Brain Tumor Investigation in Wescoe Hall, KU Lawrence Campus

John S. Neuberger, Dr.P.H.
Professor
Department of Preventive Medicine and Public Health
University of Kansas School of Medicine
3901 Rainbow Boulevard, MS 1008
Kansas City, KS 66160

July 3, 2007

EXECUTIVE SUMMARY

An industrial hygiene and an epidemiologic study were conducted regarding a concern about a potential excess of brain tumors in Wescoe Hall occupants. With regard to air sampling, one sampling timeframe revealed some formaldehyde levels that exceeded NIOSH guidelines. However, there was no evidence of formaldehyde (or any other chemical levels) exceeding federal standards. Air quality sampling during the second time period did not find any elevations of concern for formaldehyde. However, air flow in many of the sampled offices in the building was inadequate in both sampling periods. The investigation also revealed that there was no statistically significant excess of brain tumors in Wescoe Hall and that there was no obvious explanation for the occurrence of these tumors. The ratio of observed to expected cases decreased as time increased in the building. Reports of other exposures to cases, such as ionizing radiation to the head or petrochemical exposure, were generally negative. Further investigation of air quality or brain tumor excess might be considered if there are identified pollution episodes or if additional brain tumor cases occur in the studied population.

INTRODUCTION

Because of a concern by faculty and staff about a possible excess of brain tumors in Wescoe Hall, coupled with a concern about a possible air quality problem in the same building, environmental and epidemiological investigations were undertaken. The former was conducted by an Industrial Hygienist and, after review of that report and input from this investigator, a report was provided to the University.

With regard to the epidemiological investigation, five brain tumor cases (benign or malignant) were initially identified in the previous five years; eight cases were ultimately reported prior to the beginning of our investigation. Several of these cases had offices that were within 75 feet of one another. It was deemed advisable by the University administration to study this matter in more detail to determine whether the concern was justified.

The causes of brain cancer are largely unknown. The major risk factor identified to date is ionizing radiation to the head, often done in the past to treat children with ringworm of the scalp. Other risk factors identified in various studies, but not confirmed overall, include dental X-rays, nitrosamines in the diet, work in the petrochemical industry, and vinyl chloride exposure.

This study was designed to determine if the building is safe, if there is a cluster of brain tumors, and what might any cluster of brain tumors be associated with.

METHODS

A literature review was conducted concerning the carcinogenicity of selected chemicals and risk factors for benign and malignant brain tumors. The search was on MEDLINE and encompassed the years 2000-2006. Terms utilized included “Brain Tumors and

Cancer", "Brain Cancer and Formaldehyde", and "Brain Cancer Risk Factors". The database of the International Agency for Research on Cancer was contacted and the search term "Formaldehyde" was used.

A detailed Industrial Hygiene survey of the building was conducted by Stewart Industrial Hygiene and Safety, Inc. of Kansas City, Missouri. This survey was designed to look for the presence in air of biological, chemical, and physical agents, including viable bacteria, mold, fungus, asbestos, lead, formaldehyde, carbon dioxide (a surrogate for adequate air exchange), volatile organic chemicals, vinyl chloride, and particulates. Radiation was also evaluated, including radon and electromagnetic fields. All case rooms were sampled, as were a random sample of control rooms. Control rooms were on all floors of the building and did not have any complaints related to brain tumors. Measurements were also obtained on the roof. Sampling was conducted on two separate occasions, in the spring and fall of 2006. Comparison was made of findings to standards of the Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA). Comparison was also made to recommendations of the National Institute for Occupational Safety and Health (NIOSH) and the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

Sampling was also conducted in the fall of one drinking water fountain on each of the four floors of Wescoe Hall. The center fountain on each floor - near the elevators – was selected. Measurements were made for metals and halogenated hydrocarbon byproducts of water purification (disinfection byproducts).

An epidemiologic analysis was conducted focusing on occupants of Wescoe Hall from 1995 through 2006. The purpose was to survey the population, compare observed to expected cases, and interview brain tumor cases and controls for potential risk factors. Departments were selected if they had ten or more people in them and if they were present in Wescoe Hall for at least six of the last eleven years. Faculty and staff of these departments were then individually selected if they had been in Wescoe Hall for at least one year prior to 1995. Individuals had to be at least 21 years of age at the start of the study for inclusion.

An initial survey was conducted of the residents of Wescoe Hall. An initial meeting was held to inform them of the study and the procedures that would be followed. Subsequently, several surveys were conducted in the nearby auditoriums in Budig Hall. E-mails were sent to all occupants encouraging them to attend if they had been a resident of Wescoe Hall for at least one year. Additional participants were sought by means of delivering survey forms, consent forms, and medical release forms to mailboxes of occupants of Wescoe who had not participated in the survey. In addition, additional surveys of Wescoe Hall participants were done in Bailey Hall.

The survey forms asked for self-reports of cancer, brain tumors, and other serious illnesses. For all cancers except that of the brain, where the number of reported cases exceeded two, comparison was made of the observed to the expected number of cases.

All reported brain tumor cases were verified by contacting their physicians and obtaining their pathology reports. A random sample of 20 non-brain tumor cases was selected from the survey forms for those who had signed a medical release form. Their physicians were contacted to determine the validity of their non-brain tumor status.

All histologically confirmed cases of benign or malignant brain tumors were interviewed. All but one were interviewed in person; one was interviewed by telephone.

A list of names of individuals that we could not locate or who were known to be deceased since 1995 (from the Social Security Death Index) was provided to the Kansas Department of Health and Environment. This was to determine if any of the individuals had died and/or confirm that the individuals had died and the underlying cause of death. We also provided a complete list of names to the Kansas State Cancer Registry to determine the number of cancer cases.

The number of observed cases was obtained from either the State Cancer registry or the self-report of cancers, whichever was the greater number.

Expected number of cases were calculated for malignant and benign brain and central nervous system tumors combined utilizing data from the Central Brain Tumor Registry of the United States (CBTRUS). Total tumors include tumors of neuroepithelial tissue, tumors of cranial and spinal nerves, tumors of meninges, lymphomas and hemopoietic neoplasms, germ cell tumors, tumors of sellar region, local extensions from regional tumors, and unclassified tumors. Average rates per 100,000 per year were calculated for 1990-1994 and from 1998-2002. These rates are for all races and both genders combined. Eight age groups were utilized: 0-19, 20-34, 35-44, 45-54, 55-64, 65-74, 75-84, and 85 and over. Rates for each of these age groups were applied to the total population of Wescoe Hall residents as they aged from birth (lifetime risk) and as they aged throughout their Wescoe Hall time period (Wescoe Hall risk). Separate calculations were first made for those with one or more years in Wescoe Hall and secondly for those with five or more years in Wescoe Hall.

Expected number of cases of malignant brain tumors utilized data from the Surveillance, Epidemiology, and End Results (SEER) registry of the United States operated by the National Cancer Institute. This includes all types of malignant, primary site brain and central nervous system tumors. For other cancers (prostate, colon, breast, and lung), the expected number of cases was obtained from the SEER registry as well. Average rates per 100,000 per year were calculated for 1975-1979 and from 2000-2004. These rates are for all races, both genders combined, and for males only. Eighteen age groups were utilized: 1-4, 5-9, 10-14, 15-19, …, 70-74, 75-79, 80-84, and 85 and over. Rates for each of these age groups were applied to the population of Wescoe Hall residents as they aged from birth (lifetime risk) and as they aged throughout their Wescoe Hall time period (Wescoe Hall risk). Separate calculations were first made for those with one or more years in Wescoe Hall and secondly for those with five or more years in Wescoe Hall.

A Standardized Morbidity Ratio (SMR) was calculated, which was the observed number of cases divided by the expected number of cases. This ratio was used to determine whether there was any excess risk of cancer in the population. The ratio was calculated for both malignant (both sexes combined and males only), benign (both sexes combined), and malignant plus benign (both sexes combined). Since there were no cases in females, the ratio was not calculated for females only. Using this ratio, a statistical test was used to determine the statistical significance of such a risk.

Twelve statistical tests looking at exposure were completed. Two groups of six tests each were performed. The two groups were based on lifetime years versus years in Wescoe Hall. Subsequently, the analysis focused on either one or more years in the building or five or more years in the building. The six tests were split based on cancer type: invasive vs. invasive/benign combined. No tests were run for the benign alone as data for the age specific rates were not available. The Type I error rate used for each test was adjusted using a Bonferroni adjustment to maintain an overall Type I error rate of 0.05 (Schork and Remington, 2000). Accordingly, 0.05 divided by 12 results in a Type I error rate of 0.004 for each test. Therefore, a test was only found to be statistically significant if the p-value was less than 0.004. The statistical test used was the Generalized One-Sample Binomial Test for a difference in SMR. All tests were two-tailed.

The number of person-years that each individual spent in each age specific category was summed up. At the end, a total number of person years was obtained for each age specific group and this was multiplied by the age specific rate to determine the expected total number of cases. Rates were calculated for males and females combined and males only both for lifetime and for years in Wescoe. This was done for all subjects and was also performed on a subgroup in which the subject was in Wescoe for a minimum of five years. The Wilcoxon two-sample test was utilized, with 95% confidence intervals, to compare total hours in Wescoe Hall for cases versus total hours in Wescoe Hall for controls.

Brain tumor patients and non-brain tumor controls were interviewed. Controls were matched to cases on age (plus or minus five years), gender, faculty or staff status, and department. A detailed form was utilized that asked about prior exposures, including radiation to the head and other areas of the body, diet, cooking practices, occupation, smoking (active and passive), chemical exposures, well water use, residential history, medical history, hobbies, sports, injuries, and length of time in Wescoe Hall. The form has been previously used in other brain cancer investigations. Differences between responses of cases and controls were analyzed using a chi-square test.

Individually identified information was held in complete confidence. Both mortality and cancer incidence data, as well as self-reported data from the survey is held in strict confidence. The Kansas Cancer Registry is mandated by State law to maintain confidential records. Information on health conditions will not be shared with the University. The project was approved on July 26, 2006 by the University of Kansas Medical Center's Human Subjects Committee (HSC #10519).

RESULTS

Air and Water Sampling

In the spring, there were no exceedances of any standards of OSHA. Formaldehyde levels were slightly elevated in the building in the first set of samples. While they did not exceed any Federal standard, over half of the rooms did exceed the NIOSH recommended guideline of 30 parts per billion (ppb). The highest value obtained was 33 ppb; the OSHA standard is 750 ppb. An excess of some indoor pollutant chemicals were found in some rooms compared to roof readings. This included formaldehyde. However, the level of formaldehyde was not any higher in case rooms than in control rooms. Many of the rooms tested had inadequate airflow, with five out of the thirteen tested having no airflow at all (Stewart, 2006).

In the fall testing, the levels of formaldehyde dropped to a maximum of 13 ppb and thus did not exceed the NIOSH recommended guideline of 30 ppb. There were no exceedances of any OSHA standards or EPA guidelines. An airflow problem was found again, however. There was no airflow in all of the rooms tested on the first, second, and third floors. There was adequate airflow on the fourth floor. There were no elevated levels of metals or disinfection byproducts found from testing of the water supply at the fountains in Wescoe Hall (Stewart, 2007).

In summary, although formaldehyde levels in air exceeded NIOSH guidelines in the spring testing, levels did not exceed these guidelines in the fall. In addition, no OSHA or EPA standards were violated for air or water pollution. However, ASHRAE guidelines for airflow per room per person were not maintained.

Literature Review

Formaldehyde is classified as a Class A carcinogen by IARC, particularly for the nasopharyngeal region. It is considered a contact carcinogen, not a systemic one; it acts locally. It should also be noted that the human body manufactures formaldehyde as a normal part of the metabolic process. A few studies have noted that high levels of formaldehyde have been associated with brain cancers in pathologists. These individuals are, however, exposed to higher levels of this agent. At this time there is no consensus in the scientific community that low levels of formaldehyde are associated with brain cancer (IARC, 2006).

Cancers Reported from Survey, State Cancer Registry, and Death Records

A total of 765 individuals in ten employee classifications and eighteen departments were included in the study. Of these individuals, 262 (or their surrogates) filled out survey forms (34.2%). Eleven individuals specifically indicated to us that they refused to participate in the survey. Table 1 shows the self-reported number of cancers and benign brain tumors among these individuals. A total of 54 cancers and benign brain tumors

were reported over the individuals' lifetimes, 39 in males and 15 in females. Two of the skin cancers were malignant melanomas.

Self reported cancers from 1995 to the present are shown in Table 2. As can be seen, 36 cancers were reported, with the majority being cancers of the skin. Overall, males reported more cancers than females (thirty versus six). Besides skin cancer, the most commonly reported cancer in males was that of the prostate and the most commonly reported cancer in females was that of the breast.

Brain cancer was reported in four individuals and benign brain tumors were reported in three individuals, totaling seven. After review of pathology records and conversations with the physician of record, two malignant brain tumors were excluded. One was a metastasis to the head from another site and one was a primary site that was located elsewhere in the head. One self reported and one surrogate reported malignant brain tumor were thus reclassified, resulting in five medically confirmed tumors occurring during the period 1995 to 2006.

Many non-cancers and non-brain tumors were identified in these reports. However, a wide variety of different health problems and conditions were noted, with none being predominant. These were not a primary focus of the study and are not discussed further.

The entire list of 765 names were checked against the State Cancer Registry to search for malignancies from 1996-2006. On the date that the registry was checked, over 90 percent of the cases were estimated to have been recorded for the year 2005; 60 percent of the cases were estimated to have been recorded for the year 2006. Table 3 indicates that forty-six cancers were found in the registry, with the largest number being prostate (n = 12) and breast (n = 5). Two primary site, malignant brain cancers were found.

For comparison of Table 2 to Table 3, thirteen skin cancers and three benign brain tumors need to be removed from Table 2. Skin cancers are not recorded by the registry unless they are either malignant melanoma or are basal or squamous cell carcinoma of the mucus membranes. Benign brain tumors have only been recorded by the registry in the last year. Thus, assuming that the skin cancers were not of the mucus membranes, for the 1995-2006 period 46 cases in the registry (Table 3) should be compared to 36 minus 16, or 20 cases reported by surveyed individuals (Table 2). Thus, despite incomplete reporting for the total time period, the registry detected over two times more cancer cases in the overall studied population than cancer cases reported by individual survey participants.

We were able to identify 398 individuals whose status was unknown (not at the University) or whom we knew from various sources to be deceased. These names were provided to the Vital Statistics Section at the Kansas Department of Health and Environment. They provided us with information indicating the number dying from various underlying causes of death during the time period chosen. Nineteen deaths were found, including nine malignancies. Of these nine, there were four lung cancers and one each of the following: brain, colon, kidney, malignant melanoma of the skin, and

pancreas. All but two were in males. Upon further checking with the State Cancer Registry, the brain cancer was found to be a metastasis from another location in the body.

Table 4 refers to lifetime risk among individuals with one or more years of exposure to Wescoe Hall. For brain tumors - benign plus malignant and malignant alone - the observed number of cases was greater than that expected. However, the excess was not statistically significant. For all cancers other than that of the brain, the observed number of cases was less than expected. There are a statistically significant lower number of observed cases when compared to the expected number of cases for cancers of the lung and cancers of all sites.

Table 5 refers to lifetime risk for those with five or more years of exposure to Wescoe Hall. None of the SMR results, ranging from 0.60 to 1.08, were statistically significant. In addition, the ratios of observed to expected brain tumor cases - or Standardized Morbidity Ratios (SMR's) - all decreased when comparing Table 5 to Table 4.

Table 6 refers to Wescoe Hall brain tumor risk for those with one or more years of exposure. The SMR's ranged from 3.17 to 4.76; none were statistically significant (i.e., had a p-value less than 0.004, the Bonferroni correction factor).

Table 7 refers to Wescoe Hall brain tumor risk for those with five or more years of exposure. While the SMR's ranged from 1.67 to 2.70, none of the results were statistically significant. In addition, the SMR for all categories of brain tumor decreased, compared to those with one or more years of exposure (Table 6), suggesting that the risk for brain tumors decreased as more time is spent in that building. The risk would be expected to increase if the brain tumor risk was related to occupancy in Wescoe Hall.

The case-control interviews utilized information from 5 cases and 20 controls. The controls were randomly picked from the matched group of individuals who had agreed to participate further if asked (n = 226). All cases and controls were male faculty members. Analysis of the cases combined malignant plus benign because the numbers were so small for each category when analyzed separately. Figure 1 indicates that although the cases spent more time than the controls in the building, the difference was not statistically significant.

None of the results of the interviews appeared to be noteworthy; statistical power was low. With regard to the only known risk factor for brain cancer, medical radiation to the head, this was reported equally by cases (one out of five = 20%) and controls (four out of twenty = 20%) (data not shown). Previous exposure to chemicals and petroleum occupations among cases was negligible.

DISCUSSION

Overall Findings

The study did find airflow problems in many of the offices tested in Wescoe Hall. However, no air or water pollution above Federal standards was found. Brain tumors have not been found to be related to airflow problems. Low levels of formaldehyde were found in the spring sampling; these exceeded NIOSH guidelines. However, these levels did not exceed any standards promulgated by OSHA and seemed in line with many readings by EPA in office buildings throughout the US, which averaged 16 ppb. In the fall sampling, the levels of formaldehyde in the offices were lower than in the spring and did not exceed the NIOSH guidelines. The source of the formaldehyde is unknown, but could be related to coatings on the filters in the air handling system.

No increased incidence of cancers or brain tumors was found among occupants of the building. No excess of medical radiation to the head was found among cases. While the cause of the brain tumors in Wescoe Hall is unknown, we conclude that the proximity of these tumors are likely due to chance, and are unrelated to occupancy in that building.

The reduction in risk for other cancers is to be expected among a highly educated population, where lifestyle and occupational risk factors are generally reduced. We did not interview individuals other than brain tumor cases and controls. Thus, we do not know the extent of their exposure to other risk factors (e.g., smoking).

Study Limitations

With regard to air sampling, the study was hampered by the fact that the wind was not from the South or Southwest during most of the study period. Thus, pollutants that might have originated from other buildings in that direction may not have been measured. It was difficult to coordinate the industrial hygiene survey with specific wind direction days.

An additional air sampling problem was that one or two of the rooms that were being measured had individuals going in and out during the measurement period. This was particularly true in the spring readings in a conference room. We did request individuals to stay out of these rooms during the six or seven hour measurement period. Considering the limited time during which this occurred, the industrial hygienist did not think that this invalidated the readings.

A low participation rate (34%) resulted in a small sample size. This limits our ability to draw conclusions from the survey. Every effort was made to contact individuals, both in person and by mail. There appeared to be considerable personnel turnover among staff and, to a lesser extent, faculty during the period from 1995 through 2006. This limited our ability to contact individuals.

Self-reports of illnesses and exposures are often subject to inaccuracies. We did check the cancer reports for brain tumors and they were mostly accurate. In addition, we checked a sample of non-cancer controls and they were completely accurate. The cancer registry also was utilized and provided information on the total number of many cancers.

Human Resource records were not 100 percent accurate in listing who was an occupant of Wescoe Hall and who was not. Approximately six to ten individuals reported that, although they were on the Wescoe Hall list, they never had an office in Wescoe Hall; they were excluded from the analysis. Eight individuals who indicated that they were or had been occupants of Wescoe Hall volunteered to participate in the study. However, they were not on the Wescoe Hall list and were excluded.

Human Resource records did not accurately account for hourly time in Wescoe Hall; cases and controls reported fewer hours than would be expected for the years recorded by the Human Resources Department. Some of the individuals spent a large amount of time outside the building, even with an office in the building.

Data from CBTRUS may be incomplete with respect to benign brain tumors. A number of states report widely differing ratios of benign to malignant brain tumors. Some states have more complete reporting of benign brain tumors. Recording of benign brain tumors started in 2004 for the National Program of Cancer Registries (NPCR); the Kansas Cancer Registry is part of this program. CBTRUS does not provide tables of age specific rates for benign tumors only.

Records of the State Cancer Registry are not fully complete for 2005 and are more incomplete for 2006. It typically takes two years for all records to be submitted. Thus, additional cancer cases will eventually be placed in the observed columns of Tables 3 through 6.

Combining benign with malignant brain tumors may not be the most appropriate strategy because there very likely are different causes for these two rather diverse disease groupings. However, this approach was included to increase the sample size when comparing observed to expected cases or brain tumor cases to non-brain tumor controls.

Death certificate records are often inaccurate as to the underlying cause of death. In this case we were able to review cancer deaths by means of the State Cancer Registry. We did not access the National Death Index to incorporate causes of death in former Wescoe Hall occupants who might have moved out of Kansas. Given our limited number of deaths and cases found using Kansas data, as well as the time and cost of obtaining additional mortality data from other states, we did not consider this a fruitful avenue to pursue. A preliminary analysis from review of names in the Social Security Death Index indicated that in the vast majority of deaths, the last state of residence was Kansas.

We used both lifetime and Wescoe Hall risk estimates to calculate the expected number of cases. This was supplemented by using one and five year occupancy cut-points to provide some information on the risk involved with time spent in the building. Using

either of the methods the risk decreased the longer the building was occupied, suggesting that the building was not responsible for the increased SMR.

Lifetime risk assumes that someone's risk begins at birth, thus increasing the sample size (person-years). The disadvantage of using this approach is that the Wescoe Hall group is a selected sample of unique surviving individuals who may not share the risk of the overall population. This approach also does not focus attention on the building of concern.

Wescoe Hall risk assumes that someone's risk begins at the time of occupying Wescoe Hall; an approach widely used in occupational studies. The disadvantage of using this approach is that it assumes that the relevant exposure has occurred in Wescoe Hall and that exposures outside of the building (e.g., at home) are not a factor. In addition, an individual's actual time spent in the building may vary considerably from personnel records, possibly leading to an incorrect number of expected cases.

We began the case finding period in 1995, thus allowing for as long as 23 years of Wescoe Hall occupancy (1973-1995) prior to the development of any cancer. This approach can allow for a suitable latency period in the building prior to the development of any cancer. In addition, we expanded the years of case finding to 11 years after 1995 (1995-2006) in order to increase the number of person-years and to include as many cases as possible. We were not just focused on the initial reports.

Person-years are used to calculate the expected number of cases. As an example of its use, ten person-years are equivalent to either following one person for ten years or following ten persons for one year. While the former calculation is more relevant for chronic disease and the latter calculation for acute disease, they are considered equivalent for calculating rates in epidemiologic investigations. Years of exposure were terminated when an individual developed a tumor, was lost to follow-up, or died.

The Bonferroni method of adjustment for multiple comparisons is used in a wide range of studies. The rationale is that given enough comparisons, some will turn out to be statistically significant just due to chance. While this method may reduce the number of false positive findings, it may also increase the number of false negative findings. Use of this method does not, however, change any of our critical results in Tables 5 and 7.

Recommendations

For optimal health, the lack of appropriate airflow in Wescoe Hall offices should be corrected as soon as possible. The levels should reach the guidelines of ASHRAE (15 cubic feet per minute per person). If there are identified air pollution episodes or complaints in the future then further study would seem warranted.

Monitoring of brain tumors in Wescoe Hall occupants should continue. If additional cases are found, particularly if these are confirmed primary site malignant brain tumors, further study would seem warranted. Of particular interest would be malignant tumors

identified among faculty or staff who were long-term occupants (greater than five years) of the building and who were located in the same department as, or located near, the brain tumor cases.

ACKNOWLEDGEMENTS

The participation of KU Lawrence faculty and staff, area Neurologists, and staff of the Kansas Cancer Registry are gratefully acknowledged. The Kansas Department of Health and Environment's Division of Health, Center for Health and Environmental Statistics, provided mortality data. Stanford L. Loeb, Ph.D., of the KU Lawrence campus, served as the liaison between the two campuses. He assisted us greatly in arranging for the environmental sampling, in general discussions about the project, in providing background information, and in helping to organize the general meetings and individual interviews. We are appreciative of the financial support provided by the University of Kansas, Lawrence, Kansas.

Research for this project was conducted by faculty and staff in various departments of the University of Kansas School of Medicine, Kansas City, Kansas (see list below). The industrial hygiene surveys were conducted by Stewart Industrial Hygiene and Safety, Inc., of Kansas City, Missouri. By mutual agreement the study was conducted independently of the University of Kansas Main Campus, Lawrence, Kansas. The opinions expressed herein are solely those of the authors and do not necessarily represent the views of the University of Kansas Medical Center.

CO-INVESTIGATORS LISTED BY DEPARTMENT OR ORGANIZATION

Departments:

Preventive Medicine and Public Health:

Tom D.Y. Chin, MD, MPH
John Keighley, Ph.D.
Sue Min Lai, Ph.D.
Colin Thomasset, MPH

Neurosurgery: Ania Pollack, M.D.

Pharmacology, Toxicology, and Therapeutics: John Doull, Ph.D.

Radiation Oncology: Bruce Kimler, Ph.D.

Organization:

Stewart Industrial Hygiene and Safety, Inc.: Albert Stewart, CIH, CSP, CHCM and other industrial hygienists.

Cancer Type	Total	Male	Female
Skin	23 (2)*	16 (1)	7 (1)
Prostate	8	8	-
Breast	5	0	5
Brain	4	4	0
Kidney	2	2	0
Leukemia/Lymphoma	2	2	0
Thyroid	2	0	2
Colon	1	1	0
Lung	1	1	0
Nasal	1	1	0
Parotid	1	0	1
Benign Brain Tumor	4	4	0
TOTAL	**54**	**39**	**15**

Table 1. Self-reported cancers and benign brain tumors by gender for lifetime.

* malignant melanomas in parentheses.

Cancer Type	Total	Male	Female
Skin	13	11	2
Prostate	5	5	-
Brain	4	4	0
Breast	3	0	3
Kidney	2	2	0
Leukemia/Lymphoma	2	2	0
Colon	1	1	0
Lung	1	1	0
Nasal	1	1	0
Parotid	1	0	1
Benign Brain Tumor	3	3	0
TOTAL	**36**	**30**	**6**

Table 2. Self-reported cancers or benign brain tumors by gender from 1995 to 2006.

Cancer Type	Total
Prostate	12
Female Breast	5
Brain	2
Colorectal	2
Lung	2
Other Types	23
TOTAL	**46**

Table 3. Cancers in Kansas Cancer Registry* for total workforce during 1996-2006.

*Database accessed 5/21/07.

Cancer Type	Person-Years	Total Observed Cases	Total Expected Cases	SMR	p value
Brain and Central Nervous System (malignant)	38,407	2	1.74	1.15	1.00
Male Brain and Central Nervous System (malignant)	19,888	2	1.01	1.98	0.54
Benign plus Malignant Brain and Central Nervous System	38,407	5	3.84	1.30	0.68
Prostate	19,888	12	20.34	0.59	0.07
Female Breast	18,519	5	9.80	0.51	0.15
Non-Hodgkin's Lymphoma	38,407	2	3.73	0.54	0.56
Lung	38,407	2	10.29	0.19	0.00*
Thyroid	38,407	2	2.52	0.79	1.00
All Sites	**38,407**	**46**	**88.24**	**0.52**	0.00*

Table 4. Comparison of Observed to Expected Cases for Brain Tumors and Various Cancers. One or more years of exposure to Wescoe Hall. Lifetime Risk.

* statistically significant at less than 0.004.

Cancer Type	Person-Years	Total Observed Cases	Total Expected Cases	SMR	p value
Brain and Central Nervous System (malignant)	37,291	1	1.69	0.60	0.99
Male Brain and Central Nervous System (malignant)	19,303	1	0.99	1.01	0.52
Benign plus Malignant Brain and Central Nervous System	37,291	4	3.72	1.08	1.00

Table 5. Comparison of Observed to Expected Cases for Brain Tumors. Five or more years of exposure to Wescoe Hall. Lifetime Risk.

Cancer Type	Person-Years	Total Observed Cases	Total Expected Cases	SMR	p value
Brain and Central Nervous System (malignant)	8,018	2	0.63	3.17	0.27
Male Brain and Central Nervous System (malignant)	4,759	2	0.42	4.76	0.14
Benign plus Malignant Brain and Central Nervous System	8,018	5	1.56	3.21	0.04*

Table 6. Comparison of Observed to Expected Cases for Brain Tumors. One or more years of exposure to Wescoe Hall. Wescoe Hall Risk.

* using Bonferroni correction need 0.004 for statistical significance.

Cancer Type	Person-Years	Total Observed Cases	Total Expected Cases	SMR	p value
Brain and Central Nervous System (malignant)	7,425	1	0.60	1.67	0.90
Male Brain and Central Nervous System (malignant)	4,509	1	0.41	2.44	0.67
Benign plus Malignant Brain and Central Nervous System	7,425	4	1.48	2.70	0.13

Table 7. Comparison of Observed to Expected Cases for Brain Tumors. Five or more years of exposure to Wescoe Hall. Wescoe Hall Risk.

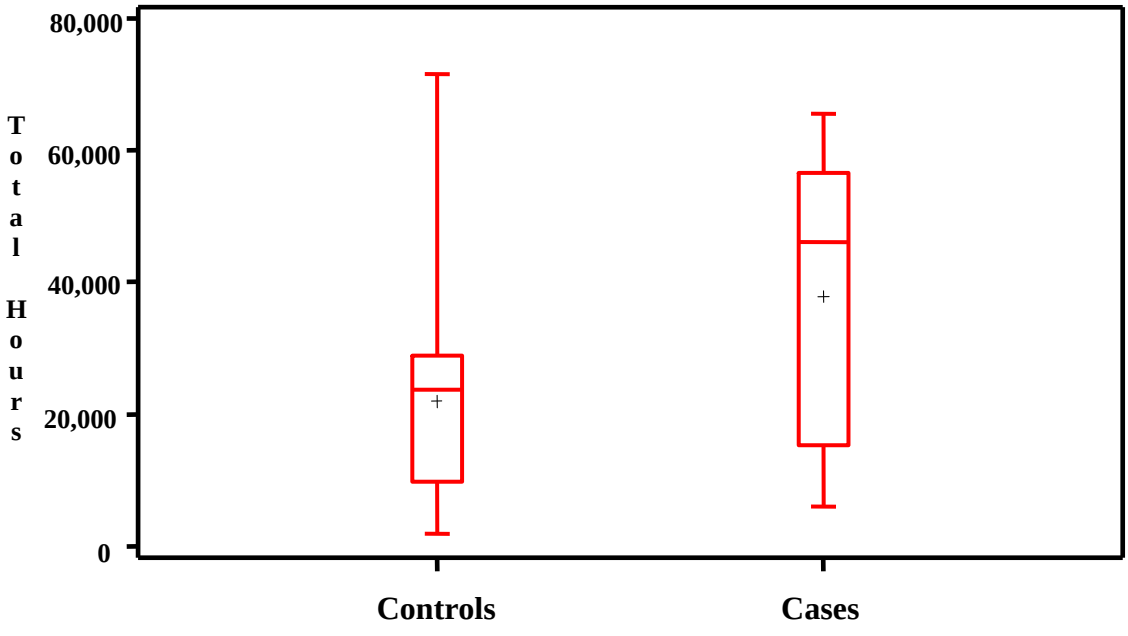

Figure 1. Hours worked in Wescoe Hall for cases and controls.

Mean: Cases = 37,909 hours (95% Confidence Interval = 5,589 to 70,230)
Controls = 21,926 hours (95% Confidence Interval = 14,234 to 29,618)

Median: Cases = 46,117 hours
Controls = 23,660 hours

Wilcoxon two-sample test: p = 0.2461

REFERENCES

1. Stewart Industrial Hygiene and Safety, Environmental Indoor Air Quality Evaluation of Wescoe Hall, University of Kansas, Lawrence, KS, August 7, 2006.

2. Stewart Industrial Hygiene and Safety, Inc., Environmental Indoor Air Quality Evaluation of Wescoe Hall, University of Kansas, Lawrence, KS, January 25, 2007.

3. http://monographs.iarc.fr/ENG/Monographs/vol88/volume88.pdf (Accessed 5/16/07).

4. Schork MA, Remington RD, Statistics with Applications to the Biological and Health Sciences, 3rd Edition, Prentice Hall, Upper Saddle River, New Jersey, 2000.