Health Consultation

Non Hodgkin Lymphoma Incidence

In Southington, Connecticut 1984-1996

In Relation to Emissions from

Solvents Recovery Services of New England

Southington, Hartford County, Connecticut

EPA Facility ID: CTD009717604

March, 2002

Prepared by the Connecticut Department of Public Health
Under a Cooperative Agreement with the

Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR).
Atlanta, Georgia 30333

Table of Contents

Summary

This report summarizes the follow-up investigation of the incidence of non-Hodgkin lymphoma (NHL) in Southington, Connecticut conducted for the period 1986 to 1996 by the Connecticut Department of Public Health (DPH). This follow-up study found the rates of NHL within Southington to be similar to State of Connecticut rates for the same time period. An earlier investigation of cancer incidence in Southington for the period 1968-1991 had been conducted by the DPH at the request of residents. In the earlier study a non statistically significant increase in the age standardized incidence ratio (SIR) of NHL was found among women exposed to air emissions from Solvents Recovery Services of New England (SRSNE). In the earlier study, among females the SIR did tend to increase with increasing estimated exposure to air emissions; air level 1 (background exposure) SIR=0.59 (95% CI 0.10 1.08), air level 2 SIR=0.59 (95% CI 0.00, 1.47), air level 3 SIR=2.42 (95% CI 0.43, 4.40)[1] Therefore, this follow-up study was intended to determine if that elevation of NHL cases among women had continued.

Improper disposal practices by SRSNE had caused the air, public drinking water, and soil in Southington to be contaminated with waste solvents and metals. In order to evaluate the relationship of exposure and cancer incidence, environmental contaminant exposure indices were established for the earlier cancer incidence study for air and water routes of exposure for each census block in Southington. These exposure estimates were used in this follow-up analysis. Census blocks with the same relative exposure rankings were grouped for analysis.

A possible dose response relationship between exposure to emissions from SRSNE and NHL cancer risk was explored by calculating age and sex standardized

incidence ratios (SIR) by exposure categories. In this follow up study, no statistically significant elevations in the NHL SIRs were found in any of the air or water exposure categories for either males or females. Among women the SIRs did increase with increasing exposure to air emissions however, the increase was slight, based on few cases and the individual SIRs were not statistically significant: air level 1 (background exposure) SIR=0.78 (95% CI 0.27 1.29), air level 2 SIR=1.06 (95% CI 0.00, 2.12), air level 3 SIR=1.30 (95% CI 0.00, 2.63).

Background

In March 1998, the Connecticut Department of Public Health (DPH) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), published a study entitled, "Cancer Incidence in Southington, CT 1968-1991 in Relation to Emissions from Solvents Recovery Services of New England".[1] This health consultation serves as a follow-up to that original cancer study.

Solvents Recovery Services of New England (SRSNE) is a National Priority List (NPL) hazardous waste site located in Southington, Connecticut. A public health assessment has been prepared for SRSNE by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Connecticut Department of Public Health (DPH) which provides a complete description of the site.2

The area surrounding the SRSNE has a mixture of commercial, residential, light industrial, and agricultural uses. SRSNE functioned as a hazardous waste treatment facility processing waste solvents from 1955 until May 1991, when the facility closed down all operations permanently. Ground water and soil, both on-site and off-site have been contaminated with waste solvents and metals due to improper disposal practices.

SRSNE began its solvent-recovery operations in 1955. The facility processed between 3 and 5 million gallons of liquid hazardous wastes and 100,000 pounds of solid hazardous wastes annually. The liquid wastes included unrecoverable solvent-based fuels, chlorinated solvents, and wastes generated from its fuel-blending operations. Solid hazardous wastes included gloves, rubber, cloth, rags, plastics, asphalt, and mine wastes. The facility processed approximately 170,000 gallons of state-regulated wastes annually which included lubricating fluids, hydraulic oils, and antifreeze. Waste water generated on-site included well overflow from the ground water recovery system, boiler steam condensate, and storm water runoff.[2]

From 1955 to 1988 the facility operations included the distillation of recoverable solvents in batch stills. From 1957 to 1967 the distillation process generated unusable solvent still bottom sludges which were disposed of in two unlined on-site lagoons. The sludges were also disposed of at the Old Southington Landfill approximately 6 miles south of SRSNE from 1966 to 1967. After the lagoons were filled in 1967, the surface water runoff from SRSNE continued to contaminate the ditch, stream, and wetlands with solvents and oils. From 1988 to 1991, SRSNE performed only fuel blending and waste transfer.

A review of records from SRSNE gathered by EPA revealed that SRSNE processed a wide variety of solvents and other compounds. Some of these compounds were also measured in the drinking water and in the air surrounding the SRSNE facility. The water was not tested for the presence of solvents until analytical methods became available in the late 1970's. Air measurements were not made during most of the operation of SRSNE.

Statement of Issues

The original study of cancer incidence in Southington, CT was suggestive of a possible link between exposure air emissions and risk of NHL among women. The results had a non statistically significant elevated SIR among women who were estimated to be exposed to higher levels of air emission from SRSNE. For females the SIR increased with increasing estimated exposure to air emissions; air level 1 (background exposure) SIR=0.59 (95% CI 0.10 1.08), air level 2 SIR=0.59 (95% CI 0.00, 1.47), air level 3 SIR=2.42 (95% CI 0.43, 4.40).[1]

Also, in the original study, the cases of NHL in the higher air emission area were as likely to be nodular cell type as diffuse cell type, where as in the general population diffuse cell type is more common. This follow-up study was intended to determine if that elevation of NHL cases among women had continued and whether the ratio of diffuse to nodular cell type continued to be different than the general population.

Methods

Case Ascertainment

Methods used were similar to the earlier study of cancer incidence in Southington.[1] Records of residents of Southington, Connecticut diagnosed with non-Hodgkin lymphoma between 1984 to 1996 were located in the Connecticut Department of Public Health Tumor Registry (TR). TR records were reviewed and specific information was abstracted. Information gathered included the case's gender, date of diagnosis, age at diagnosis, histological type (either diffuse or nodular NHL), and address at the time of diagnosis.

The time period of 1984 to 1996 was chosen for analysis because it provided an additional 5 years of data from the original study period of 1968-1991. Data from 1984

to 1991 was included in these analyses to provided data for both before and after the 1990 census period.

Exposure Assessment

The exposure assessment methods were the same as used in the earlier study of cancer incidence in Southington.[1] Data on exposure to emissions from SRSNE from the contaminated drinking water and air was estimated using modeling techniques. Each census block received a relative exposure score for air emissions, an exposure score for water emissions, and an exposure score for air and water emissions combined. No actual measurements of contaminant levels at case addresses was available. A more complete description of the drinking water contamination, air emissions, modeling techniques used for exposure assessment, and SRSNE operations is presented in the original report.[1]

Water contaminant modeling

The Southington Water Company's production wells 4 and 6 are located approximately 1,200 feet south of SRSNE. Well 4 was installed in 1966 and well 6 in 1976. The wells were identified as contaminated with volatile organic compounds (VOCs) and possibly heavy metals in 1976 and 1977. According to the Southington Water Company, all public water well sources are pumped into the town's distribution system and therefore blended together. Wells number 4 and 6 yielded between six (6) and thirty-six (36) percent of the town's water supply during the years they were in operation (from 1966 to 1980). However, those residences located in the immediate vicinity of these wells could have received as much as 90 percent of their water supply from these wells. It is not known when the contaminants first appeared in the public drinking water system, since the water was not tested for the presence of these compounds until 1976. Well 4 was deactivated in 1979 and Well 6 was deactivated in

1980.[3] For the original study, the public water supply system was hydrologically analyzed to determine the areas of town (census blocks) that received drinking water that was contaminated.

Air emission modeling

Air quality modeling of probable emissions from the SRSNE site was performed using the EPA Industrial Source Complex Long-Term (ISCST2) model. Estimates from various sources of air emissions from SRSNE were combined to derive an overall estimate of air emissions. The sources of emissions from SRSNE included receiving and storage tanks, solvent reclamation operations, blend tanks, primary and secondary lagoons, an open pit incinerator, and an air stripper. These various sources operated at different times between the mid 1950's and early 1990's, but are combined to make one overall relative exposure score for the period of SRSNE operations.

Maps of Estimated Water and Air Exposures from SRSNE

Figure 1 is a map categorizing geographic areas by their estimated relative exposure to contaminated drinking water, Figure 2 presents areas and their relative exposure to air emissions, and Figure 3 displays the geographic areas with their relative exposure to either contaminated drinking water or air emissions. These maps use 1990 census block boundries. These maps were created by overlaying the 1980 census block boundries and exposure information from the original report on the 1990 census block map in order to translate the 1980 information to 1990 data.

Case Mapping

The case residential address was mapped using a Geographic Information System (GIS). Air, water, and combined exposure scores were assigned to each case. The GIS also was used to delineating census block areas, and managing spatial data. The GIS

software used in this project was ArcInfo and ArcView from Environmental Systems Research Institute, Inc., and Matchmaker 2000 from Geographic Data Technology.

Estimates of the Population at Risk

Census 1990 information at the block level was used to derive population estimates for the various exposure groups. At the block level, information is available on age and gender. The population data for similar exposure categories were grouped together for analysis of the standardized incidence ratios (SIR).

Statistical Analysis

The indirect method of age standardization and State of Connecticut incidence rates from the DPH Tumor Registry were used to calculate age standardized incidence ratios (SIR). SIRs were calculated for non Hodgkin lymphoma for each drinking water and air exposure ranking. The indirect rather than direct method of age standardization was chosen for these analyses because the number of cases was small, resulting in incidence rates that would be too unstable for age standardization using the direct method.

$$\text{SIR} = \frac{Observed}{Expected}$$

Observed = the sum of the number of cases diagnosed in each age group in Southington

Expected = the sum of the Connecticut incidence rate for each age group times the age specific population for each age group in Southington

$$95\%\ \text{Confidence Interval for SIR} = \text{SIR} \pm 1.96\ \frac{\sqrt{Observed}}{Expected}$$

A Bonferroni correction was made to adjust for multiple comparisons.[4] For SIR calculations, this study evaluated the association between NHL risk and exposure to emissions for 3 air exposure levels, 3 water exposure levels, and for males and females,

making a total of 18 independent comparisons. In order to adjust for the large number of statistical comparisons, the significance level was divided by two times the number of comparisons, to determine the appropriate z level.

for $\alpha = 0.05$ $0.05/36 = 0.00139$

$z = 3.00$

$$95\% \text{ Confidence Interval for SIR } = \text{SIR} \pm 3.00 \frac{\sqrt{Observed}}{Expected}$$

Results

The results of the analyses are presented in Table 1, Table 2, and Table 3. There were no statstically significant elevation in SIRs among males or females for any of the exposure categories. Overall the incidence of NHL in Southington is lower than State of Connecticut rates as shown in Table 1, there were 74 cases of NHL diagnosed among Southington residents between 1984 to 1996 while approximately 89 cases would have been expected to occur. Among women the SIRs did increase with increasing exposure to air emissions however, the increase was slight, based on few cases and the individual SIRs were not statistically significant: air level 1 (background exposure) SIR=0.78 (95% CI 0.27 1.29), air level 2 SIR=1.06 (95% CI 0.00, 2.12), air level 3 SIR=1.30 (95% CI 0.00, 2.63).

Among men, the SIR actually decreased with increasing exposure to air emissions, however, again, the decrease was slight, based on few cases and the individual SIRs were not statistically significant: air level 1 (background exposure) SIR=0.84 (95% CI 0.35 1.32), air level 2 SIR=0.69 (95% CI 0.00, 1.53), air level 3 SIR=0.47 (95% CI 0.00, 1.29).

A review of the epidemiology of NHL in Connecticut documented not only that NHL incidence has been increasing during the past several decades, but also that the histology of the tumors is tending to change. Proportionally, more cases of nodular NHL are occurring. The ratio of diffuse cell type to nodular cell type among women had decreased from 9:1 to about 3:1 from the 1960's to the 1980's.[5] One of the somewhat unusual findings in the original study was that there was an greater liklihood to for the histological type of NHL to be of nodular cell type (rather than diffuse cell type) among the air emission exposed cases than you would expect to see. However, in this follow-up study the ratio of diffuse to nodular cell type was more typical, with a 2:1 ratio of diffuse to nodular NHL among women in the high air exposure group (rather than the approximately 1:1 ratio found in the original study).

Conclusions

It appears that the non statistically significant elevation of NHL among women exposed to higher levels of air emissions from SRSNE observed in the original study is not continuing. The number of cases diagnosed to female residents of Southington in the part of town extimated to receive the highest historical exposure to air contaminants was within the range of what would be expected bases on State of Connecticut NHL incidence rates. Also the cell type of NHL was more typical than observed in the original study.

Since the suggestive findings in the original study did not achieve statistical significance these lower levels in the current study could indicate:

The earlier elevations were a normal fluctuation in the rates of NHL, or the factors causing the elevation (eg past exposures) were no longer causing excess cases of NHL.

Recommendations

The epidemological methods employed in both the original study and in this follow-up study are not able determine a cause and effect relationship between exposures to emissions to SRSNE and the incidence of cancer. These methods, however, can be suggestive of avenues of further research. Future studies of low level exposures to VOCs should consider the development of NHL as a possible health outcome to evaluate.

Public Health Action Plan

The Public Health Action Plan for SRSNE contains a descripton of the actions to be taken by the Agency for Toxic Substances and Disease Registry, and the Connecticut Department of Public Health in the vicinity of the site. Included in this plan is a commitment on the part of the Agency for Toxic Substances and Disease Registry and the Connecticut Department of Public Health to follow up on this plan to ensure that there is implementation. The public health actions to be implemented by the Agency for Toxic Substances and Disease Registry and the Connecticut Department of Public Health are as follows:

The Connecticut Department of Public Health will review and summarize additional tumor data collected by the Connecticut Tumor Registry. Breast cancer was not evaluated in the original study or as this component of the follow up, but will be reviewed in another health consultation.

The Connecticut Department of Public Health will provide environmental health education for the local public health officials, the local medical community, and local citizens.

Preparers of Health Consultation

Diane D. Aye, MPH, PhD
Epidemiologist

And

Gary V. Archambault, MS
Epidemiologist
Connecticut Department of Public Health

Table 1 Non Hodgkin Lymphoma, Age Standardized Incidence Ratios for Females and Males by Air and Water Exposure Categories, Southington, CT 1984-1996

	OBS	EXP	SIR	95% CI
Southington	74	88.9	0.83	0.54, 1.12
Air Level 1	48	59.0	0.81	0.46, 1.17
Air Level 2	15	17.2	0.87	0.20, 1.55
Air Level 3	11	12.7	0.87	0.08, 1.65
Air Level 2+3 (any air exposure)	26	29.9	0.87	0.36, 1.38
Water Level 1	45	55.5	0.81	0.45, 1.17
Water Level 2	18	21.4	0.84	0.27, 1.44
Water Level 3	11	12.0	0.92	0.09, 1.75
Water Level 2+3 (any water exposure)	29	33.4	0.87	0.38, 1.35
No air or water exposure	37	47.0	0.79	0.40, 1.17
Any air or water exposure	37	41.9	0.88	0.45, 1.32

Table 2 Non Hodgkin Lymphoma Age Standardized Incidence Ratios for Females by Air and Water Exposure Categories, Southington, CT 1984-1996

	OBS	EXP	SIR	95% CI
Southington	38	41.8	0.91	0.47, 1.35
Air Level 1	21	27.0	0.78	0.27, 1.29
Air Level 2	9	8.5	1.06	0.00, 2.12
Air Level 3	8	6.3	1.3	0.00, 2.63
Air Level 2+3 (any air exposure)	17	14.8	1.2	0.31, 1.99
Water Level 1	25	25.8	0.97	0.39, 1.55
Water Level 2	6	10.5	0.57	0.00, 1.28
Water Level 3	7	5.6	1.25	0.00, 2.67
Water Level 2+3 (any water exposure)	13	16.1	0.81	0.14, 1.48
No air or water exposure	18	21.8	0.82	0.24, 1.41
Any air or water exposure	20	20.0	1.00	0.33, 1.67

Table 3 Non Hodgkin Lymphoma Age Standardized Incidence Ratios for Males by Air and Water Exposure Categories, Southington, CT 1984-1996

	OBS	EXP	SIR	95% CI
Southington	36	47.3	0.76	0.38, 1.14
Air Level 1	27	32.3	0.84	0.35, 1.32
Air Level 2	6	8.7	0.69	0.00, 1.53
Air Level 3	3	6.3	0.47	0.00, 1.29
Air Level 2+3 (any air exposure)	9	15.4	0.60	0.00, 1.20
Water Level 1	20	30.0	0.67	0.21, 1.11
Water Level 2	12	11.0	1.10	0.15, 2.04
Water Level 3	4	6.4	0.63	0.00, 1.57
Water Level 2+3 (any water exposure)	16	17.3	0.92	0.23, 1.61
No air or water exposure	19	25.4	0.75	0.23, 1.26
Any air or water exposure	17	21.9	0.78	0.21, 1.34

[1] Aye DD, Archambault GA. Cancer Incidence in Southington, CT 1968-1991 in Relation to Emissions from Solvents Recovery Services of New England. NTIS Pub no PB98-137045. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia. March, 1998.
[2] ATSDR. Public Health Assessment of Solvents Recovery Services of New England. 1991. US Department of Health and Human Services.

[3] Southington Water Company. Records on water contaminants, water pumping, and pipe characteristics. 1992.
[4] McClave JT, Dietrich FH. Statistics. San Francisco: Dellen Publishing Co. ,1988.
[5] Zheng T, Mayne ST, Boyle P, Holford TR, Liu WL, Flannery J. Epidemiology of non-Hodgkin lymphoma in Connecticut 1935-88. Cancer 1992;70:840-849.