Cancer Cluster Investigation in a School District

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ABSTRACT: *Because of concern about a possible cancer cluster among employees of an elementary school, an industrial hygiene survey and health investigation were completed. An indoor-air quality survey was conducted by a certified industrial hygienist (CIH). A separate health survey concerning cancer occurrence was conducted by the authors among current (1995) and former (back to 1990) employees. Cancer data from the state health department registry were used to supplement self-reports. The number of observed cancers were compared to those expected based on statewide and county data. A marginally significant increased risk was found for breast cancer among female employees who had worked for the school. No other excess in cancers was found. This excess of breast cancer was unlikely to have been related to an occupational exposure. Based on the study supported by the school district, which prefers to remain anonymous, this paper discusses the conduct of cancer cluster investigations in schools and recommends that screening and education for breast cancer be conducted in schools.* (J Sch Health. 1997;67(9):380-383)

Cancer cluster investigations are quite common today.[1-6] Cancer clusters can be defined as a statistically significant increase in the rate of cancer incidence (new cases) or mortality in a particular population during a specified period of time. Frequently, reports of excess cancers are coupled with reports of potential or real environmental contamination. This coupling often forces investigations to be mounted and proceed along two parallel lines of inquiry, health, and environment. Many times, such investigations are hampered by a small sample size. Thus, causal links are often difficult to establish. However, if a "signal" cancer is present that is rare in the general population (mesothelioma, for example), the investigation may be more fruitful.

Notwithstanding, cancer cluster investigations can be useful for educating the public on known risk factors and preventive steps needed for the disease in question. They can allay public anxiety and engender good will through a candid appraisal of risk. Of course, the possibility exists that a problem will be found and preventive measures implemented. However, most cancer cluster investigations either do not show an excess or are unable to link an excess to a known cause.

Reports of a number of cancers — such as those of lung, brain, breast, and non-Hodgkin's lymphoma — among employees of an elementary school near Kansas City, Missouri, stimulated discussion of a cancer investigation at this school. To more fully document the number and types of cancers and exposures of concern, a cancer survey and a review of industrial hygiene data was undertaken to examine 1) whether an excess of cancers existed among the employees, and 2) whether any relationship existed between any excess and environmental exposure(s). After some discussion with the appropriate school district administrators, it was decided that a two-phase project was warranted. The first phase would analyze data of exposures and cancer outcomes at the group level of detail. The second phase, pursued only if the first phase indicated a need, would analyze data of exposures and cancer outcomes at the individual level of detail. With an understanding of this, the project was approved. This paper reports findings of the first, and only, phase.

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METHODS

Industrial hygiene data were reviewed to ascertain methods used and results obtained. Additional materials concerning asbestos abatement and the heating, ventilating, and air conditioning systems were also reviewed. A walk-through survey of the school was conducted on two separate occasions. Letters received by the school district from the Missouri Department of Health and the National Institute for Occupational Safety and Health were reviewed. A literature review was conducted concerning cancer cluster investigations using the MEDLINE data base.

An indoor-air quality investigation was conducted at the school in the fall of 1994 by a certified industrial hygienist (CIH). This investigation included: 1) measurement of radon using nine radon packets deployed in the utility tunnels and classrooms for three and a half days; 2) measurement of 18 gases or vapors, including volatile organic compounds and carbon dioxide, using passive dostitubes; and 3) measurement of microorganisms, such as fungi and bacteria, using plate cultures. All measurements were repeated on a second day. All methods used were based on EPA, NIOSH, or OSHA standards.

Health surveys were distributed to 563 employees or former employees. Of these, there were 489 responses for a response rate of 86.9%. There was a 99.2% response rate among current employees and a 57.9% response rate among former employees. With information received from the Missouri Department of Health, the overall response rate was 96.4%, based on information on 543 employees. Of them, Whites numbered 524 (96.5%), 457 (87.2%) of whom were female. By restricting statistical analysis to Whites within the 20-69 age groups, 454 White females and 66 White males were concentrated upon for analysis.

Table 1 shows the observed number of cases among males and females for the elementary school in question and for the remainder of the district. Nineteen cancers are shown in 18 individuals, as one person reported two cancers. The largest number of cancers is seven for breast cancer in White females. Five individuals are deceased. Note that one non-White case had worked in the district approximately one year prior to date of diagnosis.

For White males, there were too few cases to analyze

specific cancer sites. A total of four cancers were observed, with 2.2 expected (p=n.s.). Although the ratio of observed to expected cases was elevated, the number of cases was small; thus, statistical significance could not be achieved. As previously noted, a non-White male with two reported cancers had worked at the school for approximately one year, too short a time for an occupational carcinogen to have acted within that work setting.

Table 2 shows a comparison between observed and expected total and breast cancer cases for White females. For total cancers, a marginally significant increase in risk exists for women who had ever worked at the elementary school in question. The confidence limit excludes 1.00. There is no increase in SMR for the total district. For breast cancer, a marginally significant increase in risk (SMR) of 5.0 is found for women who had ever worked at the school, and the confidence limit excludes 1.00. When cases of breast cancer are excluded from the analysis, no significant increase in risk remains for total cancers among those who had ever worked at the elementary school.

A number of risk factors are believed to be important in the etiology of breast cancer: family history of breast cancer; a previous breast cancer in the same individual; chest x-ray irradiation; high socioeconomic status; early-age menarche; late-age menarche; late-age menopause; a high-fat diet.[8] For the most part, these risk factors are genetically or life-style related, but they are not job related. Although some of these risk factors may be shared by teachers as a group, they cannot be attributed to any work-place exposures. Radon exposure — found to be slightly elevated at the school in question— has not been shown to be a risk factor for breast cancer.[9]

The wide variety of other cancers found at the school do not make a case for common etiology. Generally caused by different factors, these cancers show little commonality among themselves individually and between breast cancer collectively. Table 3 indicates such risk factors for these cancers.

Some limited information on cancer occurrence among the elementary school employees was obtained from the school district. In order to obtain more complete health information, the investigative group designed a protocol and health survey instrument, administered in person to all current elementary school employees within the district at the end of 1995. In addition, former employees of elementary schools in the district dating as far back as 1990 were surveyed by mail. Information requested of the current or former employee included cancer site and date of diagnosis, as well as employee age, gender, and race. For former employees, dates of employment and schools where employed were also ascertained. (The instrument remains on file at the principal investigator's office and at the school district's main office.) Former employees who had not responded to the survey received follow-up reminders

Table 1
Observed Number of Cancer Cases in the Elementary School District, 1990 - 1995

Males

Site	*Type of Cancer*	*# of Cases*
Elementary School in Question	Non-Hodgkin's Lymphoma (w)**	1
	Non-Hodgkin's Lymphoma and Lung (non-w)*	1
Remainder of District	Bladder (w)**	1
	Leukemia (w)	1
	Prostate (w)	1

Females

Site	*Type of Cancer*	*# of Cases*
Elementary School in Question	Brain (w)**	1
	Breast (w)	1
	Liver (w)**	1
Remainder of District	Breast (w)	6
	Skin (w)	2
	Colon (w)	1
	Pancreas (w)**	1

* - One year employment in district prior to date of diagnosis
** - Deceased
W - White
non-W - Non-White

Table 2
Observed and Expected Cancer and Breast Cancer Cases in White Females in the Elementary School District, 1990 - 1995

Total Cancers

Site	*Observed*	*Expected*	*Ratio*	*95% Confidence Limit*
School in Question (most recent)	3	1.6	1.88	0.39 - 5.48
School in Question (ever)*	5	1.6	3.13	1.02 - 7.28
Total District	13	13.5 13.9	0.96 0.94	0.49 - 1.59

Breast Cancers

Site	*Observed*	*Expected*	*Ratio*	*95% Confidence Limit*
School in Question (most recent)	1	0.6	1.67	0.04 - 9.30
School in Question (ever)*	3	0.6	5.0	1.03 - 14.6
Total District	7	4.9 5.0	1.43 1.40	0.56 - 2.88

* - Two individuals had previously worked at the school in question

by telephone. For those who still had not responded, reports either of cancer incidence or mortality of specific individuals were requested from the Missouri Department of Health (MDOH). The population employed at the elementary school and throughout the elementary school district were obtained by age (20-29, 30-39, . . . 60-69), gender, and race (White, non-White) either from the survey or from personnel records.

Cancer incidence rates were obtained from the MDOH for the State of Missouri and for Jackson County, Missouri, for the period 1985-1992. The MDOH also provided the 1990 population for the state and county. All data were age (20-29, 30-39, . . . 60-69), gender, and race (White, non-White) specific. The expected number of new cancer cases among elementary school employees in the district was determined by applying rates from Missouri and from Jackson County to the number of past and present elementary school district employees, by age, gender, and race.

The observed number of new cancer cases among elementary school employees in the district during 1990-1995 was tabulated from the survey. The observed number of cancer cases was compared to the expected number, and a standardized morbidity ratio (SMR) was then calculated for both the school in question and the elementary school district. Exact 95% confidence limits for the SMR, a Poisson-distributed variable, were evaluated for each cancer.[7] For any cancers in excess, a literature review was conducted to determine the known risk factors.

RESULTS

No significant employee exposures to carcinogens, except possibly radon, existed at the school. Radon levels were below 2 pCi/L in classrooms. However, in the utility tunnels, radon levels ranged from 29 to 33 pCi/L. Measurements of gases and vapors revealed all but carbon dioxide to be below the limits of detection. The carbon dioxide level was 300 ppm, well below the OSHA-proposed standard of 800 ppm. Compared to outside ambient air, the air of some classrooms and the utility tunnel held different microorganisms, such as fungi and bacteria. Bacterial levels in one classroom exceeded bacterial levels found outdoors by a factor of 10. Because bioaerosol monitoring must be conducted in conjunction with clinical correlates, no absolute colony-forming unit number was justifiable.

A number of points should be noted. Excluding radon, no significant exposure(s) to any known carcinogenic agent existed at the elementary school in question. Custodians had minimal time exposure to elevated levels of radon (progeny), and their doses comprised a small fraction of an amount that might give a uranium miner lung cancer. No significant excess of lung cancers were found among employees of the school. Only one case was observed, from a man who had a very brief exposure time to radon (≤ 1 year). A marginally significant excess of total cancers and breast cancers existed among White females ever employed at the school, and the excess of total cancers was caused by this excess in breast cancer. Diverse cancers were found, many fairly common in the general population. No "signal" cancer was found that could point to an occupational cause; mesothelioma due to asbestos exposure, for example. A short latency period (< 1-2 years) existed for some cancers found. For all these reasons, an occupational etiology for the cancers observed in the elementary school and school district is extremely unlikely.

Table 3
Major Risk Factors for a Number of Other Cancer Cases Found in the Elementary School District

Type of Cancer	*Risk Factors*
Lung	Cigarette smoking, environmental tobacco smoke, radon, asbestos
Non-Hodgkin's Lymphoma	Immune disorders, viruses, herbicides, organ transplants
Bladder	Cigarette smoking, dyes, infections
Brain	Oil refineries, dental x-rays
Liver	Hepatitis B, aflatoxins, vinyl chloride

IMPLICATIONS

Breast cancer is second only to lung cancer as a leading cause of cancer mortality in women in the United States. At least one other interview study found breast cancer to be more common in school teachers and other professionals than in the general U.S. female population.[10] Reasons for this excess shown by the earlier study are unknown.

Although a considerable amount of material has been gathered on current employee exposures in the school, information on past exposures has not been measured. An employee's past exposure to a school incinerator, for example, is unknown. Prior exposure to asbestos could lead to an increase in mesothelioma, for example. For these reasons, obtaining cancer information among current and former employees is especially important.

Some questions do exist about the validity of self-reported information on cancer. In general, self-reporting is better than surrogate reporting. However, objective medical reports are better than both methods. Because the initial concerns arose from a compilation of self-reports, data was compiled from throughout the district in order to see which self-reported problems might emerge. This data was supplemented by cancer data from the Missouri Cancer Registry, which is more objective. When an overlap existed between individuals who reported and the requested registry data (two individuals), results were identical.

Inevitably, there was some loss to follow-up in this study. Several individuals could not be found in Missouri, and there was no record of them having had cancer in Missouri. However, such numbers lost were very few. If staff had surveyed former employees who had begun work in the 1985-89 time period, losses to follow-up would undoubtedly have been greater.

For non-responding former employees, staff placed heavy reliance on obtaining MDOH cancer data, which may be incomplete. Rates were based on 1985-1992 reports which are reasonably complete. Cases in the school district from 1990-1992 are also reasonably complete. However, cases occurring during 1993-1995 would not have been completely reported, and this could affect the number of

observed and the number of expected cases, particularly during 1993-1995.

RECOMMENDATIONS

Corrective measures implemented as a result of the industrial hygiene investigation included: 1) sealing access to school utility tunnels; 2) placing these utility tunnels under negative pressure and venting air to the outside, at a considerable distance from classroom windows; 3) decontaminating walls, floors, and ceilings in the contaminated tunnels and classrooms with a 1:5 household bleach solution.

Staff of this research project made three general recommendations:

1. Because data did not suggest an occupational etiology, no further work-site health study is currently warranted.

2. The Missouri Department of Health had suggested that the American Cancer Society undertake an educational activity on cancer risk factors and screening, especially for breast cancer, and this suggestion seems worthwhile. In addition, the school district should encourage female employees to follow American Cancer Society screening guidelines for breast cancer, which include regular mammograms. Accordingly, project staff left the school district with videotape materials on breast cancer from a National Institutes of Health breast cancer summit.

3. In the future, the district could follow up with current and former employees who have rare cancers, such as non-Hodgkin's lymphomas and brain cancers. If a number of these occurred among long-term employees (> 5 years), then the district might consider re-investigating the issue. However, it is not clear at this time which occupational exposure could be hypothesized. In order to follow up for rare cancers, a mechanism must be in place to record all cancers.

Separate oral presentations on these findings were made to the board of education, school district administrators, and employees of the affected school. In general, the recommendations were accepted, although further follow-up for rare cancers appears doubtful.

CONCLUSION

Given this study's findings, perhaps other school districts should consider implementing educational activities on breast cancer risk factors and screening. Evaluation of such programs would be an important component of this endeavor.

Studies such as this one are clearly warranted in schools when either a worker's compensation or other health reporting data suggest a basis for a cluster, and/or when exposure monitoring results such as industrial hygiene data or perception of an environmental problem support the plausibility of cancer causation. Examples in schools include lung cancer and/or significant radon exposure; lung or skin cancer and/or incinerator smoke exposure; non-Hodgkin's lymphoma and/or significant herbicide exposure; and mesothelioma and/or asbestos exposure. A cluster of unusual cancers — brain cancer, for example — should be followed with additional research. Lung cancer in non-smokers also appears worthy of further investigation.

In the event that preliminary information suggests either a health or an exposure problem, consultation with an industrial hygienist and a cancer or an environmental/occupational epidemiologist is recommended. Available in most states, cancer registry data can be very helpful in determining whether or not a cancer cluster exists. ■

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