Brain Cancer Cluster Investigation in a Texas City, Texas Chemical Plant

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Introduction:

In February of 1979, The National Institute for Occupational Safety and Health (NIOSH) of the Department of Health and Human Services, the Occupational Safety and Health Administration (OSHA), of the Department of Labor, and the Union Carbide Corporation began an investigation of a cluster of brain tumors at the company's Texas City, Texas plant. The initial events and the characteristics of the cases have been described by Dr. Victor Alexander. We here describe the conduct and present status of a case-control study of occupational histories of employees of that plant who developed primary brain tumors.

Methods and Materials:

The method of case identification has been described by Dr. Alexander; the company was able to identify 12 cases, matching company records with lists of all adult males who were residents of surrounding counties and who died of malignant brain tumors yielded four more cases, three additional cases became ill and died during the course of the study, and three cases have been found so far in the course of determining the vital status of all workers ever employed in the plant. Medical records and tissue specimens were obtained, where possible, and a best diagnosis was chosen from the available evidence.

Following the advice of Schoenberg et al., we included all deaths due to primary intracranial neoplasms except those of the pituitary. This excluded one case with a metastatic lesion and one with a congenital anomaly but with no tumor found at autopsy. Two of the most recently discovered cases have not been included, pending confirmation of the diagnosis. Analyses of the residual 18 cases will be done both for the group as a whole and for the 15 proven gliomas.

For each employee, the company completed coding sheets containing identifying personal data, date of each new job title or department code, job code, department accounting code, and date of each layoff or date of termination. Vital status was coded, when known. Every 50th record was copied and sent to NIOSH for independent verification of coding. A random sample of the original records will be drawn by NIOSH and used for verification of completeness of cohort identification.

Six controls were drawn for each case from the pool of all people ever employed at the plant. Cases were matched to potential controls by race and sex; date of birth was matched to within three years; date of first hire for the control was before that of the case, but not more than three years before; the date the control was last employed was later than the case's last date of employment. The control could be living but, if dead, must not have died of a malignancy. Pools of controls meeting the criteria outlined above were formed and the actual controls used were drawn by random number from the pool.

The company provided translations for the job and department codes and provided a list of chemicals encountered in each major department group. The departmental coding schemes used for accounting purposes within the plant have changed over the years, so a common list tracing the history of each department was prepared and all codes were transformed to conform to a single coding scheme. Although catalysts have changed often, there appears to be no problem in characterizing the feedstocks, intermediate products, and output of each department through the years the plant has been in operation.

Each job, department, major department group, or chemical exposure represented by at least three cases was tested for possible significance by X^2 or Fisher's Exact Test. Since this approach is a multiple sampling technique which should lead to about one "significant" association for every twenty jobs, departments, or exposures considered, it is used here as an hypothesis generating mechanism, not as a means of properly testing the hypotheses. For example, since at least one case was exposed to each of nearly 200 chemicals, chance alone should lead to identification of about 10 chemicals whose proportion is significantly different between cases and controls. About half of the ten would be positive and half would be negative associations.

Results:

Only one job code, "Operator" was represented by more than three cases. Table I shows the distribution of operators among the cases and controls. There is no significant difference in proportions.

When analyzed by department accounting code, only the maintenance department, with eight cases, was represented by more than three cases. Table II shows the distribution of maintenance department workers among the cases and controls. Grouping the accounting codes into major departments did not yield any new concentrations of three or more cases. There were no significant differences in proportions.

When cases and controls were analyzed by chemical exposures, a new problem was encountered: the exact exposure of a maintenanceman is difficult to characterize accurately, due to their mobility throughout the plant. Accordingly, as a first step, we have examined the data in three ways: in the first, maintenancemen are excluded from analysis; in the second, they are considered to have been exposed to everything in the plant; in the third, they are considered to have been exposed to nothing in the plant. The data are presented in Tables III, IV, and V; only those chemicals to which more than three cases were exposed and which showed a relative risk greater than 1.0 are tabulated.

Discussion:

So far in the course of this investigation, no convincing association has been found between any historical exposure and the development of brain tumors at this plant. The incomplete characterization of the maintenance employees' exposures is a significant weakness in the analysis done so far, but fortunately can be corrected, at least in part, by further review of existing records. Some of the maintenance department employees had reasonably well defined exposures; for example, one case was an instrument repairman whose work rarely took him out of the instrument shop. We pl to define exposures of cases and controls who worked for the maintenance department as completely as possible and study the full data set. At that time, there should also be enough information at hand to study the exposures by latency.

It is possible that the tumors seen are the result of a more general effect or exposure. We plan to examine the geographic location within the plant of cases and controls, to see if any pattern emerges, and will atempt to determine the residence at time of first hire, to see if there appears to be any unusual clustering outside the plant.

Finally, we must ask whether we are really seeing an effect which requires explanation. The excess of observed over expected reported earlier[2], combined with an apparent excess when compared to local rates[3], could be the result of chance. The reported correlations

with duration of employment and latency since first employment argue against this hypothesis but do not refute it. Inquiry into exposures present in other populations with apparent excesses of brain tumors may provide needed additional clues.

Table I: Distribution of Operators Among Cases and Controls

IA. All Cases	Cases	Controls	Total
Operators	9	49	58
Non-operators	9	59	68
Total	18	108	126

Odds ratio = 1.2; $X^2 = 0.045$; p greater than 0.75

IB. Proven Gliomas	Cases	Controls	Total
Operators	7	40	47
Non-operators	8	50	58
Total	15	90	105

Odds ratio = 1.1; $X^2 = 0.024$; p greater than 0.75

Table II: Distribution of Maintenance Workers Among Cases and Controls

IIA. All Cases	Cases	Controls	Total
Maintenance workers	7	46	53
Non-maintenance workers	11	62	73
Total	18	108	126

Odds ratio = 0.86; X^2 = 0.087; p greater than 0.75

IIB. Proven Gliomas	Cases	Controls	Total
Maintenance workers	7	37	44
Non-maintenance workers	8	53	61
Total	15	90	105

Odds ratio = 1.3; X^2 = 0.163; p greater than 0.75

Table III: Distribution Among Cases and Controls of Workers Exposed to Selected Chemicals (Maintenancemen Excluded)

IIIA. All Cases		Cases	Cont.	Total	Odds	p*
Exposed	1. Diethyl ether	3	2	5		
	2. Ethanol	3	2	5	7.87	0.07
	3. Sodium phosphate salts	3	2	5		
	4. Lubricating oil	6	15	21	3.20	0.30
	5. Monoethanolamine	4	10	14	1.73	0.42
	6. Ethylene glycol	3	8	11	1.41	0.80
	7. Naphtha	3	8	11		
	8. Potassium hydroxide	2	5	7	1.44	0.81
Unexposed	1. Diethyl ether	4	21	25		
	2. Ethanol	4	21	25		
	3. Sodium phosphate salts	4	21	25		
	4. Lubricating oil	1	8	9		
	5. Monoethanolamine	3	13	16		
	6. Ethylene glycol	4	15	19		
	7. Naphtha	4	15	19		
	8. Potassium hydroxide	5	18	23		
Total		7	23	30		

* Fisher's exact test

Table III (Con't): Distribution Among Cases and Controls of Workers Exposed to Selected Chemicals (Maintenancemen Excluded)

IIIB. Proven Gliomas		Cases	Cont.	Total	Odds	p*
Exposed	1. Diethyl ether	2	1	3		
	2. Ethanol	2	1	3	13.0	0.11
	3. Sodium phosphate salts	2	1	3		
	4. Lubricating oil	4	9	13	inf.	0.23
	5. Monoethanolamine	3	6	9	4.00	0.29
	6. Ethylene glycol	2	5	7	1.80	0.86
	7. Naphtha	2	5	7		
	8. Potassium hydroxide	2	2	4	6.00	0.98
Unexposed	1. Diethyl ether	2	13	15		
	2. Ethanol	2	13	15		
	3. Sodium phosphate salts	2	13	15		
	4. Lubricating oil	0	5	5		
	5. Monoethanolamine	1	8	9		
	6. Ethylene glycol	2	9	11		
	7. Naphtha	2	9	11		
	8. Potassium hydroxide	2	12	14		
Total		4	14	18		

* Fisher's exact test

Table IV: Distribution Among Cases and Controls
of Workers Exposed to Selected Chemicals
(Maintenancemen Counted as Exposed)