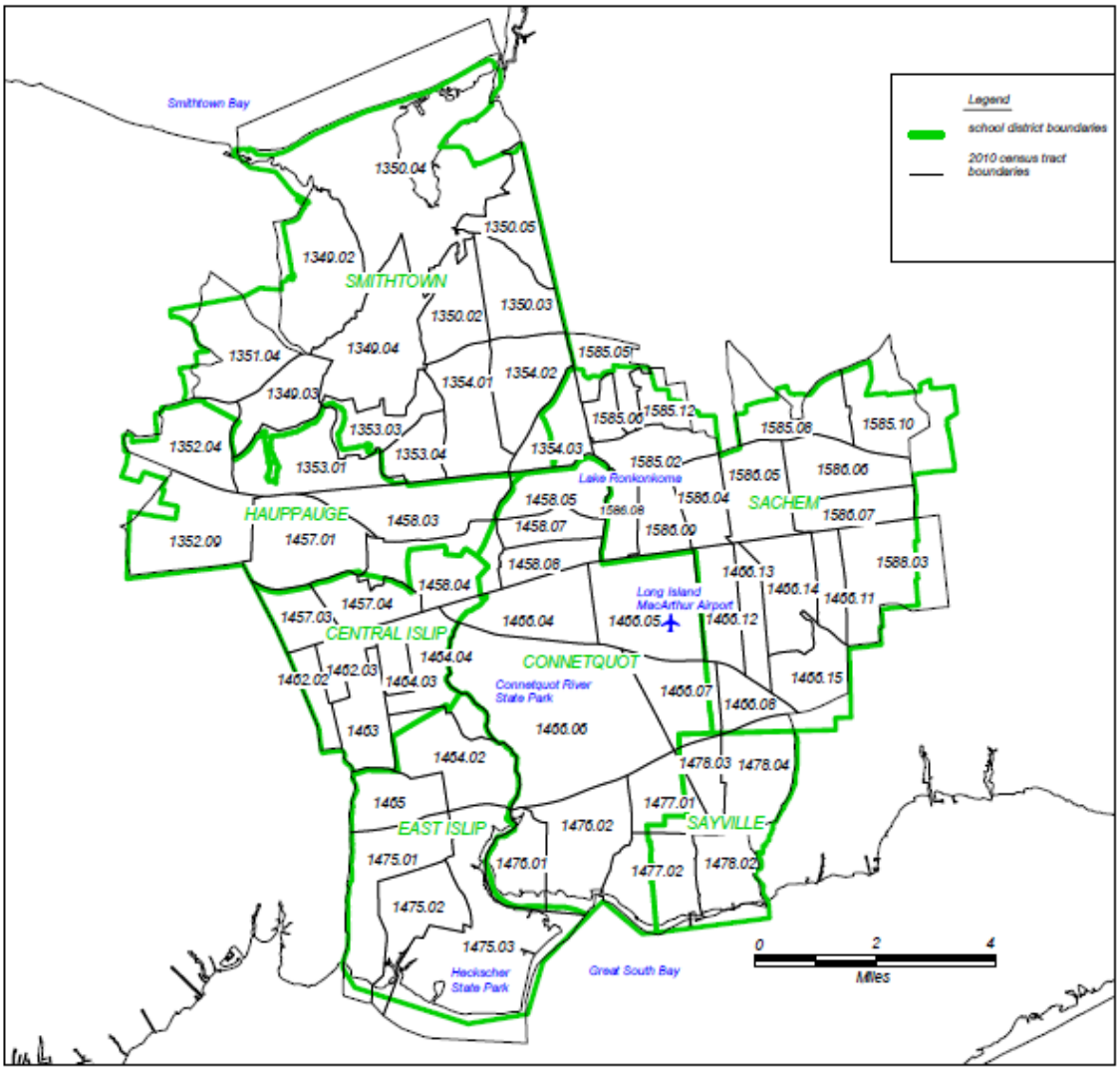
Methods

To determine whether the confirmed leukemia diagnoses among school-age children in the Connetquot school district as reported by the resident were part of any larger pattern of childhood cancer occurrence, childhood cancers in other geographic areas and time frames and in children of other ages were examined. To do this, the observed numbers of childhood cancer cases were compared with numbers of cancer cases one would expect to find if cancer rates were the same as in similar areas of the state.

Study areas: In the initial cancer evaluation, an unusual pattern was confirmed in children the resident reported as living or having lived in the Connetquot school district, but not in the neighboring Sachem district. To see if this elevated number of diagnoses was present in other geographic areas, the investigation identified children with cancer in the Connetquot school district and all school districts that bordered it. These include the Central Islip, East Islip, Hauppauge, Sachem, Sayville, and Smithtown school districts. Because detailed population data for school districts are estimated from the American Community Survey of the US Census and may not be reliable for all combinations of age, sex, and race/ethnicity, school districts in this study were approximated by census tracts (Fig. 1). A census tract was included in a given school district if half or more of its population lived within the school district boundaries. The seven school districts in this study included 64 census tracts.

Time periods: The cancer evaluation confirmed leukemia cases diagnosed in 2014 and 2015 among the children reported by the resident as living or having lived in the Connetquot school district. Data were examined to identify all cases diagnosed in 2014 and later years among children living in the Connetquot school district and the surrounding school districts. To see if this occurrence was present in earlier years, the investigation also examined data for the 10-year period prior to 2014, 2004-2013, for each school district.

Figure 1 Map of the Connetquot school district and the six bordering school districts



Cancer types: Children can develop many different types of cancer. To see whether children in the Connetquot area were more likely to develop types of cancer other than leukemia, the investigation looked at all types of childhood cancers combined, and at leukemia and lymphoma, another type of blood cancer often found in children, separately.

Age groups: The children reported by the resident who were confirmed to have developed leukemia were all of school age, 5-19 years. To see if younger children were affected, or if any particular age group was affected more than others, the investigation included all children ages 0-19 years, and examined five-year age groups within that range separately.

Source of data: The source for the data on childhood cancers was the New York State Cancer Registry. The Cancer Registry contains information on all cases of cancer diagnosed or treated in New York State, as mandated by law. The completeness and accuracy of the Cancer Registry depend upon reporting from hospitals, laboratories, managed care organizations, and other sources. The Cancer Registry has been certified as more than 95 percent complete by the North American Association of Central Cancer Registries. In addition, the Cancer Registry has met all criteria for high quality incidence data established by the Association since 2000 (data year 1996) (1). Statistical analyses were initially conducted in June 2019, at which time data were official through diagnosis year 2016. In August 2022, results for leukemia were updated with data through diagnosis year 2019, the latest year for which data are considered official.

One person can be seen many times, by different healthcare providers, over a period of years for the same cancer. The same person can also develop multiple cancers. Each separate healthcare encounter for diagnosis or treatment of cancer is reportable to the Cancer Registry. As multiple reports on the same person are received, they are reviewed to determine whether they are new reports on a previously reported cancer or reports of a new cancer. Reports on previously reported cancers are combined with existing information to continuously update Cancer Registry files to reflect the most complete and accurate information available.

To identify cases to include in this study, a listing was generated of all cancers diagnosed since 2004 in children under age 20 who lived in ZIP Codes containing any of the seven school districts at the time they were diagnosed. The addresses were then examined individually to determine whether the child lived in any of the census tracts making up the school districts included in the study. Cases were then grouped by school district, year of diagnosis, and type of cancer (leukemia, lymphoma, or other type). These are referred to as “observed” cases.

Calculation of expected incident cancers: To determine whether the number of observed cases of cancer was unusual, it was necessary to calculate the number of cases of cancer that would be expected in each study area. This calculation accounts for the population size and age distribution of the study area. Cancer rates vary among different racial and ethnic groups, so the calculation also considered the various racial and ethnic groups in the study area. Three groups were defined for this study: 1) non-Hispanic whites, 2) Hispanics, and 3) others (including non-Hispanic blacks, Asian, Pacific islander, American Indian, and Alaskan Native).

To calculate the numbers of cases of childhood cancers that would be expected, cancer incidence rates by five-year age group for each of the racial/ethnic groups for a reference area were applied to the estimated population of the study area by age for each of the race/ethnic groups, and the resulting numbers were summed over all age and race/ethnic groups. To ensure the stability of the reference rates in all age and racial/ethnic categories, the reference area selected was all of New York State. The population for each study area was estimated using data from the 2000 and 2010 US Census for the census tracts making up each study area.

Statistical testing: The probability that chance alone could explain an increase or decrease in the observed number of cancer cases compared to the expected number was evaluated based on the Poisson distribution (2). In statistics, the Poisson distribution describes a process where a rare event occurs in a large population. If the probability of observing an excess or deficit was 0.025 or less for any cancer site, the result was marked as statistically significant. Non-significant excesses or deficits were considered to represent random variations in observed patterns of disease.

Results

Connetquot and other school districts: This study was undertaken due to the confirmation of school-age children reported by the resident as living or having lived in the Connetquot school district who had been diagnosed with leukemia in 2014 and 2015. To investigate whether these cases were part of any larger pattern, Cancer Registry files were examined to identify any other children in the Connetquot school district who had been diagnosed with leukemia or other cancers between 2014 and 2016. These would include any children who had not reached school age or who were not known to the resident.

At the time the first round of data analysis for this investigation was conducted, Cancer Registry data were official through diagnosis year 2016. In the Connetquot school district, no children of school age (ages 5-19) other than the children reported by the resident were found to have been diagnosed with leukemia between 2014 and 2016. There were no younger children who had been diagnosed with leukemia in this time frame. A small number of children had been diagnosed with other types of cancer. To protect patient confidentiality, the actual numbers of children in any area or time frame who were diagnosed with cancer cannot be provided when these numbers are under six.

To assess whether the number of cases of cancer diagnosed in children between 2014 and 2016 was unusual, the number of cases that would be expected given the number of children of different ages living in the district was calculated. This calculation was based on rates for New York State as a whole for the most recent five-year time period for which data were official, 2012-2016. A five-year period was chosen to ensure the stability of the rates in the different age and racial/ethnic groups. This calculation showed that about 1.4 cases of leukemia would be expected in the three years in the Connetquot study area, or just under one case in two years. The number of children with leukemia diagnosed in 2014 and 2015 who were identified from Cancer Registry files as living in the Connetquot school district at the time of their diagnoses was greater than the number expected in two years. The difference was not statistically significant, however, meaning it could easily occur by chance. Some of the children reported by the resident as living or having lived in the Connetquot school district did not have official addresses at the time of their diagnoses that were within the school district and so were not identified by the Cancer Registry. When these children were added to the total number of cases observed, the excess became statistically significant.

When lymphoma, another type of blood cancer that children can develop, was examined for the time period 2014-2016, the calculations predicted that about 1.2 cases would be expected. No cases of this type of cancer were identified among children living in the Connetquot school district in this time period. When all types of childhood cancer were taken together, the calculations showed that 6.4 children in the Connetquot school district would be expected to develop any type of cancer in the three years. The number of cases of all types of childhood cancer actually identified between 2014 and 2016 was similar to this number.

Files were also examined to identify children in neighboring school districts who were diagnosed with leukemia or other cancers between 2014 and 2016. The number of cases of leukemia diagnosed in all other school districts combined between 2014 and 2016 was somewhat less than the 10.2 cases expected, but the difference was not statistically significant. Numbers of lymphomas identified in all other school districts were also similar to the numbers expected. For all types of childhood cancers combined, there were 38 cases of cancer identified, which was not statistically different from the 46 that would be expected. When the individual school districts were examined separately, no single school district had numbers of cases of all cancers combined or leukemia or lymphoma taken separately that were statistically different from the numbers expected.

Even though numbers of leukemias diagnosed between 2014 and 2016 were not unusual in any other school district, cases diagnosed in these years in other school districts were examined individually to see if any of them might share characteristics with the cases in the Connetquot school district. Particular attention was given to geographic proximity to Connetquot, the child's age at diagnosis, and the year of diagnosis. A small number of children of school age was identified whose addresses were within about a mile of the Connetquot boundary and were diagnosed between 2014 and 2016. These children were included in further data collection efforts to ensure that all cases with similar characteristics were reviewed.

In August 2022, childhood leukemias diagnosed in 2017 through 2019 were examined for Connetquot as well as the surrounding school districts combined. The number of leukemia cases diagnosed among children in the Connetquot school district was again similar to the number expected. In the other six school districts, there were a total of 13 cases observed, statistically similar to the 10.2 expected.

Previous time period: To determine whether there might be an unusual pattern in childhood leukemia diagnoses in the Connetquot school district in earlier years, childhood cancer cases were examined for the ten years prior to 2014, 2004-2013. In the Connetquot school district, the Cancer Registry identified 22 cases of cancer among children under the age of 20 that were diagnosed between 2004 and 2013. This compares with 19.6 cases that would be expected to be diagnosed in this time frame given the number of children living in the district. The difference between the observed number of total cancers and the number of total cancers expected was not statistically significant. When leukemias and lymphomas were examined separately, the observed numbers of these two cancers were not significantly different from the numbers

expected (fewer than six cases of leukemia observed vs. 4.7 expected and 7 cases of lymphoma observed vs. 3.3 expected.)

Numbers of observed and expected cases were also examined for different 5-year age groups. For all cancers combined, the numbers of cases observed were similar to the number expected for all age groups taken separately. When leukemia alone was examined, numbers of cases observed were also similar to the numbers of cases expected for all age groups. However, the number of cases of lymphoma observed was significantly greater than the number expected for children ages 15-19 years (six cases observed, 1.7 expected). The numbers of cases observed were similar to the numbers expected in all other age groups.

Because of the significantly higher than expected number of children ages 15-19 with lymphoma in the Connetquot school district, these cases were looked at more closely. Most of the teenagers had been diagnosed with Hodgkin lymphoma. When Hodgkin lymphoma was considered separately from the non-Hodgkin lymphomas, there was a significantly higher than expected number of cases of Hodgkin lymphoma among children of all ages. All cases of all types of lymphomas in children of all ages were then reviewed. This showed that all the children diagnosed with lymphomas were in their teens. Most had been diagnosed with Hodgkin lymphoma, and most were between 15 and 19 years old. There were both males and females. About half the cases were diagnosed in 2011 and half were diagnosed earlier. The cases diagnosed in 2011 included younger teenagers, and teenagers with non-Hodgkin lymphoma. For the Hodgkin lymphomas, the majority were of the nodular sclerosing cell type, the type most frequently found among teenagers and young adults. The home addresses of the teenagers with lymphoma were plotted on a map of the school district. The children lived throughout the school district, with no apparent concentration in any one section.

For the other six school districts in this investigation taken together, the Cancer Registry identified 125 cases of childhood cancer in 2004-2013. This compares with 139.2 cases expected, a difference that is not statistically significant. There were 26 cases of leukemia identified compared with 34.1 cases expected, and 19 cases of lymphoma compared with 23.3 expected. Neither of these differences was statistically significant. When 5-year age groups were taken separately, there were no statistically significant differences from expected numbers of cases for any single 5-year age group for all types of cancer taken together, or for leukemia or lymphoma taken separately.

Cancer incidence for the period 2004-2013 was also examined for each of the other school districts taken separately. The numbers of total childhood cancers in each school district were not significantly different from the numbers expected for any single school district. Numbers of cases of leukemia or lymphoma taken separately were also not significantly different from the numbers expected in any single school district. When individual age groups were examined separately for each school district, there were no significant differences from expected for total cancers, leukemia, or lymphomas in any 5-year age group in any one school district.

Records review

Methods

To further confirm the diagnoses and to gain additional information about individual risk factors, medical records from the time of cancer diagnosis were reviewed for the children reported by the resident as living or having lived in the Connetquot school district who were diagnosed with leukemia. Records were also reviewed for the small number of children from other school districts with similar characteristics. Records were requested from all the hospitals and other reporting sources that reported each child to the Cancer Registry. Information sought included the presence of certain genetic syndromes, a family history of cancer, a personal history of past radiation treatments or treatment for prior cancers, and certain conditions at birth, such as elevated birth weight or an older mother that have been linked with a greater risk of leukemia.

To obtain information on residence at the time of birth and to identify any conditions present at birth that have been linked with leukemia, birth certificate information was reviewed for all the children who were born in New York State. Whether a child had been born in New York State, outside of New York City, was determined by matching the child's identifying information against the files of the NYSDOH Bureau of Vital Records. Information for any children not found to be born in New York State, outside of New York City, was then matched against the birth files of the New York City Department of Health and Mental Hygiene to determine whether they had been born in New York City. The relevant information from the birth certificates was then reviewed.

Results

Medical records from the time of diagnosis were obtained for all but one of the children. Records were not available for the remaining child, however information for this child was obtained from the treating physician.

Preliminary review of the medical records indicated that none of the children with addresses in other school districts near the border with the Connetquot school district were actually New York residents at the time of their initial diagnosis. They had, however, been treated in New York. These children were therefore excluded from further review.

For the children from the Connetquot school district, the information obtained further confirmed the diagnoses of leukemia and the specific sub-type. None of the children had any pre-existing medical conditions that are strong individual risk factors for leukemia, although some had a history of other conditions. About half of the children had a family history of some type of cancer, including some children with multiple family members with cancer. A small number of children had a family history of leukemia.

Most of the children from the Connetquot school district had birth certificates on file at the NYSDOH Vital Records section. Of those who did not have a birth certificate showing they were

born in New York State, outside of New York City, none had certificates on file in New York City. Some of the children who were born in New York State lived in the Connetquot school district at the time of their birth, while others lived elsewhere in Suffolk County. Birth certificate information for those born in New York State showed that none of the mothers was over age 35 at the time of the child's birth. No congenital malformations were noted on the birth certificates. None of the children for whom birth certificates were obtained had a low birthweight (less than 2500 g/5.5 lbs.), however some of the children had a birthweight of over 3,500 g (7.7 lbs.).

Birth match

Methods

To evaluate whether children born in the Connetquot School District had a greater risk of developing cancer, a list of children born in Connetquot was matched against the Cancer Registry. The list was obtained from the NYSDOH Bureau of Vital Records and included all children born in the census tracts approximating the Connetquot School District between 1998 and 2009. This time period includes years from two years before the birth of the oldest child reported by the requestor to two years after the birth of the youngest child reported by the requestor.

Information on these children, including each child's full name, gender, and date of birth, was then matched against the New York State Cancer Registry to identify children who were diagnosed with cancer through December 31, 2017. Information on the children was also matched to NYSDOH death files to identify children who had died from any cause during this time period.

The number of cancers that would be expected to have developed in children born in the Connetquot school district was then calculated. This was done using a person-years approach, with person-years for the children accumulated from birth to death or December 31, 2017. The expected number of cancer cases was then computed by applying incidence rates by cancer site, year, gender, and age for New York State excluding New York City to the person years contributed by the children in each year, gender, and age category. The demographics of Connetquot school district residents were similar to those residing in areas outside of New York City. Since race/ethnicity was not adjusted for in this calculation, New York State excluding New York City was used as the reference population.

Results

A total of 5,001 births were identified in the Connetquot school district between 1998 and 2009. Of these, 26 children had died in New York between 1998 and 2017. Linkage with the Cancer Registry identified 12 children who had developed cancer between 1998 and 2017. Calculations estimated that 13.1 children would have developed cancer in this time period, a difference that was not statistically significant. When leukemia and lymphoma were examined separately, the number of leukemias diagnosed was similar to the 3.7 expected. There were no lymphomas

identified among the children compared with 1.3 expected, a not statistically significant difference.

Discussion

Study findings

The study did not find any children in the Connetquot school district who had been diagnosed with leukemia between 2014 and 2016 other than the ones reported by the resident. Since the number was less than six, the exact number is not reported to protect patient confidentiality. The study found a higher-than-expected number of children from the district who were diagnosed, but this difference was statistically significant only if the total number of children included children with official addresses at the time of diagnosis that were outside of the study area. The numbers of children in the Connetquot district who were diagnosed with other types of cancer, including lymphoma, were not elevated. In the six school districts surrounding Connetquot, there were no statistically significant elevations in numbers of children diagnosed with any type of cancer, or leukemia or lymphoma taken separately, in any single school district or in all the other school districts combined.

For the ten-year period prior to 2014 (2004-2013), the number of children in the Connetquot school district diagnosed with leukemia was similar to the number expected. There were no significant elevations in all types of childhood cancers combined. However, there was a greater than expected number of teenagers diagnosed with lymphoma. Most of the diagnoses were Hodgkin lymphoma and most of these were the most frequently diagnosed subtype. The teenagers lived throughout the school district. For the neighboring school districts, there were no significant findings in the neighboring districts combined or taken separately in this time period for total childhood cancers, or childhood leukemia or lymphoma taken separately.

The records review confirmed that the unusual occurrence of childhood leukemias did not extend outside the school district, as the children with leukemia in the closest geographic proximity to the school district did not actually live at that location at the time of their diagnosis. There were no strong individual risk factors, such as a genetic condition, identified among the children. Many of the children had a family history of cancer, including some with a family history of leukemia, and some had a high birth weight.

The match of birth records against the Cancer Registry showed that children born in the Connetquot school district between 1998 and 2009 were not any more likely to be diagnosed with cancer in general or leukemia in particular than children in New York State, excluding New York City, as a whole.

Childhood cancers

Compared with adults, cancer is rare in children. Still, about 1,000 children a year develop cancer in New York State, and it is the second leading cause of death in children after injuries.

The types of cancers children develop are also different from the types most often seen in adults. Leukemia, tumors of the brain and central nervous system, and lymphomas, including Hodgkin lymphoma and the non-Hodgkin lymphomas, are the most frequently diagnosed types of cancer in children.

Leukemia is a cancer of the blood cells. Leukemia is usually classified by the course of the disease (acute or chronic), and the type of blood cell affected. The most frequently diagnosed type of leukemia in children is acute lymphocytic leukemia (ALL), a cancer of the lymphocyte type of white blood cell that progresses rapidly. ALL accounts for two thirds of all childhood leukemias. Acute myelogenous leukemia, or AML, is the second most frequently diagnosed type of leukemia in children. AML accounts for about 15% of leukemia cases in all children, and about one quarter of cases in teenagers ages 15-19 (3).

Boys are slightly more likely than girls to develop leukemia, and the greatest risk for the disease in the US occurs between ages 2 and 5. Rates of childhood leukemia have generally been observed to be higher in industrialized nations than in developing nations (4). In the U.S., rates are generally higher in Hispanics and Whites than in Blacks/African Americans, Asians/Pacific Islanders, and Native Americans/Alaska Natives (5).

Only a few risk factors have been identified for childhood leukemia. Risk is known to be elevated in children with certain genetic syndromes such as Down syndrome. Exposures to ionizing radiation, such as pre-natal X rays, and prior chemotherapy for other cancers are also established risk factors, although they account for only a small fraction of cases. Scientists are also studying the possible role of infections, conditions at the time of birth such as a high birth weight (3,500 g/7.7 lbs. or over) or an older mother (age 35 or older), and exposures the child's parents may have had (4, 6).

The scientific literature contains numerous accounts of clusters of childhood leukemia cases. None of these has been linked conclusively with environmental exposures, although in some cases suggestive links have been found. For others, links with possible infectious agents or processes have been suggested. A recent systematic review (7) concluded that diagnoses of leukemia are more likely to cluster in space and time than would be expected by chance alone in children ages 0-5 but not in older children.

NYSDOH has developed a spatial scan statistic to identify "clusters" of different cancers across the state (https://www.health.ny.gov/statistics/cancer/environmental_facilities/mapping/). When applied to childhood leukemia diagnoses between 2005 and 2016, the statistic identified areas where numbers of childhood leukemias were significantly greater than expected and areas where numbers of cases were significantly less than expected over different time spans. Areas where numbers of cases were significantly greater than expected were all in New York City (Manhattan and sometimes extending into Queens). There was an area in Brooklyn where the number of childhood leukemia cases was significantly less than expected in one five-year time period; and an area extending into as many as 24 counties in central and western New York where numbers of cases were less than expected during various time periods beginning around 2011. Because of the method used, these findings are very unlikely to have occurred solely by

chance, but there are many other possible explanations, including differences in cancer diagnosis and reporting as well as differences in underlying causes.

Lymphoma is a cancer that starts in lymphocytes, infection-fighting cells that are a part of the body's immune system. Lymphocytes may be found in lymph nodes (small, oval-shaped organs located throughout the body) and in many organs. There are two main types of lymphoma – Hodgkin lymphoma (formerly called Hodgkin's disease) and non-Hodgkin lymphoma. These are distinguished by the way the cells look under the microscope. Hodgkin lymphoma is rare in young children but is the type of lymphoma most frequently seen in teenagers. Non-Hodgkin lymphoma occurs more often than Hodgkin lymphoma among younger children, but less often than Hodgkin lymphoma in teenagers (3).

People with depressed immune systems, such as those who have had organ transplants and people with HIV/AIDS, have an increased risk of getting both Hodgkin lymphoma and non-Hodgkin lymphoma. Other risk factors for non-Hodgkin lymphoma include having an autoimmune disease such as rheumatoid arthritis, lupus or celiac disease, and having a family history of non-Hodgkin lymphoma. Certain infections in addition to HIV have been linked with specific types of non-Hodgkin lymphoma. Some research studies suggest that occupational exposures to herbicides, pesticides, and certain other chemicals, including some solvents, may be associated with the development of non-Hodgkin lymphoma. Scientists are also studying the roles of obesity and exposure to ultraviolet radiation in non-Hodgkin lymphoma (8, 9).

Infection with the Epstein-Barr virus, which causes infectious mononucleosis, is believed to account for about a third of cases of Hodgkin lymphoma, particularly cases among young children and older adults (10). Other identified risk factors include a family history of Hodgkin lymphoma, particularly in a sibling, and living in an area with higher income and education, particularly for young adults. Scientists have also studied possible associations with occupational exposures, including pesticides and occupations in the woodworking industry, but so far results have not been consistent (10, 11).

Study limitations

In drawing conclusions from these data, several aspects of the statistical methodology need to be addressed. First, since the statistical tests mark as statistically significant excesses that would occur solely by chance 2.5 percent of the time or less (probability of 0.025 or less), with over 160 individual tests of significance conducted (three cancers or groups of cancers in seven areas in four age groups in two time periods), it would be expected that several results might appear statistically significant even though the differences between observed and expected numbers of cases were due entirely to random fluctuations in the data. Thus, the finding of the statistically significant excess in lymphomas in children ages 15-19 in the Connetquot school district in 2004-2013 could be due to chance.

Second, the numbers of children in individual school districts identified as having been diagnosed with cancer were small (for statistical purposes). Small numbers are more

susceptible to the effects of chance variation, making it more difficult to draw any firm conclusions.

Another statistical issue relates to the way the study was defined. In the confirmation of the initial reports of childhood leukemias and the further analyses, the geographic area and time frame for the analysis were chosen to correspond to the characteristics of the reported cases; this combination of characteristics would not have been chosen if the cases had not been reported. This situation is analogous to playing a game of darts and drawing the bullseye after throwing the darts. Defining the study area in this way, as compared to specifying a hypothesis in advance or studying predefined areas, increases the likelihood of obtaining significant findings.

An additional limitation is that geographically based analyses based on Cancer Registry data use patients' official addresses as reported by the hospital or other reported source to the Cancer Registry. These analyses cannot account for migration, that is, movement of people in or out of the study area, or people who may have more than one usual address. The Cancer Registry does not contain information on a patient's address(es) before they were diagnosed with (their first) cancer or on any other addresses a patient might have other than the address on their medical record. The Registry-based analysis identified cancers among children whose official addresses were in the study areas when their cancers were diagnosed. Children who lived in the study areas but moved away prior to being diagnosed could not be included, while children who developed cancer shortly after moving into the area were included. Children who had an official address outside the study area but spent some or all of their time living in the study area could not be included, while children who had an official address in the study area but spent some or all of their time living outside the study area were included.

When only children whose official addresses were within the Connetquot school district were included in the analysis, the number of cases of leukemia actually identified was greater than expected, but the excess was not statistically significant. The difference became statistically significant when children reported by the resident as having some association with the school district but not having an official address within district boundaries at the time of diagnosis were added. However, calculations of the numbers of children expected to be diagnosed with cancer did not include children who had moved away or who had another address outside the school district. This information is not readily available on the school district level. If the numbers of children who had moved away or had an alternate address were known and this number had been incorporated in the calculations, the number of children expected to develop cancer would have been greater. The finding of an elevated number of leukemia cases among school-age children in the Connetquot school district therefore might not have been statistically significant.

Migration is also important to consider when attempting to interpret the findings of the births analysis. This analysis was not able to identify any children born in the school district who had moved out of New York State before being diagnosed with cancer (and were not diagnosed or treated in state). Data from the American Community Survey of the US Census for the five-year periods 2006-2010 and 2011-2015 estimate that about 1.7% and 1.4% respectively of children

ages 1-19 had moved from Suffolk County to another state or Puerto Rico in the past year (12). Yearly out-migration percentages were around 7% for children ages 18 and 19, and around 1% or less for younger children. Applying these yearly percentages to the approximate numbers of children of different ages at different times shows that about 7% of children born in the Connetquot school district between 1998 and 2009 would have moved out of state and been lost to follow-up in the 20 years of the study. Accounting for this loss would have reduced the number of cases expected by a small amount and would not have affected the overall conclusions in this study.

Interpretation

The first part of the study was intended to determine whether the elevated number of school-age children confirmed to have been diagnosed with leukemia was part of any larger patterns of childhood cancer occurrence. No children in the Connetquot school district other than those reported by the resident were identified who had been diagnosed with leukemia from 2014 through 2016. Diagnoses of leukemia or other childhood cancers were not high in any school district bordering Connetquot. The numbers of children diagnosed with leukemia in the Connetquot school district as well as the surrounding school districts between 2017 and 2019 did not differ from the expected numbers.

The study identified an excess in lymphomas that were diagnosed among teenagers in the Connetquot school district in an earlier time period, however their characteristics did not suggest that the cases were related to the cases of childhood leukemia in 2014 and 2015. This finding may be related to the large number of statistical tests that were done. Childhood leukemia was not found to be elevated in any neighboring school district in the previous time period. These findings suggest that the elevated numbers of children living in or associated with the Connetquot school district who had developed leukemia between 2014 and 2016 were not part of any larger patterns of cancer occurrence.

The second part of this study was intended to determine whether there were any exposures the children with leukemia may have had in common, or any individual risk factors that may have played a role in the diagnoses. Review of the medical records did not identify any strong individual risk factors that would explain individual cases. Some of the children had a family history of leukemia or another form of cancer, and some had a high birthweight. A family history of cancer is quite common in the general population, and many children have a birthweight over 3,500g. Given the relatively small numbers of children with leukemia, it is not possible to say whether these factors may have played a role in the diagnoses.

If there were any widespread, long-term environmental risk factors within the Connetquot school district, these may have affected children born in that area, even if the children had moved away after birth. The births match was intended to study this possibility. The analysis did not show that children born in the Connetquot district were at higher risk of developing cancer in general or leukemia or lymphoma in particular.

The detailed calculations that were done as part of this investigation showed that the number of school-age children with official addresses within the Connetquot school district who developed leukemia between 2014 and 2016 was within the range that could occur by chance. Since it is not possible to calculate the numbers of children who had moved away or had alternate addresses outside of the district who would be expected to develop cancer, it is not possible to say with any certainty whether the total number of children reported by the resident, including those with official addresses outside the district, was in fact outside the range of chance variation. The information reviewed in this investigation does not point to any single reason that the children reported by the resident had developed leukemia. The occurrence of these cancers could be the result of factors it was not possible to identify. It could also be the result of chance.

References

1. Sherman R, Firth R, De P, Green D, Hoffercamp J, Johnson C, Kohler B, Charlton M, Hofer B, Hsieh M, Nash S, Qiao B (eds). *Cancer in North America: 2012-2016. Appendix D: Data Quality Indicators by Year and Registry.* Springfield, IL: North American Association of Central Cancer Registries, Inc. May 2019. Available at https://www.naaccr.org/cancer-in-north-america-cina-volumes/#Vol1 . Accessed March 4, 2020.
2. Molina EC. Poisson's Exponential Binomial Limit. Huntington, NY: Robert E. Krieger Co., 1973.
3. New York State Cancer Registry. *Cancer Incidence and Mortality in New York State, 1976-2016*. Cancer among Children and Adolescents (Ages 0 to 19 Years). Accessed April 2, 2020.
4. Ross JA and Spector LG, Cancers in Children, in Schottenfeld D and Fraumeni JF, *Cancer Epidemiology and Prevention, Third edition*, New York: Oxford University Press, 2006.
5. Howlader N, Noone AM, Krapcho M, Miller D, Brest A, Yu M, Ruhl J, Tatalovich Z, Mariotto A, Lewis DR, Chen HS, Feuer EJ, Cronin KA (eds). SEER Cancer Statistics Review, 1975-2016, National Cancer Institute. Bethesda, MD, https://seer.cancer.gov/csr/1975_2016/, based on November 2018 SEER data submission, posted to the SEER web site, April 2019. Accessed April 7, 2020.
6. New York State Department of Health, About leukemia, at https://www.health.ny.gov/statistics/cancer/registry/abouts/leukemia.htm , revised April 2017.
7. Kreis C, Doessegger E, Lupatsch JE, Spycher BD, Space-time clustering of childhood cancers: a systematic review and pooled analysis, *European Journal of Epidemiology* 34:9-21, 2019.
8. New York State Department of Health, About non-Hodgkin lymphoma, at https://www.health.ny.gov/statistics/cancer/registry/abouts/nhl.htm, revised May 2018.
9. American Cancer Society, Non-Hodgkin lymphoma risk factors, at https://www.cancer.org/cancer/non-hodgkin-lymphoma/causes-risks-prevention/risk-factors.html . Accessed August 4, 2020.
10. Hjalgrim HJ, Chang ET, and Glaser S, Hodgkin Lymphoma, in Thun MJ, Linet MS, Cerhan JR, Haiman CA, Schottenfeld D, eds., *Schottenfeld and Fraumeni Cancer Epidemiology and Prevention, Fourth Edition,* New York: Oxford University Press, 2018.
11. Melbye M and Adami H-O, Hodgkin's Lymphoma, in Adami H-O, Hunter D and Trichopoulos D, *Textbook of Cancer Epidemiology*, New York: Oxford University Press, 2002.
12. United States Census Bureau, County-to-County Migration Flows, at https://www.census.gov/topics/population/migration/guidance/county-to-county-migration-flows.html . Accessed August 4, 2020.

Appendix A

SUMMARY OF ENVIRONMENTAL INFORMATION FOR THE INVESTIGATION OF CHILDHOOD CANCER INCIDENCE IN THE CONNETQUOT CENTRAL SCHOOL DISTRICT

Overview

NYSDOH staff reviewed the available environmental information to support the investigation of childhood cancer incidence in the Connetquot Central School District (CCSD). In conducting this review, staff aimed to identify any potential unusual community exposures to environmental hazards that could possibly pose long-term cancer risk factors. Additionally, staff also investigated concerns raised by the investigation's requestor about aircraft fuel dumping on approach to the Long Island MacArthur Airport, refuse disposal and chemical/hazardous waste disposal sites, the Ronkonkoma Railroad Station, and a large concrete company in the area.

Approach

Department staff reviewed the available environmental records for the Connetquot School District and the surrounding area. The records include information related to inactive hazardous waste disposal sites and brownfields sites, and data for public and private drinking water wells and the public drinking water distribution system. Department staff also communicated with staff from the Department of Environmental Conservation (NYSDEC) about issues raised by the investigation's requestor.

Summary of Findings

The environmental evaluation identified inactive hazardous waste disposal and brownfields sites within the school district or near school district boundaries that might have been the source of unusual exposures to contaminants in the past (prior to 1991). Chemicals from some of these sites contaminated public and private water supplies with low levels of organic chemicals. Some of the chemicals associated with these historic contaminated sites have been associated with leukemia in occupational studies. However, through a series of actions, any potential for exposure had been eliminated by 1991, long before there could have been any potential exposures to the study population. Parents of the children could have been exposed to site-related contaminants in the past if they resided near or worked at these sites but more information on parents' occupational and residential exposure history would be necessary to identify an unusual exposure in common. Overall, there is no evidence of unusual environmental exposures in common amongst the study population that would likely contribute to a detectable increase in cancer incidence.

Inactive Hazardous Waste Disposal and Brownfield sites

Since the enactment of State and Federal toxic waste cleanup programs beginning in the early 1970s, the NYSDEC and NYSDOH each have a role in managing contaminated sites and preventing and/or minimizing human exposures to site-related contaminants. NYSDOH staff work with NYSDEC staff to investigate the potential for human exposure to site-related environmental contamination, primarily at inactive hazardous waste sites and brownfield sites. In addition, NYSDOH staff prepare public health assessments for federal superfund sites under an agreement with the federal Agency for Toxic Substances and Disease Registry. Staff also conduct exposure investigations as part of the state's Cancer Surveillance Improvement Initiative. NYSDEC's online database of remedial sites in New York State may be accessed at: https://www.dec.ny.gov/cfmx/extapps/derexternal/index.cfm?pageid=3.
Based on a review of the available NYSDOH records, the NYSDEC remedial program database and the United States Environmental Protection Agency (USEPA) on-line information, four inactive hazardous waste sites were identified within the CCSD boundary (ZIP codes 11779, 11716, 11769, 11782, 11796, and a portion of 11788). Seventeen additional sites were identified within the ZIP codes associated with the school district but were sufficient distance away that exposures from these sites are unlikely for district residents. Three additional sites located near the school district boundary were included in the review. A total of seven sites were reviewed to determine whether on- or off-site contamination resulted in any usual exposures for this area. These may include some of the sites referred to by the investigation's requestor. Table A1 provides additional information about these sites.

In summary, there were potential historical exposures, estimated to be associated with low health risks in the area from four of these sites via ingestion of drinking water (see Table 1), and potentially via direct contact with on-site contaminated materials before site restrictions and remedial activities. These potential exposures pre-date by at least four years the birthdates of the children with leukemia. Parents of these children could have been exposed to on-site contaminants if they lived near and worked at these sites but identifying exposures in common is constrained by a lack of parents' occupational and residential histories. All past potential exposures due to contamination in public water supply wells ended by 1991, with installation of treatment systems, reduced well use and blending with uncontaminated wells, and removal of wells from service. Recent public water supply data support the absence of unusual exposures to contaminants in drinking water (see next section).

Drinking water

The NYSDOH, county health departments, and the federal government regulate public water systems. In 1974, Congress passed the Safe Drinking Water Act that standardized the protection of drinking water on a national level. These national drinking water standards first went into effect in 1977.

Public drinking water in the CCSD area is provided by the Suffolk County Water Authority (SCWA), which operates numerous wells in southern Suffolk County. People drinking water in the study area receive water from a mixture of nearby wells that pump at various rates to meet consumer demand. NYSDOH scientists reviewed routine sampling data (2000-2015) for water

supply wells within one-half mile of the study area as the likely contributors to the drinking water distribution system.

Review of environmental records related to inactive hazardous waste sites and brownfield sites in the study area indicate that shallow public water supply wells were contaminated with volatile organic compounds, including chlorinated solvents and metals. Because levels measured in the well water exceeded applicable drinking water standards, public water was provided to residential areas from 1984-1986. Additionally, SCWA took steps to monitor, blend, filter/treat, and mitigate contamination so that community exposures were minimized and eliminated by 1991. Deeper water supply wells have shown no evidence of contamination.

Data from the same time frame were also provided for private drinking water wells in the area. Some samples had a few low detections of contaminants but all were below drinking water standards. Even though public drinking water standards do not govern private water supplies, they are used as guidance values for private water supplies. The standards are designed to protect against possible adverse health effects from long-term exposure to chemical contaminants. In addition, on-site groundwater monitoring well data collected between 2011 and 2012 as part of an environmental investigation at a property located in Bohemia were evaluated. These groundwater monitoring wells were not used for drinking water. Elevated levels of volatile organic compounds were detected in these wells and a follow-up soil vapor intrusion investigation found that exposures were not likely occurring due to soil vapor intrusion.
In summary, no unusual exposures to environmental contaminants from identified sites or in drinking water are known to have occurred during the lifetimes of the children confirmed to have cancer. However, it is possible that parents of the children with leukemia may have been exposed to levels of contaminants in drinking water that exceeding drinking water standards in place prior to 1991 and by contact with chemicals located at these former industrial sites.

Air Quality

In 1957, the New York State Legislature enacted one of the nation's first comprehensive air pollution control laws by passing the Air Pollution Control Act “to safeguard the air resources of the state from pollution” by controlling or abating air pollutant releases from existing sources and preventing new source releases for the public good. Since the 1970 Clean Air Act, the US Environmental Protection Agency (USEPA) has been regulating “criteria” air pollutants which are carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, ozone, and lead through National Ambient Air Quality Standards (NAAQS). Additional information about criteria pollutants is available on the USEPA’s web site at https://www.epa.gov/criteria-air-pollutants. In 1990, the Clean Air Act was amended to include a list of “hazardous air pollutants” (HAPs) selected by Congress based on potential health and/or environmental hazards. Additional information about HAPs is available on the USEPA’s web site at https://www.epa.gov/haps. The enactment of Federal and State regulatory actions under the Clean Air Act and its Amendments has drastically improved air quality across the state, which show decreasing trends of criteria pollutant concentrations in the study area. Currently, Suffolk County is in attainment for the NAAQS for all criteria pollutants with the exception of ozone. NYSDEC publishes an annual air

quality report (https://www.dec.ny.gov/chemical/8406.html) and provides additional information about permitted facilities via DECinfo Locator map (https://www.dec.ny.gov/pubs/109457.html). There is no evidence of unusual exposures related to outdoor air quality for this area. Program staff from the NYSDEC Division of Air Resources are available to answer any questions about any specific facility in the area.

Additional Environmental Concerns

Fuel dumping at Long Island MacArthur Airport: The requestor for this investigation raised concerns about fuel dumping at the Long Island MacArthur Airport. Federal Aviation Administration regulations regarding aircraft fuel dumping capabilities have been in effect since at least the late 1950s. NYSDOH researchers unsuccessfully attempted to obtain information on aircraft fuel dumping practices from officials at Long Island MacArthur Airport and from the Federal Aviation Administration. Fuel dumping may occur if an aircraft's maximum landing weight is less than their maximum take-off weight, and not all aircraft are capable of jettisoning fuel. For aircraft with this capability, dumping fuel is done only when the aircraft needs to land shortly after take-off, such as in the case of a medical emergency or an equipment problem. The fuel is jettisoned over a wide area, and, depending on altitude and the ambient temperature, most of it evaporates before it reaches the ground. It was not possible to obtain any specific information on fuel dumping at Long Island MacArthur Airport.

Ronkonkoma Long Island Railroad: The Ronkonkoma station on the Long Island Railroad is located along the middle of the Ronkonkoma branch that terminates in Greenport. The station is owned and operated by the Metropolitan Transportation Authority and is located north of the Long Island MacArthur Airport. Although NYSDEC does not regulate emissions from operations at the station and railroad, commuter traffic, idling trains, and maintenance are sources of air pollution from this station. There is no evidence that these emissions contributed to unusual exposures for the children that are the subject of this investigation.

Un-named facilities: The requestor raised concerns about a concrete company and a composting/waste facility. Due to the non-specific nature of these concerns, NYSDOH scientists were unable to locate any information about these facilities. Community members can direct any concerns about environmental facilities to the Regional Office of the NYSDEC (https://www.dec.ny.gov/about/259.html).

Table A1. Inactive Hazardous Waste and Brownfield Sites within and adjacent to the boundaries of the Connetquot Central School District.

Site Name	Site Number	Site Status	Description and Exposure Potential
I. **Sites *within* the boundaries of the Connetquot Central School District**			
Bioclinical Laboratories 1585 Smithtown Avenue, Bohemia	152020	Federal Superfund Site Delisted Class C (Remediation Complete) The USEPA Delisted the site in 1994 after determining "No Further Action was needed."	This company operated between 1972 and 1984 repackaging and distributing chemicals. In addition to leaking on-site storage of chemicals in drums, chemical residues were discharged to on-site septic systems or directly onto the ground. After a fire in 1981, USEPA removed wastes and contaminated materials and Suffolk County ordered cleanup of the sanitary systems. Soils and groundwater were contaminated with volatile organic compounds (trichloroethene, 1,1,1-trichloroethane, trichlorofluoromethane, 1,1-dichloroethane, bis(2-ethlylhexyl)phthalate) and heavy metals (arsenic, chromium, lead). With a few exceptions, concentrations of chemicals in the on-site and off-site groundwater met their respective water standards, according to USEPA's 1992 Record of Decision (ROD). As part of this ROD, a baseline risk assessment was conducted to estimate potential human health risks associated with current and future use. The results of this assessment found that the estimates risks associated with potential exposure to site contaminants, including the use of groundwater, were low and below or within USEPA's acceptable risk range. The site was listed to the National Priorities List in 1989. Current use includes commercial and light industrial businesses. Drinking water: Prior to remedial actions, people using private wells near this site may have been exposed to site-related contaminants until public water connections were provided. However, USEPA estimated these risks to be low based on exposure to concentrations of chemicals found in on-site groundwater. Two shallow public water supply wells on Locust Avenue were contaminated with volatile organic compounds (unidentified source) over their respective, applicable NYS drinking water standards. These wells were returned to service with carbon treatment in 1991. Deeper wells have shown no contamination and are monitored. Public water was provided to the residential areas (1984-1986) and no private wells are known to be used currently for potable water.

Site Name	Site Number	Site Status	Description and Exposure Potential
Dayton Brown, Inc. 555 Church Street, Bohemia	152001	Delisted Class N State Superfund site, meaning 'No Further Action'	This site is listed with the NYSDEC as a regulated active research and industrial facility. Plating waste sludge is stored in underground tank prior to disposal. Disposal site is closed. NYSDEC lists heavy metal sludge, iron, zinc, and cyanide as contaminants of concern. A 1987 Potential Hazardous Waste Site Inspection Form contains minimal information, but says two shallow public water supply wells are located nearby, but were taken out of service due to organic contamination. The specific chemicals were not identified.
Suffolk County Water Authority Wellfield Locust Avenue, Bohemia	152074	Class N site meaning 'No Further Action'	These are public water supply wells operated and maintained by the Suffolk County Water Authority. NYSDOH has limited information on this site. The Site Inspection Report lists Bioclinical Laboratories as a potential source. NYSDEC's site database indicates that 1,1,2-trichloroethylene is the contaminant of concern. The wells have been treated to remove contaminants since 1991 for contaminants prior to distribution.
CAMCO, Central Aviation and Marine Corp. 2125 Smithtown Ave Ronkonkoma	152206	Class C (Remediation Complete). An "Environmental Easement" is in place for site controls.	The property was occupied by CAMCO from WWII to 1996. Prior to 1980, operational wastes were discharged into a series of leaching pools and storm drains. Elevated levels of chlorinated solvents (1,1,1-trichloroethane, methylene chloride and trichloroethene) and cadmium were found in leaching pools and drains. Contaminated leaching pools and dry wells were remediated in 2008. High levels of trichloroethene were detected in sub-slab vapor at the site but that building has since been demolished.
II. **Sites *adjacent* to school district boundaries**			
Goldisc Recording Broadway Avenue Holbrook	152022	State Superfund, Class 4 site Meaning site is "closed" but requires site management and monitoring.	Before the current industrial/commercial use of the property, this site was the location of several manufacturing facilities that operated from 1968-1983. Primary wastes included nickel plating wastes, hydraulic oil, solvents and polyvinyl chloride. Wastes contaminated on-site surface soils and groundwater through leaking drums, storm drains and leaching facilities, and spills. Remedial activities were completed and institutional and engineering controls are in place and monitored.

Site Name	Site Number	Site Status	Description and Exposure Potential
			A 1988 preliminary health assessment identified contamination in groundwater on-site and off-site, and in surface soils and waste disposal areas. The ATSDR published a Public Health Consultation in March 2000 that concluded that the site posed no apparent public health hazard because there were no on-going exposures. Past exposures likely occurred while working at the site, trespassing on-site and contacting waste materials, use of contaminated private wells and public water. Prior to cleanup, an area of on-site petroleum contamination was determined to be an indeterminate public health hazard because workers and trespassers could be exposed to the contamination. The report concludes that exposure to the highest measured groundwater concentrations of chlorinated solvents detected on-site, could pose a moderate to low increased cancer risk. Exposure to the highest concentration of nickel found in on-site groundwater monitoring wells could pose a low risk of adverse health effects. Drinking water: Between 1977 and 1984 Suffolk County Department of Health Services determined that two shallow wells on Church Street were contaminated with chlorinated solvents (tetrachloroethene, 1,1,1-trichloroethane, 1,1-dichloroethane and trichloroethene), but not the deeper well. All contaminants except for 1,1-dichloroethane were found above their respective, applicable drinking water standards. SCWA indicated that the contaminated wells were not used after exceedances were identified but people who received water from this well prior to identifying the contamination (<1977-1984) could have a low risk for developing cancer. People using private wells may have been exposed to site-related contaminants until public water connections were provided. Cleanup activities allowed the shallow wells to be returned to service in 1988 however, a groundwater plume containing nickel was found to be threatening the shallow wells in the early 1990s and the water is monitored and blended to meet drinking water standards.
Sayville Landfill Lincoln Ave Veteran's Memorial Highway Islip	152053	Class N site This is a delisted site.	The site is an inactive municipal landfill however no hazardous waste disposal was documented at the site. No contamination was detected in downgradient test wells for the public water supply wells. The site was referred to NYSDEC Solid Waste for closure as no hazardous waste was found. There is no suggestion of off-site exposures associated with this site.

Site Name	Site Number	Site Status	Description and Exposure Potential
Turf Specialist 444 St. James Street Holbrook	152160	Class N site This is a delisted site	No information was available on the NYSDEC website or in the NYSDOH file for this site.

Use the "site number" to search NYSDEC's Environmental Site Remediation Database for information.