# NEOPLASIA IN THE WOOD AND PULP INDUSTRY *

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## Introduction and Method

I recently completed an occupational mortality analysis of nearly 300,000 death records filed in Washington State for men dying during the years 1950–1971.[1] This paper presents the neoplasia experience of men working in the wood products industry.

The method used is an age and year of death-specific, proportionate mortality analysis. The death certificate occupational and cause-of-death statements are the major analytic variables. The death records of all males age 20+, dying in the years 1950–1971, were abstracted, and the occupational statement was coded and added to an existing death punch card. The cards were read onto magnetic tape and a proportionate mortality ratio (PMR) program was run. Observed and expected deaths and a PMR are printed for 161 detailed causes of death for each of 195 occupational groups. Since nonwhite deaths made up less than 3% of the file, they were excluded from the analysis for the sake of racial homogeneity.

## Results

Men who work in the wood products industry in this state may be divided roughly into two classes: Men who work in the forests, and men who work in the mills.

With the coding system used, only one occupational group, loggers, could be identified as working primarily in the forests. Because professional foresters also spend some time in the forests, they are included in the analysis. Three major classes of millworkers were identifiable: pulp and paper millworkers, plywood millworkers, and a miscellaneous millwork category that included sawmill workers.

Table 1 shows the mortality picture for Washington State loggers. The overall cancer rate is low, and cancers of the stomach and prostate are the only neoplasms showing excess mortality. Other causes of death with elevated proportionate mortality ratios are: respiratory tuberculosis, bronchiectasis, and work-related accidents. The occupational mortality study done on U.S. 1950 deaths [2] shows excellent agreement with the Washington State pattern. Tuberculosis, stomach cancer, and accidents show increased mortality in the U.S. data. Since loggers have the highest accidental death rates of any group in the state, the proportional mortality ratio method will inflate the expected deaths in the

* This study was supported in part by Contract Number CDC 997426 from the U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

TABLE 1

PROPORTIONATE MORTALITY RATIOS (PMRs) WHITE MALE DEATHS IN WASHINGTON STATE, 1950–1971

LOGGERS

| Cause of Death | I.C.D. Number * | Deaths | | PMR † |
|---|---|---|---|---|
| | | Observed | Expected | |
| Tuberculosis of respiratory system | 001–008 | 74 | 57 | 130 |
| Bronchiectasis | 526 | 31 | 16 | 199 |
| All malignant neoplasms | 140–204 | 1,798 | 1,933 | 93 |
| Stomach cancer | 151 | 223 | 185 | 120 |
| Cancer of the prostate | 177 | 289 | 253 | 114 |
| Blow from falling object | 910 | 368 | 34 | 1075 |

* I.C.D. = International Classification of Diseases, 7th revision.
† PMR underlined if $p \leq 0.05$.

nonaccidental death categories and cause PMR values to be artificially low. For men under age 50, these PMRs are about 25% lower than they would be if loggers had the same accidental death experience as the rest of the work force. A case-control analysis of the loggers, excluding accidental deaths, shows that leukemia also has increased mortality in loggers, especially the category 204.0, lymphatic leukemia.

TABLE 2 shows the PMR data for professional foresters. Men in this group show elevated PMRs for total malignant neoplasms. (Observed, 40 deaths; expected, 22.) Increased cancer PMRs are seen for digestive organs and peritoneum due especially to cancers of the rectum and pancreas. Although based on small numbers of deaths, elevated PMRs are seen for respiratory cancer,

TABLE 2

PROPORTIONATE MORTALITY RATIOS (PMR'S) WHITE MALE DEATHS IN WASHINGTON STATE, 1950–1971

PROFESSIONAL FORESTERS

| Cause of Death | I.C.D. Number * | Deaths | | PMR † |
|---|---|---|---|---|
| | | Observed | Expected | |
| All malignant neoplasms | 140–204 | 40 | 22.5 | 177 |
| Neoplasms of | | | | |
| Digestive organs and peritoneum | 150–159 | 13 | 7.3 | 177 |
| Respiratory system | 160–165 | 10 | 5.9 | 169 |
| Lymphatic and hematopoietic tissues | 200–205 | 5 | 2.5 | 193 |

* I.C.D. = International Classification of Diseases, 7th revision
† PMR underlined if $p \leq 0.05$.

lymphatic and hematopoietic cancers, and asthma. Since professional foresters spend considerable time in mills and offices as well as in the forests, their environmental exposures may be quite varied.

TABLE 3 shows the mortality pattern for pulp and paper millworkers in Washington State. Cancers of the small intestine and cancers of the lymphatic and hematopoietic tissues show excess deaths. Lymphosarcoma, Hodgkin's disease, multiple myeloma, and lymphatic and monocytic leukemia also show PMR elevations. Interestingly, diseases of the blood and blood-forming organs show an excess due primarily to fatal anemias.

The 1966–1967 supplement on cancer published by the Registrar General for England and Wales [3] shows increased proportional registration ratios for Hodgkin's disease, multiple myeloma, and cancer of the small intestine in paper

TABLE 3

PROPORTIONATE MORTALITY RATIOS (PMRs) WHITE MALE DEATHS IN WASHINGTON STATE, 1950–1971

PAPER AND PULP MILL WORKERS

| Cause of Death | I.C.D. Number * | Observed | Expected | PMR † |
|---|---|---|---|---|
| All malignant neoplasms | 140–204 | 364 | 353.3 | 103 |
| Cancer of small intestine | 152 | 5 | 1.1 | 447 |
| Cancer of rectum | 154 | 20 | 13.9 | 144 |
| Lymphosarcoma | 200.1 | 10 | 5.4 | 182 |
| Hodgkin's disease | 201 | 10 | 5.2 | 192 |
| Multiple myeloma | 203 | 12 | 4.9 | 243 |
| Leukemia | 204 | 23 | 16.4 | 140 |
| Diseases of blood and blood-forming organs | 240–249 | 10 | 4.9 | 208 |
| Multiple sclerosis | 345 | 6 | 2.9 | 203 |
| Arteriosclerotic heart disease (age 20–64) | 420 | 423 | 352.5 | 120 |

* I.C.D.=International Classification of Diseases, 7th revision.
† PMR underlined if $p \leqq 0.05$.

and printing workers. Also, a case-control study of Hodgkin's disease done with New York State death records [4] showed a 12:3 excess of paperworkers. The excess mortality from fatal anemias may be linked to the excess mortality due to cancers of the lymphatic and hematopoietic tissues. Agents that cause fatal anemias are good candidates for also being carcinogens of the lymphatic and hematopoietic tissues.

TABLE 4 presents plywood millworkers mortality. Cancer of the stomach and cancers of the lymphatic and hematopoietic tissues show PMR increases. Multiple myeloma, myeloid and acute leukemia, but not lymphatic leukemia, are responsible for the hematopoietic cancer excess.

TABLE 5 presents the mortality pattern for workers in sawmills and other types of wood machining operations. Only tumors of the testis (observed, 15 deaths; expected, 9) and cancer of the pancreas, in men under age 65 at death,

TABLE 4

PROPORTIONATE MORTALITY RATIOS (PMRs) WHITE MALE DEATHS IN WASHINGTON STATE, 1950–1971

PLYWOOD MILL WORKERS

| Cause of Death | I.C.D. Number * | Deaths Observed | Deaths Expected | PMR † |
|---|---|---|---|---|
| All malignant neoplasms | 140–204 | 273 | 262.5 | 104 |
| Cancer of the stomach | 151 | 32 | 20.9 | 153 |
| Leukemia | 204 | 23 | 11.9 | 193 |
| Myeloid leukemia | 204.1 | 8 | 2.9 | 271 |
| Acute leukemia | 204.3 | 10 | 3.5 | 279 |

* I.C.D.=International Classification of Diseases, 7th revision.
† PMR underlined if $p \leq 0.05$.

show mortality increases. This is a very heterogeneous group (sawmills, shakemills, pole, sash, doormills, etc.), and excess mortality in a specific group of workers may be hidden.

Although carpenters are not members of these industries, they work with wood, and their mortality pattern may offer insights into mortality patterns seen by the wood-products industry.

TABLE 6 presents Washington State carpenter's mortality. Stomach cancer shows an excess, as does Hodgkin's disease. Multiple myeloma and the leukemias also show small PMR excesses.

TABLE 5

PROPORTIONATE MORTALITY RATIOS (PMRs) WHITE MALE DEATHS IN WASHINGTON STATE, 1950–1971

SAWMILL AND OTHER MILL WORKERS

| Cause of Death | I.C.D. Number * | Deaths Observed | Deaths Expected | PMR † |
|---|---|---|---|---|
| All malignant neoplasms | 140–204 | 1829 | 1931 | 94 |
| Cancer of the stomach | 151 | 202 | 187 | 108 |
| Cancer of the Pancreas (under age 65) | 157 | 54 | 39 | 138 |
| Cancer of the testis | 178 | 15 | 9 | 166 |

* I.C.D.=International Classification of Diseases, 7th revision.
† PMR underlined if $p \leq 0.05$.

## Discussion

The one obvious common denominator that men working in this industry have is exposure to wood. It is logical, then, to ask whether these data suggest that wood itself is a carcinogen. Acheson et al.[5] have furnished convincing proof that adenocarcinoma of the nose and paranasal sinuses is an occupational disease of furniture workers in England. None of the occupational groups in this study had any excess mortality from either cancer of the nasopharynx or cancer of the nose. One major difference in exposure of the two groups is in the type of wood. The British furniture workers are exposed primarily to hardwoods, whereas the Washington State workers are exposed basically to only softwoods. A recent fortuitous observation [6] in mice has implicated cedar as a carcinogen. Occupational coding does not allow me to examine this question directly in the Washington State data.

Table 6

Proportionate Mortality Ratios (PMRs) White Male Deaths in Washington State, 1950–1971

Carpenters

| Cause of Death | I.C.D. Number * | Deaths | | PMR † |
|---|---|---|---|---|
| | | Observed | Expected | |
| All malignant neoplasms | 140–204 | 2,283 | 2,147 | 106 |
| Cancer of stomach | 151 | 271 | 211 | 128 |
| Hodgkin's disease | 201 | 38 | 24 | 162 |
| Multiple myeloma | 203 | 36 | 28 | 129 |
| Leukemia | 204 | 39 | 33 | 117 |

* I.C.D.=International Classification of Diseases, 7th revision.
† PMR underlined if $p \leq 0.05$.

Table 7 is an attempt to look at the neoplasia patterns in these occupations simultaneously. The fact that stomach cancer shows a modest PMR increase in all these groups, with the possible exception of the miscellaneous millworker category, suggests that ingested (or inhaled and swallowed) wood particles may cause gastric cancer. The hematopoietic cancer increases, especially in the pulp and paper and plywood mils, suggests that physical and chemical breakdown products of wood may be carcinogenic. It must be remembered that these mortality figures are averages for all the men in a given occupation. Mortality figures for men working in high-risk processes may be much higher.

The major negative finding of this study is that men who work in sawmills where wood is simply machined, do not show a striking neoplasia excess as seen in the paper, pulp, and plywood industries.

In summary, this study is an attempt to derive useful occupational mortality information from a readily available data source. The mortality patterns seen in certain parts of the wood-products industry and in carpenters suggest that

TABLE 7

PROPORTIONATE MORTALITY RATIOS (PMRs) WHITE MALE DEATHS IN WASHINGTON STATE, 1950–1971

ALL WOOD-EXPOSURE OCCUPATIONS

| Neoplasm | I.C.D. Number * | PMR †‡ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Loggers | | Pulp and Paper Makers | | Plywood Workers | | Sawmill and Other Mill Workers | | Carpenters | |
| Stomach cancer | 151 | 120 | (223) | 115 | (33) | 153 | (32) | 108 | (202) | 128 | (271) |
| Small intestine cancer | 152 | 66 | (4) | 447 | (5) | 0 | (0) | 140 | (7) | 87 | (3) |
| Hodgkin's disease | 201 | 65 | (18) | 192 | (12) | 92 | (4) | 91 | (21) | 162 | (38) |
| Multiple myeloma | 203 | 71 | (18) | 243 | (12) | 190 | (7) | 89 | (23) | 129 | (36) |
| Leukemia | 204 | 84 | (76) | 140 | (23) | 193 | (23) | 100 | (62) | 117 | (39) |
| All malignant neoplasms | 140–204 | 93 | (1,798) | 103 | (364) | 104 | (273) | 95 | (1,839) | 106 | (2,283) |

* I.C.D.=International Classification of Diseases, 7th revision.

† ( )=Number of cases.

‡ PMR underlined if $p \leq 0.05$.

these work environments contain carcinogens. Whether the carcinogenic agents are the woods themselves, chemical and physical breakdown products of wood, or agents associated with wood processing or treatment, remains to be resolved. Population-based studies should be done to corroborate and refine the findings of this study.

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