Pediatric Cancer Incidence and Proximity to Nuclear Facilities in Illinois

Introduction

A recent report suggested that, after nuclear power reactor closings, the geographic areas surrounding the reactor sites showed improvements in infant and child health within short periods of time.[1] The explanation for these "improvements" is that the fetus, infant and young child are most susceptible to effects of radiation and other toxic exposures. One of the measures used as an index to arrive at this conclusion was pediatric cancer incidence, especially among children ages 0 to 4 years.

Illinois has a number of nuclear power plants housed in different counties throughout the state. These plants have been in existence for varying lengths of time and are located in counties with differing population characteristics. Most plants are still in operation thus making an assessment of "closing effect" impossible. Nevertheless, if an improved health outcome is related to cessation of operation, then an equally plausible hypothesis would be that infants and children living near a nuclear power plant have worse health outcomes than those living elsewhere. This hypothesis was tested in the present study by evaluating the effects of possible nuclear exposure on pediatric cancer incidence in Illinois.

Methods

Seven nuclear power plants and their residing counties were identified. These include Braidwood in Will County (commenced in July 1988), Byron in Ogle County (commenced in August 1987), Clinton in DeWitt County (commenced in November 1987), Dresden in Grundy County (commenced in August 1960), LaSalle in LaSalle County (commenced in January 1984), Quad Cities (commenced in February 1973) and Zion in Lake County (commenced in December 1973 and closed in January 1998).

The seven counties with nuclear facilities were combined to form the nuclear facility county group. Each of these counties was matched to a comparison county. The criteria for matching included population density (rural, small urban, suburban), proportion of children ages 0 to 19 and similar racial composition. An effort was made once these criteria were met to select a comparison county that was geographically distant from any counties with nuclear facilities. The seven matched counties were combined to form the comparison, non-nuclear facility county group.

The analysis was a cross-sectional evaluation of cancer incidence reported to the Illinois State Cancer Registry (ISCR) for Illinois' children during the 1990 to 1997 time period for the two groups. The particular time period was selected because it follows the commencement of all plant operations and the aggregation of eight years allows the calculation of more stable rates for evaluation.

Pediatric cancer was defined as the diagnostic groups established using a scheme revised in 1996 by the International Agency for Research on Cancer (IARC), which uses site and morphology in ICD-O-2.[2, 3] Pediatric cancer incidence for children ages 0 to 19 years and also children ages 0 to 4 years was evaluated. The inclusion of younger as well as older age groups assured inclusion of cancers that may vary by age at onset yet might be influenced by exposure to nuclear emissions (i.e., bone cancer incidence is greatest for 15- to 19-year-old teenagers).[4] Likewise, a separate evaluation for children ages 0 to 4 years was made because the vulnerability of the youngest children to nuclear emission effects has been noted.

Pediatric cancer incidence for all diagnostic groups combined and for the major diagnostic groups were calculated for the nuclear and non-nuclear county groups and then compared . Average annual age-adjusted pediatric cancer incidence rates were examined for children ages 0 to 19. Then, average annual age-specific pediatric cancer incidence rates were calculated and evaluated for children ages 0 to 4 years. The purpose of this comparison was to determine if more pediatric cancer incidence was occurring in the geographic regions with nuclear facilities than those not in close proximity to such facilities. An additional evaluation compared pediatric cancer incidence for those counties with older nuclear plants to those housing newer nuclear plants. The purpose of this comparison was to determine any "dose response" effects resulting from length of time a nuclear facility was operational within a county.

Results

Table 1 shows pediatric cancer incidence counts, rates and 95 percent confidence intervals for the nuclear facility county and the non-nuclear facility county groups. No differences observed between the two groups for all diagnostic cancer groups combined and for specific major diagnostic groups were statistically significant for ages 0 to 19 years

or for the youngest children ages 0 to 4 years. Rate differences were not consistent - combined diagnostic groups seemed to be higher for the nuclear facility county group, while some site-specific diagnostic group rates seemed to be higher for the non-nuclear facility county group (i.e., leukemias for ages 0 to 19 as well as ages 0 to 4).

Table 2 presents pediatric cancer incidence counts, rates and 95 percent confidence intervals for the older vs. the newer nuclear facility county groups. Again, no significant differences were apparent for any rate comparison for either age group of Illinois children.

Comment

This evaluation of pediatric cancer incidence and proximity to nuclear facilities in Illinois failed to find significant and meaningful cancer incidence rate differences for Illinois children residing in counties with nuclear facilities as compared with those in comparable counties without such facilities. In addition, no “dose response” effect could be detected when comparing counties with nuclear facilities in operation for long and short periods of time. These results were observed in analyses of pediatric cancer incidence for ages 0 to 19 years, as well as those for younger children ages 0 to 4 years. These findings do not support an association between pediatric cancer risks and living in close proximity to nuclear power facilities and, therefore, are not in agreement with those recently published suggesting that pediatric cancer incidence decreases when exposure risk for nuclear emissions is reduced by plant closures.[1] However, they are in agreement with a recently reported study of 68,000 female defense workers that found no general mortality increases among women working in nuclear weapons plants during the Cold War.[5]

References

1. Mangano JJ. Improvements in local infant health after nuclear power reactor closing. *Environmental Epidemiology and Toxicology.* 2000;2:32-36.

2. Percy C, Van Holten V, Muir C (eds). *International classification of diseases for oncology*. 2nd edition. Geneva: World Health Organization, 1990.

3. Chen VW, Howe HL, Wu XC, Hotes JL, Correa CN (eds). *Cancer in North America, 1993-1997*. *Volume One: Incidence. Appendix B.* Springfield, IL: North American Association of Central Cancer Registries, April 2000.

4. Ries LAG, Smith MA, Gurney JG, Linet M, Tamra T, Young JL, Bunin GR (eds). *Cancer Incidence and Survival among Children and Adolescents: United States SEER Program 1975-1995,* National Cancer Institute, SEER Program. NIH Pub. No. 99-4649. Bethesda, MD, 1999.

5. Health News. Study Examines Mortality Rates of Women in Nuclear Weapons Plants. Available at: http://www.intelihealth.com/enews?288155. Accessed July 18, 2000.

Table 1.
Pediatric Cancer Incidence by Diagnostic Group, All Races, Both Sexes, Illinois, 1990-1997
Nuclear Facility County Group vs. Non-nuclear Facility County Group#

Average Annual Age-adjusted Pediatric Cancer Incidence Rates, Ages 0-19

	Nuclear Facility County Group				Non-nuclear Facility County Group			
	Count	AAR	Lower CI	Upper CI	Count	AAR	Lower CI	Upper CI
All diagnostic groups	497	150.2	137.2	164.1	530	142.9	130.9	155.8
Leukemia	119	34.6	28.6	41.5	158	41.2	35.0	48.3
Lymphoma	69	22.1	17.2	28.0	77	22.1	17.4	27.6
Central nervous system	101	30.7	25.0	37.4	87	24.0	19.2	29.7
Sympathetic nervous system	24	6.4	4.1	9.6	26	6.2	4.0	9.2
Retinoblastoma	16	4.2	2.4	7.0	11	2.5	1.3	4.6
Renal tumors	22	6.0	3.7	9.2	27	6.6	4.3	9.7
Hepatic tumors	5	1.4	0.4	3.3	8	1.9	0.8	3.9
Malignant bone tumors	26	8.5	5.5	12.4	27	7.9	5.2	11.5
Soft tissue sarcomas	30	9.1	6.1	13.0	36	9.8	6.8	13.6
Germ cell, trophoblastic and other gonadal	30	9.6	6.4	13.7	35	9.8	6.8	13.7
Carcinomas and other malignant epithelial	50	16.4	12.2	21.6	34	9.9	6.8	13.8
Other and unspecified malignant neoplasms	5	1.4	0.4	3.3	4	1.1	0.3	3.0

Average Annual Age-specific Pediatric Cancer Incidence Rates, Ages 0-4

	Nuclear Facility County Group				Non-nuclear Facility County Group			
	Count	ASR	Lower CI	Upper CI	Count	ASR	Lower CI	Upper CI
All diagnostic groups	193	226.8	196.0	261.2	194	198.6	171.7	228.6
Leukemia	65	76.4	59.0	97.4	78	79.9	63.1	99.7
Lymphoma	10	11.8	5.6	21.6	7	7.2	2.9	14.8
Central nervous system	34	40.0	27.7	55.8	28	28.7	19.1	41.4
Sympathetic nervous system	22	25.9	16.2	39.1	22	22.5	14.1	34.1
Retinoblastoma	15	17.6	9.9	29.1	11	11.3	5.6	20.2
Renal tumors	18	21.2	12.5	33.4	21	21.5	13.3	32.9
Hepatic tumors	4	4.7	1.3	12.0	7	7.2	2.9	14.8
Malignant bone tumors	1	1.2	0.0	6.5	2	2.0	0.2	7.4
Soft tissue sarcomas	11	12.9	6.5	23.1	12	12.3	6.3	21.5
Germ cell, trophoblastic and other gonadal	6	7.1	2.6	15.3	5	5.1	1.7	11.9
Carcinomas and other malignant epithelial	3	3.5	0.7	10.3	1	1.0	0.0	5.7
Other and unspecified malignant neoplasms	4	4.7	1.3	12.0	0	0.0	0.0	3.8

AAR - Age-adjusted rates are per 1,000,000 and age-adjusted to the 1970 U.S. standard. Confidence intervals are 95% for rates.
ASR - Age-specific rates are per 1,000,000. Confidence intervals are 95% for rates.
Nuclear Facility County Group: DeWitt, Grundy, Lake, LaSalle, Ogle, Rock Island and Will counties
Non-nuclear Facility County Group: Adams, Champaign, DuPage, Kane, Macoupin, McDonough and Richland counties
SOURCE: Illinois Department of Public Health, Illinois State Cancer Registry, December 1999

Table 2.
Pediatric Cancer Incidence by Diagnostic Group, All Races, Both Sexes, Illinois 1990-1997
Older Nuclear Facility County Group vs. Newer Nuclear Facility County Group#

Average Annual Age-adjusted Pediatric Cancer Incidence Rates, Ages 0-19

	Older Facility County Group				Newer Facility County Group			
	Count	**AAR**	**Lower CI**	**Upper CI**	**Count**	**AAR**	**Lower CI**	**Upper CI**
All diagnostic groups	283	153.4	135.9	172.6	214	146.6	127.5	167.7
Leukemia	69	36.0	27.9	45.7	50	33.0	24.5	43.7
Lymphoma	39	22.4	15.9	30.7	30	21.6	14.6	30.9
Central nervous system	59	31.9	24.2	41.3	42	29.0	20.9	39.3
Sympathetic nervous system	15	7.0	3.9	11.7	9	5.6	2.6	10.9
Retinoblastoma	12	5.6	2.9	10.0	4	2.5	0.7	6.6
Renal tumors	10	4.8	2.3	9.2	12	7.6	3.9	13.4
Hepatic tumors	1	0.5	0.0	3.0	4	2.6	0.7	6.9
Malignant bone tumors	15	8.9	5.0	14.7	11	8.0	4.0	14.3
Soft tissue sarcomas	17	9.3	5.4	15.0	13	8.9	4.7	15.3
Germ cell, trophoblastic & other gonadal	18	10.5	6.2	16.7	12	8.5	4.4	14.9
Carcinomas & other malignant epithelial	27	16.2	10.6	23.5	23	16.9	10.7	25.4
Other & unspecified malignant neoplasms	1	0.6	0.0	3.4	4	2.5	0.7	6.6

Average Annual Age-specific Pediatric Cancer Incidence Rates, Ages 0-4

	Older Facility County Group				Newer Facility County Group			
	Count	**ASR**	**Lower CI**	**Upper CI**	**Count**	**ASR**	**Lower CI**	**Upper CI**
All diagnostic groups	111	227.1	186.9	273.5	82	226.4	180.1	281.0
Leukemia	36	73.7	51.6	102.0	29	80.1	53.6	115.0
Lymphoma	7	14.3	5.8	29.5	3	8.3	1.7	24.2
Central nervous system	23	47.1	29.8	70.6	11	30.4	15.2	54.3
Sympathetic nervous system	14	28.6	15.7	48.1	8	22.1	9.5	43.5
Retinoblastoma	11	22.5	11.2	40.3	4	11.0	3.0	28.3
Renal tumors	8	16.4	7.1	32.3	10	27.6	13.2	50.8
Hepatic tumors	1	2.0	0.1	11.4	3	8.3	1.7	24.2
Malignant bone tumors	1	2.0	0.1	11.4	0	0.0	0.0	10.2
Soft tissue sarcomas	6	12.3	4.5	26.7	5	13.8	4.5	32.2
Germ cell, trophoblastic & other gonadal	3	6.1	1.3	17.9	3	8.3	1.7	24.2
Carcinomas & other malignant epithelial	1	2.0	0.1	11.4	2	5.5	0.7	19.9
Other & unspecified malignant neoplasms	0	0.0	0.0	7.5	4	11.0	3.0	28.3

AAR - Age-adjusted rates are per 1,000,000 and age-adjusted to the 1970 U.S. standard; Confidence intervals are 95% for rates.
ASR - Age-specific rates are per 1,000,000. Confidence intervals are 95% for rates.
Older Facility County Group: Grundy, Lake and Rock Island Counties
New Facility County Group: DeWitt, LaSalle, Ogle and Will Counties
SOURCE: Illinois Department of Public Health, Illinois State Cancer Registry, December 1999