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I.H. Weaver - Manheim

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY CINCINNATI OHIO 45226

November 29, 1977

Mr. J.H. Marsh
Director of Environmental Affairs
Raybestos Manhattan
100 Oakview Drive
Trumbull, Connecticut 06611

Dear Mr. Marsh:

Enclosed is a copy of our paper "Mortality Patterns, 1940-1975, Among Asbestos Workers Employed in an Asbestos Textile, Friction and Packing Products Manufacturing Facility" which is to be presented on December 5, 1977 at the SCEH meeting on "Occupational Exposures to Fibrous and Particulate Dust and Their Extension into the Environment" published in the conference proceedings. We have incorporated into the paper the information which you and Mr. Weaver gave us on asbestos usage by fiber type and look forward to receiving a more detailed breakdown as promised.

As we discussed previously during our meeting here in Cincinnati, we would appreciate receiving any comments you may have on this paper as soon as possible.

Thank you for your cooperation.

Sincerely,

Cynthia Robinson

Cynthia Robinson
Epidemiologist, Biometry Section
Division of Surveillance, Hazard
Evaluations and Field Studies

Enclosure

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CRMC-Motley1000-Subj-002900

Mortality Patterns, 1940-1975 Among Workers Employed in an Asbestos Textile Friction and Packing Products Manufacturing Facility

NOT FOR PUBLICATION

Cynthia Robinson*
Richard Lemen, MS*
Joseph K. Wagoner, S.D. Hyg.†

To be presented at SCEH meeting on "Occupational Exposures to Fibrous and Particulate Dust and Their Extension into the Environment", December 5-7, 1977, Washington, D.C.

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INTRODUCTION

All commercial forms of asbestos tested have been found to be carcinogenic in mice, rats, hamsters and rabbits.[1] In humans, asbestos has also been demonstrated to be carcinogenic, producing respiratory tract cancer, gastrointestinal tract cancer and mesothelioma. It has also been shown to increase the incidence of nonmalignant respiratory disease and cardiopulmonary disease.

In particular, worker populations exposed to chrysotile have shown an increased risk for respiratory tract cancer, gastrointestinal tract cancer, nonmalignant respiratory disease and cardiopulmonary disease.

In this regard, McDonald et. al.[2,3] (1973, 1974) reported an increased risk of lung cancer among men employed in the Quebec chrysotile mines and mills. Those workers most heavily exposed showed a 5-fold increase in lung cancer deaths as compared to those least exposed. By 1976 a total of seven mesotheliomas had been reported among this population of miners and millers. In another study, Kogan et. al. in 1972 demonstrated a two-fold increase in lung cancer risk for males both mining and milling chrysotile. For workers over 50 years of age, the risk was much greater: 3-fold for male miners and 6-fold for male millers; 9-fold for female miners and 39-fold for female millers. In this study the authors reported no mesotheliomas.

Wagoner et. al.[5] reported an increased cancer risk for malignant and nonmalignant respiratory disease and among a cohort of workers in a large manufacturing plant utilizing predominantly chrysotile asbestos in textile, friction and packing products. At each duration

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of employment category down to and including 1-9 years of employment, an excess of respiratory cancer was demonstrated. Whereas the authors reported no mesotheliomas among the population, they did note the need for further investigation of the lymphatic and hematopoietic malignancies among these workers.

In that same year Enterline and Henderson[6] found a 2.4-fold excess of respiratory cancer for retirees who had been employed in the asbestos industry and exposed only to chrysotile. In 1972 Enterline et. al.[7] reported finding only one death due to mesothelioma out of 922 death certificates from retirees (including those exposed to amosite or mixed fibers). In contrast a subsequent investigation by Borow et. al.[8] in 1973 found 72 cases of mesothelioma in one plant in that study. However, among men within the asbestos cement industry exposed only to chrysotile a 1.4-fold excess of respiratory cancer was found.

On the basis of these and other data, the World Health Organization in 1976 concluded that in humans, occupational exposure to chrysotile, amosite, anthophyllite, and mixed fibers containing crocidolite resulted in a high incidence of lung cancer. In addition, many instances of pleural and peritoneal mesothelioma were found after exposures to crocidolite, amosite and chrysotile. As well, an excess risk of gastro-intestinal tract cancers has been demonstrated in groups occupationally exposed to amosite, chrysotile or mixed fibers containing crocidolite.[9]

More recently, Weiss et. al.[10] suggested a favorable mortality experience over a 30 year period for a cohort of workers employed in a plant reported to be using only chrysotile. He concludes "while the dearth of pertinent information makes for an unsatisfactory state of

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affairs, the favorable experience of the cohort reported in the current study suggests that the hazard of chrysotile in asbestos products manufacturing is minimal. The results are consistent with what is known of the relative dangers of chrysotile, amosite, and crocidolite".[10]

At the same time these findings were reported, NIOSH was updating its study of workers exposed predominantly to chrysotile asbestos which was originally reported by Wagoner et. al. The purpose of reinitiating this study in 1976 was two-fold. First, the original report suffered from a lost-to-follow-up rate exceeding 5%. Second, additional follow-up through 1975 permitted an additional eight years of observation for assessing the long latent effects associated with asbestos exposure.

PLANT DESCRIPTION

The plant under study began operations in the early 1900's and has historically used three different kinds of asbestos: amosite, crysotile, and crocidolite. Chrysotile was (and is) used in all departments in the plant involved with asbestos - textile, friction, and packing. Chrysotile constituted over 99% per year (5-6000 tons) of the total quantity of asbestos used in the plant, except during the war years. During the World War II (1942 through 1944), amosite asbestos was selectively used in a limited extent because of a shortage of chrysotile and constituted approximately 5% (375 tons) of the total quantity of asbestos used. Crocidolite asbestos was used to a very limited extent in this plant, its usage always less than 1% (approximately 7,500 pds./yr) of the total quantity of asbestos used, even during the war years.[11]

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In summary, 99% of the asbestos used at this plant was chrysotile. Use of amosite and crocidolite together constituted less than 1% with the exception of the three years during World War II previously mentioned. Use of crocidolite was always less than amosite, therefore a fraction of a percent of total production.[12]

METHODS

To evaluate the mortality experiences of workers occupationally exposed to asbestos at this plant, employment histories were ascertained from company personnel files. The study was restricted to workers who had achieved at least one year of employment in the plant with one day of that employment being between January 1, 1940 and December 31, 1962. The study was further restricted to exclude all office workers in non-exposed areas of the plant. 3277 workers met the cohort definition.

Follow-up was made of the vital status of cohort members from the time of termination of employment through December 31, 1975. Vital status was determined through records maintained by federal, state and local government agencies, including such sources as the Social Security Administration, state vital statistics offices, and state motor vehicle registration files. For individuals not located through these conventional sources, other sources such as city directories, postal service mailing correction services, voter records, and various other local records, were used. As a result of the follow-up program, less than 3% of the cohort was lost to observation (Table 1).

Death certificates were obtained for the known dead, and causes of death were interpreted by a qualified nosologist, according to the Revision of the International Lists of Diseases and Causes of Death in effect at the

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time of death, then converted into Seventh Revision codes.

A modified life table technique was used to obtain person-years at risk of dying by 5-year calendar time periods, 5-year age groups, duration of employment, and number of years since onset of initial asbestos exposure. Comparison was made between the observed number of deaths among the study cohort and that expected by the use of age, race, sex, calendar-time, cause-specific mortality rates for the total United States. These 78 individuals with unknown vital status were assumed to be alive as of December 31, 1975 so as not to overestimate the true risk of mortality associated with exposure to asbestos. In addition, those 38 individuals known to be deceased but for whom no death certificate was available, were assumed to be deceased, cause unknown.

RESULTS AND DISCUSSION

Table 2 shows that a total of 906 deaths occurred among male asbestos workers as contrasted with 718.6 deaths expected, an excess significant at $p<0.01$. For males several major cause of death categories contributed to the total excess: (1) All malignant neoplasms (145 observed, 110.7 expected, $p<0.01$); (2) Diseases of the heart (365 observed, 305.7 expected, $p<0.05$); (3) Nonmalignant respiratory disease (90 observed, 35.1 expected, $p<0.01$); and (4) Suicides (28 observed, 17.6 expected, $p<0.05$). The excess of malignant neoplasms was largely contributed by respiratory tract cancer, (51 observed, 35.8 expected, $p<0.05$). Likewise, the excess in nonmalignant respiratory disease (75 observed, 17.6 expected, $p<0.01$) was almost solely a function of nonmalignant respiratory disease excluding influenza and pneumonia.

Table 3 shows a total of 128 observed deaths among female asbestos workers as contrasted with 87.4 expected, an excess significant at $p<0.01$.

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As was previously seen for male asbestos workers, this excess was a function of several major cause of death categories: (1) All malignant neoplasms (30 observed, 20.9 expected); (2) Heart disease (36 observed, 28.8 expected); and (3) Nonmalignant respiratory disease (16 observed, 2.9 expected, $p<0.01$). The excess in all malignant neoplasms was largely contributed by respiratory tract cancer (12 observed, 1.4 expected, $p<0.01$); as was the excess in nonmalignant respiratory disease solely a function of nonmalignant respiratory disease after excluding influenza and pneumonia (14 observed, .9 expected, $p<0.01$).

Nonmalignant Respiratory Disease

Table 4 shows elevations in risk for nonmalignant respiratory disease for both males and females with no increased risk before 10 years latency, an observation consistent with other previous asbestos studies[13] and diseases of occupational etiology.

Suicide

Table 5 shows a significant excess in the number of deaths due to suicides by years from onset of first employment. As can be seen an overall 1.6 fold excess of observed versus expected deaths from suicide occurred in male asbestos workers. This excess follows a dose-response trend through the second latency interval since onset of employment, similar to that seen for nonmalignant respiratory disease, with a gradual tapering during the 3rd and 4th latency periods. At present a causal association between suicide and occupational exposure to asbestos can not be ruled out; continuing investigations are examining this association.

Respiratory Tract Cancer

Table 6 shows a significant increase in respiratory cancer for both males and females. An upward trend with latency was shown with plateaus

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of excess risk occurring for both males and females after 20 years. This is consistent with previous studies and diseases of occupational etiology.

Mesothelioma

- In general, previous epidemiologic studies showed a much stronger association of mesothelioma with occupational exposure to amphibole fibers, as contrasted to occupational exposure to chrysotile. These mesotheliomas associated with chrysotile exposure have been predominantly pleural in origin rather than peritoneal.[14,15,16] However, Table 7 lists the total of 17 cases of mesotheliomas which occurred among this asbestos workers study cohort. As may be seen, their distribution by site - 5 pleural, 6 peritoneal, and 6 with site unstated - is not consistent with the earlier reported predominance of pleural mesotheliomas among individuals exposed to chrysotile. A review of death certificates and clinical records has further indicated the presence of preexisting asbestosis in 3 of 5 pleural mesotheliomas and 5 of 6 peritoneal mesotheliomas among members of the study cohort.

Whereas case-series of mesotheliomas have revealed a sex ratio of 3:1 in favor of males; in fact, when analyses are made on a population base of workers exposed to asbestos, no differential risk of mesothelioma is seen. That this is so is evidenced by a rate of 2.7/10,000 for female asbestos workers and 1.9/10,000 for male asbestos workers in the present study.

Among a number of occupationally exposed groups studied, approximately 5-10% of deaths have been due to mesothelioma.[17,18,19] More recently, however, an estimate has projected that the deaths of between 8-11% of former asbestos workers from a particular factory in the U.K. will be due to mesothelioma.[20] Among asbestos textile, friction and packing

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production workers exposed to asbestos in the present study, 4.3% of all deaths indeed are due to mesothelioma.

Lymphoma and Lymphosarcoma

Several reports have suggested a possible association of asbestos exposure and/or asbestosis with various immunoproliferative and lymphoproliferative diseases including lymphoid tumors.[21,22,23] Therefore, an analysis was undertaken to evaluate the risk of lymphoid cancer among male asbestos workers during the interval 1950-1975. Because deaths due to malignancies of the lymphatic and hematopoietic system were not listed in U.S. Vital Statistics prior to 1950, this analysis was restricted to risk since that date. As seen in Table 8, seven deaths due to lymphosarcoma or malignant lymphomas were observed among male asbestos workers, whereas only 3.08 were expected on the basis of age-specific rates for all lymphosarcoma and reticulosarcoma (ICD 200).

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CONCLUSION

A study among a group of textile, friction and packing products asbestos production workers exposed to >99% chrysotile asbestos (except during the war years) demonstrated an excess risk for nonmalignant respiratory disease, suicide, heart disease, respiratory tract cancer and mesothelioma among males; and an excess risk for nonmalignant respiratory disease, respiratory tract cancer and mesothelioma among females. An increased risk due to lymphoma and lymphosarcoma among male asbestos workers was also indicated. These findings once again lend support to the conclusion that occupational exposure to chrysotile poses a severe carcinogenic risk of malignancies of multiple sites.

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TABLE 1

VITAL STATUS AS OF DECEMBER 31, 1975 AMONG WHITE MALES AND FEMALES EMPLOYED BETWEEN 1/1/40 AND 12/31/67 IN AN ASBESTOS TEXTILE, FRICTION AND PACKING MANUFACTURING FACILITY

Vital Status	Males	Females	Total
Known to be alive	1754	410	2164
Known to be deceased	906	128	1034
Death certificates obtained	878	118	996
Death certificates outstanding	28	10	38
Not known to be alive or deceased	61	17	78
Total	2722	555	3277

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TABLE 2

THE OBSERVED AND EXPECTED DEATHS ACCORDING TO CAUSE AMONG WHITE MALES EMPLOYED IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Cause of Death	List No.*	Observed	Expected	SMR
Malignant neoplasms	140-199	145	110.7	131‡
Digestive system	150-159	43	36.0	119
Respiratory system	160-164	51	35.8	142+
Other and unspecified	140-149, 165, 170-199	51	38.9	131
Vascular lesions affecting the central nervous system	330-334	48	52.2	92
Diseases of the heart	400-443	365	305.7	119+
Nonmalignant respiratory disease	470-527	90	35.1	256‡
Influenza and pneumonia	480-483, 490-493	15	17.5	86
Other respiratory disease	470-479, 484-489, 494-527	75	17.6	426‡
Suicides	963, 970-979	28	17.6	159+
Other	800-962, 964, 980-985	41	59.6	69
All other known causes		176	155.2	113
Unknown causes		28	0	——
Total		906	718.6	126+

* 7th Revision of International Lists of Diseases and Causes of Death

\+ Significant at $p<0.05$

‡ Significant at $p<0.01$

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TABLE 3

THE OBSERVED AND EXPECTED DEATHS ACCORDING TO CAUSE AMONG WHITE FEMALES EMPLOYED IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Cause of Death	List No.*	Observed	Expected	SMR
Malignant neoplasms	140-199	30	20.9	144
Digestive system	150-159	7	5.8	120
Respiratory system	160-164	12	1.4	8271 ‡
Other and unspecified	140-149, 165, 170-199	11	13.7	80
Vascular lesions affecting central nervous system	330-334	10	9.1	110
Diseases of the heart	400-443	76	28.8	12[illegible]
Noncalignant respiratory disease	470-527	16	2.9	55[illegible]
Influenza and pneumonia	480-483, 490-493	2	2.0	100
Other respiratory disease	470-479, 484-489, 494-527	14	0.9	1555 ‡
Suicide	963, 970-979	0	1.4	———
Other	800-962, 964, 980-985	3	3.9	77
All known causes		25	22.4	106
Unknown causes		10	0	———
Total		128	87.4	146 ‡

* 7th Revision of International Lists of Diseases and Causes of Death

‡ Significant at $p<0.01$

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TABLE 4

OBSERVED AND EXPECTED DEATHS DUE TO NONMALIGNANT RESPIRATORY DISEASE (LESS INFLUENZA AND PNEUMONIA) ACCORDING TO TIME INTERVAL SINCE ONSET OF EMPLOYMENT AMONG WHITE MALES AND FEMALES EMPLOYED IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Years Since Onset of Employment	Males			Females		
	Observed	Expected	SMR	Observed	Expected	SMR
< 10	2	1.2		-	.08	-
10-19	12	3.6	333	6	.16	3750
20-29	22	6.11	361	1	.32	312
≥ 30	39	6.7	582	7	.34	2058
TOTAL	75	17.63	425‡	14	.90	1555‡

‡ Significant at $p<0.01$

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TABLE 5

OBSERVED AND EXPECTED DEATHS DUE TO SUICIDE ACCORDING TO TIME INTERVAL SINCE ONSET OF EMPLOYMENT AMONG WHITE MALES EMPLOYED IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Years Since Onset of Employment	Observed	Expected	SMR
< 10	5	3.7	135
10-19	12	5.6	214
20-29	8	5.2	154
≥ 30	3	3.1	97
TOTAL	28	17.5	160+

+ Significant at $p<0.05$.

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TABLE 6

OBSERVED AND EXPECTED DEATHS DUE TO RESPIRATORY TRACT CANCER ACCORDING TO TIME INTERVAL SINCE ONSET OF EMPLOYMENT AMONG WHITE MALES AND FEMALES EMPLOYED IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Years Since Onset of Employment	Male			Female		
	Observed	Expected	SMR	Observed	Expected	SMR
<10	3	2.7	111	1	.1	-
10-19	11	7.9	139	1	.3	-
20-29	18	12.5	144	5	.5	1000
≥30	19	12.7	150	5	.5	1000
TOTAL	51	35.8	142+	12	1.4	857‡

+ Significant at p<0.05.
‡ Significant at p<0.01.

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TABLE 7

DEATHS DUE TO MESOTHELIOMA AMONG WHITE MALES AND FEMALES EMPLOYED IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Case Number	Asbestosis	Type of Mesothelioma	Sex	No. of Years of Employment	No. of Years Since Initial Employment	Age at Death
1	yes	Pleural	M	40	43	69
2	not stated		F	10	40	70
3	yes		M	42	47	67
4	no records		M	48	49	66
5	yes		M	28	32	53
6	yes	Peritoneal	M	20	40	55
7	yes		M	42	51	65
8	yes		F	14	47	74
9	yes		M	25	35	52
10	yes		M	19	25	63
11	no records		M	24	43	63
12	not stated	Unstated Site	F	8	41	60
13	not stated		M	34	44	67
14	yes		M	7	30	60
15	no records		F	6	38	65
16	not stated		M	48	53	70
17	yes		M	22	33	50

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TABLE 8

DEATHS DUE TO LYMPHOSARCOMA AND MALIGNANT LYMPHOMA AMONG WHITE MALES EMPLOYED JANUARY 1, 1950 - DECEMBER 31, 1975 IN AN ASBESTOS TEXTILE, FRICTION AND PACKING PRODUCTS MANUFACTURING FACILITY

Case	Age	Underlying Cause of Death	No. of Years Since Initial Employment	No. of Years of Employment
1	26	Lymphosarcoma	4	2
2	56	Lymphosarcoma	24	4
3	29	Lymphosarcoma	13	2
4	56	Lymphosarcoma	39	35
5	59	Malignant Lymphoma	17	17
6	34	Malignant Lymphoma	7	5
7	55	Malignant Lymphoma	38	34

7 observed vs. 3.08 expected, SMR 227, p<0.1.

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INTER OFFICE COMMUNICATION

Raybestos-Manhattan

Manheim, PA

TO: Mr. J. H. Marsh DATE: December 2, 1977

SUBJECT: Review of Robinson Paper on Mortality Patterns 1940-1975

I've reviewed subject paper and find the figures on asbestos usage coincide with information given to NIOSH by me at various times. Actually, my figure of 375 tons peak amosite usage probably is excessive. Three hundred tons might be more accurate. Unfortunately, no records appear to be available on which to base anything more accurate.

I cannot vouch for any of the medical or statistical data and must assume it is correct or at least can be justified by NIOSH.

As for mesothelioma. I think they have stretched things when they use these results to implicate chrysotile as a cause. With only 17 meso. cases in a cohort of 3277, or barely 1/2%, it is quite possible, even probable, all 17 were exposed to crocidolite and/or amosite. This should be easy to check if we can get names from NIOSH, as our employment records probably show these people to have worked with or near exposures other than chrysotile. They may all have had high crocidolite exposures.

I consider NIOSH extremely remiss in failing to investigate this. As far as I'm concerned it indicates a lack of desire to establish the true facts and constitutes another attempt to back up a preconceived notion concerning an association between chrysotile exposure and mesothelioma.

Another deficiency is the failure to relate adverse health effects to dosage. Perhaps this shouldn't be a part of such a mortality study, but it certainly is important that many of the deaths probably were related to very high exposures. I doubt NIOSH made any attempt to correlate these cases with the exposure data.

I. H. Weaver

grb

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