

Cancer Mortality in Health and Science Technicians

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Background Nearly one million U.S. women are employed as health or science technicians with various chemical and biological exposures, but few studies have looked at their health outcomes.

Methods Using 1984-1995 mortality data with coded occupation information, we calculated race- and age-adjusted proportionate cancer mortality ratios (PCMRs) and 95% confidence intervals for two age groups for black and white women with occupations of clinical laboratory (CLT), radiologic, and science technician.

Results For CLTs, the PCMRs for breast cancer were borderline significantly elevated. The PCMRs for leukemia were significantly elevated, particularly for myeloid leukemia. Radiologic technicians had no significantly elevated PCMRs. Science technicians had significantly elevated PCMRs for non-Hodgkin's lymphoma and multiple myeloma in the younger age group.

Discussion The elevated risks for lymphatic and hematopoietic neoplasms in CLTs and science technicians may be associated with occupational exposures. *Am. J. Ind. Med.* 36:155-158, 1999. Published 1999 Wiley-Liss, Inc.†

KEY WORDS: female occupations; mortality; proportionate cancer mortality; leukemia; health technicians; science technicians

INTRODUCTION

There are nearly one million women in the United States employed as health or science technicians. They are exposed to a variety of chemical and biological substances. The National Occupational Exposure Survey, conducted in the US in 1981-1983 [NIOSH, 1988, 1989, 1990] found hundreds of potential exposures for technologists and technicians, including several known or probable carcinogens such as acrylamide, asbestos, benzene, benzidine, formaldehyde, beta-naphthylamine, and radioactive substances. The few studies looking at the cancer mortality of women in these professions have been small, with inconsistent results [Belli et al., 1992; Brown et al., 1996; Carpenter et al., 1991; Cordier, 1990; Doody et al., 1998]. Among the cancers

found elevated were breast, pancreatic, brain, and non-Hodgkin's lymphoma.

This study examined the mortality outcome of three of the health and science technical occupations: clinical laboratory technologists and technicians, who work primarily in hospitals, physicians' offices, and other health services performing medical laboratory tests; radiologic technicians, who also work primarily in hospitals and other health services X-raying patients; and science technicians, a category which includes biological and chemical technicians. Science technicians are laboratory technicians who work primarily in manufacturing industries, particularly the chemical and food manufacturing industries, engaged in research and testing, and in research institutions. Women make up 62% of these occupational groups. In 1994, there were 475,000 women employed in these occupations, which was an increase of 46% over 1983 [US Bureau of the Census, 1995].

METHODS

The data for this study are from the National Occupational Mortality Surveillance (NOMS) database [Burnett et al., 1997]. This database is supported through the collabora-

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tive efforts of the National Institute for Occupational Safety and Health (NIOSH), the National Cancer Institute, the National Center for Health Statistics (NCHS), and state health departments. The database contains information from death certificates from selected states. The funeral director requests information from an informant, usually the next of kin, on the usual industry and occupation of the decedent. A single industry and occupation is recorded on the death certificate and coded by the state health departments. The data in this report are from deaths occurring in 28 states between 1984 and 1995. Occupation is coded according to the US Bureau of the Census classification system [US Bureau of the Census, 1982] and cause of death is coded according to the ninth revision of the International Classification of Diseases (ICD) [WHO, 1977].

The study includes all black and white women age 18–90 years old with cancer as the underlying cause of death and an occupation reported on the death certificate. Restricting the study to women with a reported occupation results in the loss of about half of the deaths in women, since many women are reported as homemakers. The elimination of homemakers prevents possible biases resulting from the effect of this large group in the comparison population. Race- and age-adjusted proportionate cancer mortality ratios (PCMRs) were calculated for clinical laboratory technologists and technicians, radiologic technicians, and science technicians using computer software developed at NIOSH. The proportion of a specific cancer in a specific occupation is compared to the proportion of that cancer in all occupations. The 95% confidence interval (95% CI) was computed based on the Poisson distribution [Bailar and Ederer, 1964] if the observed number of deaths was 1,000 or less; otherwise, the Mantel-Haenszel χ^2 test [Mantel and Haenszel, 1959] was used.

RESULTS

Table I shows that there were nearly 6,000 deaths in these occupations, with over 2,000 cancer deaths. Clinical laboratory technologists and technicians comprise the largest group.

Table II shows, for each occupational group, the PCMRs for the cancer sites which were reported elevated in past studies or were hypothesized to be associated with a potential exposure: pancreas, lung, breast, brain, non-Hodgkin's lymphoma, and leukemia.

For clinical laboratory technologists and technicians, the PCMR for breast cancer approached significance, with the highest PCMR in the 18–64 age group. Leukemia was significantly elevated for both age groups. The elevation occurred in the subcategory of myeloid leukemia (PCMR = 178, 95% CI 113–267; PCMR = 169, 95% CI 84–303, respectively for the two age groups; not shown in Table II).

TABLE I. Number of Total Deaths and Cancer Deaths in Three Technical Occupation Groups: NOMS,* 1984–1995

Occupation	Total deaths	Cancer deaths
Clinical laboratory technologists and technicians	3,477	1,211
Radiologic technicians	958	371
Science technicians	1,400	527
Total	5,835	2,109

*National Occupational Mortality Surveillance database.

There were no significantly increased risks for radiologic technicians, although the PCMRs for lung cancer and breast cancer were slightly elevated for both age groups. The PCMR for cancer of the oral cavity and pharynx (not shown in Table II) was statistically significantly elevated for the 18–64 age group (PCMR = 322, 95% CI 118–701), but there were no deaths in the 65–90 age group, resulting in a nonsignificantly elevated PCMR for the total (PCMR = 166, 95% CI 61–361).

For science technicians, cancers of the pancreas and lung were in excess, although not significantly elevated. Both had higher PCMRs in the younger age group. Non-Hodgkin's lymphoma was significantly elevated in the 18–64 age group but not elevated in the older one. Multiple myeloma (not shown in Table II) was significantly elevated in the younger age group but not in the 65–90 age group (PCMR = 256, 95% CI 110–503; PCMR = 97, 95% CI 36–211, respectively).

DISCUSSION

A review of the literature found few mortality studies of technicians, with no recent reports specifically on clinical laboratory technicians or technologists. Our most important finding was an elevated risk for leukemia, particularly myeloid leukemia, in both age groups. We also found an elevated risk for breast cancer. Workers in this occupation have had potential exposure to benzene, which would be consistent with the elevated risk for myeloid leukemia [Yin et al., 1996; Crump, 1996].

There have been several studies on a cohort derived from a registry of radiologic technologists [Boice et al., 1995; Doody et al., 1995, 1998]. There is particular interest in this occupational group because of the exposure to ionizing radiation. Leukemia, breast cancer and lung cancer are of a priori interest. In a mortality study of the cohort, breast cancer mortality was found to be elevated in women who had been certified before 1940 [Doody et al., 1998]. Mortality for the total cohort was not elevated for any of the three cancer sites. Two breast cancer morbidity studies

TABLE II. Proportionate Cancer Mortality Ratios (PCMR) and 95% CI for Female Technologists and Technicians by Age: NOMS,* 1984–1995

Cancer	Ages 18–64			Ages 65–90			Total age group		
	N	PCMR	95% CI	N	PCMR	95% CI	N	PCMR	95% CI
Clinical laboratory technologists and technicians									
Pancreas	26	105	68–154	23	78	50–117	49	90	67–120
Lung	110	76	63–92	110	101	83–122	220	87	76–99
Breast	227	114	100–130	83	107	85–132	310	112	100–125
Brain	24	101	64–150	12	126	65–221	36	108	76–149
Non-Hodgkin's lymphoma	28	134	89–194	22	114	71–173	50	125	92–164
Leukemia	35	158	110–219	26	166	108–243	61	161	123–207
Radiologic technicians									
Pancreas	6	92	34–200	15	147	82–243	21	126	78–192
Lung	42	108	78–146	46	123	90–164	88	115	92–142
Breast	58	105	80–136	28	105	70–152	86	105	84–130
Brain	6	78	29–170	2	61	7–221	8	73	32–144
Non-Hodgkin's lymphoma	5	80	26–186	6	85	31–186	11	83	41–148
Leukemia	4	57	15–145	7	123	49–253	11	86	43–154
Science technicians									
Pancreas	13	152	81–259	23	134	85–201	36	140	98–193
Lung	62	125	96–160	60	93	71–120	122	107	89–128
Breast	56	90	68–116	51	111	82–146	107	99	81–119
Brain	5	62	20–146	7	124	50–255	12	88	45–153
Non-Hodgkin's lymphoma	16	230	131–373	9	75	34–142	25	132	85–195
Leukemia	7	96	39–198	7	73	29–150	14	83	45–139

*National Occupational Mortality Surveillance database.

found no relationship with occupational exposures [Boice et al., 1995; Doody et al., 1995]. Our results were consistent with these studies. The PCMR for leukemia was less than expected.

Science technicians are a more diverse group than the first two occupational groups. This category includes both biological and chemical technicians, as well as a number of smaller technical occupations. Since 1990, there have been several small studies of these occupations. A study of female workers in biology laboratories in France [Cordier, 1990] found an excess of pancreatic cancer deaths ($P < 0.10$) and excesses of bone and brain cancer, based on two and three deaths, respectively. A cancer registry study in England and Wales [Carpenter et al., 1991] found an excess of deaths due to non-Hodgkin's lymphoma in laboratory assistants age 15–44 and also a slight excess of brain cancer. A study of laboratory workers in the US Department of Agriculture [Dosemeci et al., 1992] found an excess of breast cancer in women. There was also an excess of colon cancer and lymphosarcoma and reticulosarcoma in men. A study of nonadministrative workers that included scientists, laboratory technicians, and maintenance workers at the Italian

National Institute of Health [Belli et al., 1992] found excesses of pancreatic cancer and lymphosarcoma and reticulosarcoma in both men and women, based on from one to three deaths in each category. Brown et al. [1996] looked at a cohort of workers in biological research institutes in the UK. No excess cancer risks were found for persons who had worked in a laboratory, but the cohort was young. We found a nearly significant excess of pancreatic cancer, consistent with the findings of Cordier and Belli. A number of studies have examined the relationship of pancreatic to occupational exposures [Gold and Goldin, 1998], but the results have been inconsistent. We also found an excess of non-Hodgkin's lymphoma and multiple myeloma in the 18–64 age group. The incidence of non-Hodgkin's lymphoma has been increasing over the last two decades and a relationship to environmental and occupational exposures has been postulated. Among the exposures implicated are pesticides, herbicides, wood preservatives, and solvents [Persson, 1996]. The elevated risk in the younger age group suggests a relatively recent introduction into the workplace of a hazardous chemical. Multiple myeloma was also elevated in the younger age groups. Risk factors for multiple myeloma are

obscure. Studies of radiation exposure, farming, metals, benzene, rubber manufacturing, wood, leather, textile, and petroleum industries have had conflicting and inconclusive results [Riedel and Pottern, 1992]. The strongest candidates for occupational risk factors are pesticides, benzene, and other organic solvents.

One of the main strengths of this study compared to most of the previous ones is that the large number of deaths allows us to have a better look at the rare cancers. The recent deaths among the younger age group would more closely reflect current exposures than would past studies with deaths over a wide range of years. The study is limited by the fact that we cannot compute rates and that we have no information on exposures, the time or length of employment, or on possible confounders, such as smoking. PCMRs give us information about the proportion of deaths due to specific cancers, but if the overall cancer rate is lower than in the comparison population, the PCMRs will overestimate the risk and, conversely, underestimate the risk if the overall rate is higher. Also, if the rate for a common cancer, such as lung cancer or breast cancer, is low, the PCMRs will overestimate the risk for other cancers and, conversely, underestimate the risk if the rate of a common cancer is high. These limitations are factors that must be considered when interpreting our results.

Our comparison population does not include women whose death certificates reported the occupation as "Homemaker" because some women who have been employed for a significant portion of their lives but die after retirement are probably reported as homemakers. Although funeral directors have instructions from NCHS [NCHS, 1988] to enter the usual occupation worked outside the home even if the woman was also a homemaker, it is not known how well this is followed. If some women reported as homemakers were employed as technicians, the PMRs for work-related causes of death could be biased towards the null.

CONCLUSIONS

In conclusion, we found some excesses of lymphatic and hematopoietic cancers in the clinical laboratory and science technicians and technologists that could be related to chemical exposures in the workplace. No excess risks were found for radiologic technicians.

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REFERENCES

Bailar JC, Ederer F. 1964. Significance factors for the ratio of a Poisson variable to its expectation. *Biometrics* 20:639–643.

Belli S, Comba P, De Santis M, Grignoli M, Sasco AJ. 1992. Mortality study of workers employed by the Italian National Institute of Health, 1960–1989. *Scand J Work Environ Health* 18:64–67.

Boice JD, Mandel JS, Doody MM. 1995. Breast cancer among radiologic technologists. *JAMA* 274:394–401.

Brown TP, Paulson J, Pannett B, Coupland C, Coggon D, Chilvers CED, Sasco AJ. 1996. Mortality pattern among biological research laboratory workers. *Br J Cancer* 73:1152–1155.

Burnett C, Maurer J, Rosenberg HM, Dosemeci M. 1997. Mortality by occupation, industry, and cause of death: 24 reporting states, 1984–1988. Cincinnati, OH: DHHS (NIOSH) Publication No. 97–114.

Carpenter L, Beral V, Roman E, Swerdlow AJ, Davies G. 1991. Cancer in laboratory workers (letter). *Lancet* 338:1080–1081.

Cordier S. 1990. Risk of cancer among laboratory workers (letter). *Lancet* 335:1097.

Crump KS. 1996. Risk of benzene-induced leukemia predicted from the Ploofilm cohort. *Environ Health Perspect* 104(Suppl 6):1437–1441.

Doody MM, Mandel JS, Boice JD. 1995. Employment practices and breast cancer among radiologic technologists. *J Occup Environ Med* 37:321–327.

Doody MM, Mandel JS, Lubin JH, Boice JD. 1998. Mortality among United States radiologic technologists, 1926–90. *Cancer Causes Control* 9:67–75.

Dosemeci M, Alavanja M, Vetter R, Eaton B, Blair A. 1992. Mortality among laboratory workers employed at the U.S. Department of Agriculture. *Epidemiology* 3:258–262.

Gold EB, Goldin SB. 1998. Epidemiology of and risk factors for pancreatic cancer. *Surg Oncol Clin* 7:67–91.

Mantel N, Haenszel W. 1959. Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst* 22:719–748.

NCHS. 1988. Guidelines for reporting occupation and industry on death certificates. Hyattsville, MD: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, DHHS (PHS) Publication No. 88–1149.

NIOSH. 1988, 1989, 1990. National Occupational Exposure Survey: Volumes I–III. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication Nos. 88–106, 89–102, 89–103.

Persson B. 1996. Occupational exposure and malignant lymphoma. *Int J Occup Med Environ Health* 9:309–321.

Riedel DA, Pottern LM. 1992. The epidemiology of multiple myeloma. *Hematol Oncol Clin* 6:225–247.

US Bureau of the Census. 1982. 1980 Census of Population: Alphabetical Index of Industries and Occupations. Washington, DC: US Government Printing Office.

US Bureau of the Census. 1995. Statistical Abstract of the United States, 1995 (115th edition). Washington, DC: US Government Printing Office. p 411–413.

WHO. 1977. International Classification of Diseases, 1975 Revision. Geneva: World Health Organization.

Yin SN, Hayes RB, Linet MS, Li GL, Dosemeci M, Travis LB, Li CY, Zhang ZN, Li DG, Chow WH, Wacholder S, Wang YZ, Jiang ZL, Dai TR, Zhang WY, Chao XJ, Ye PZ, Kou QR, Zhang XC, Lin XF, Meng JF, Ding CY, Zhu JS, Blot WJ. 1996. A cohort study of cancer among benzene-exposed workers in China: overall results. *Am J Ind Med* 29:227–235.