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Mortality Experiences Among Talc Workers: A Follow-up Study 0790

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In an earlier study of talc workers who had 15 or more years of exposure to commercial talc dust, the authors found that the proportional mortality from carcinoma of the lung and pleura among these workers was four times that of the general population. However, the significant increase in incidence of malignancy appeared in the older talc workers, namely, the 60 to 79, rather than in the 40 to 59 year age group.¹ This observation in the talc workers was at variance with those found in a group of asbestos insulators who had the same duration of exposure covering a similar time period.² The asbestos insulators showed an increased incidence of mortality from lung cancer in both age categories. The incidence of carcinoma of the gastrointestinal tract and peritoneum among the talc workers was not significantly different from that of the general population, whereas among the asbestos insulators the incidence of gastrointestinal malignancy was significantly higher. The authors postulated that the earlier occurrence of malignancies among the asbestos insulators was due to two factors. The first was the relatively greater carcinogenicity of the chrysotile asbestos as compared to commercial talc. The second factor was the exposure of the insulators to greater quantities of chrysotile asbestos as compared to the talc workers who were exposed to lesser quantities of talc dust which was admixed with appreciable amounts of tremolite and anthophyllite

asbestos. The earlier study¹ also showed an increased incidence of deaths due to talc pneumoconiosis and/or its complications. The present study was designed to bring the mortality data among the talc workers up to date and to provide additional information not reported in the earlier study.

Materials and Methods

All the talc workers employed in 1940 who had accumulated 15 or more years of exposure to commercial talc dust as well as those who achieved a minimum of 15 years of such exposure between 1940 and 1969 were included in the study. The group totaled 260 workers and it is believed that the overall number constituted the total work force in the worker population under study.

Source of Data.— The data were obtained from a number of sources. Plant records were examined and the work history of each individual was detailed to include changes of job and specific years of employment. Death certificates were studied in all instances where they were available. The records of the physicians who had attended the workers privately were reviewed. Substantial medical information on the majority of the workers was available in the Division's files which were used as an additional source of data. Hospital records, including autopsy reports and histological specimens, were examined wherever available. Autopsy or biopsy records were obtained in 38 of the 108 deaths.

Statistical Analysis.— The causes of death included the following: malignancies, cardiac diseases other than cor pulmonale, pneumoconiosis and its complications, accidents or suicides,

and all other causes. In view of the limitations of the available data, a study of the mortality experience by person years of exposure was not feasible. As an alternate, a comparison was made of the observed proportional mortality rates from the specific causes with the expected rates among similar population groups and was found satisfactory for a descriptive study of this nature. The proportions of observed mortality attributed to cancer of the lung and pleura and of the gastrointestinal tract and peritoneum and cardiac diseases were compared to the expected mortalities due to the above causes in the various age groups. The expected mortality for the total group represents the proportion of deaths among white men in the United States due to the specific causes in the year 1955. This particular year was chosen as standard because it is the median year of death among the 108 deaths. For each of the 5-year periods the median years, namely, 1942, 1947, 1952, 1957 and 1962 were selected. Differences between observed and expected frequencies were tested for significance using the normal curve for large numbers and the Fisher's exact probability test for small frequencies.

Findings

Total Deaths.— There were 108 deaths in the group of 260 talc workers. The causes of death in the various categories are shown in Table 1. A distribution of the deaths according to age group appears in Table 2. The average age at death of the 108 talc workers was 60.3 years, with a range of 38 to 84 years. Table 3 shows cause of death and the number of deaths during each 5-year period from 1940 to 1969.

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Table 1.— Causes of Death in 108 Talc Workers
During Period of 1940 to 1969

Cause of Death	No.	%
Malignancies	25	23.1
Lung and Pleura	13	12.0
Gastrointestinal and peritoneal	9	8.3
All Other Malignancies	3	2.8
Cardiac Deaths (other than cor pulmonale)	30	27.8
Pneumoconiosis and Complications	29	26.9
Accidents or Suicides	8	7.4
All Other Causes	16	14.8
Total	108	100.0

Malignancies.—Deaths from cancer of the respiratory tract and gastrointestinal tract and observed and expected proportional mortality rates are shown in Table 2. Twelve of the 13 malignancies of the lung and pleura were carcinomas of the lung and 1 was a fibrosarcoma of the pleura. Of the 9 malignancies of the gastrointestinal tract and peritoneum, 3

were cancers of the stomach; 2 were cancers of the liver, 1 of which was a primary hepatoma of the liver and the other a metastasis from a gastrointestinal malignancy; 1 was a cancer of the colon; 2 were cancers of the pancreas; and 1 was a peritoneal mesothelioma. The 3 malignancies involving other sites included 1 retroperitoneal reticulum cell

sarcoma, 1 chronic lymphatic leukemia and 1 Hodgkins' disease. The observed deaths and expected proportional mortality from cancer of the lung and pleura and of the gastrointestinal tract and peritoneum during the 5-year periods extending from 1940 to 1969 are shown in Table 4.

Cardiac Deaths.—Of the 30 cardiac deaths, excluding cor pulmonale, 22 had coronary artery disease, 5 had hypertensive heart disease and 3 had rheumatic heart disease. Table 2 shows the deaths and proportional mortality from cardiac disease related to specific age groups and Table 5 gives a breakdown of the number of deaths from cardiac disease during the specified 5-year periods.

Pneumoconiosis and its Complications.—There were 29 deaths in this group. Twenty of the 29 were due to cor pulmonale, 5 to advanced tuberculosis and 4 to bronchopneumonia. The lapsed time from the first talc ex-

Table 2.— Deaths and Proportional Mortality from Carcinomas of the Respiratory Tract, of the Gastrointestinal Tract, and From Cardiac Diseases Among Talc Workers by Age, 1940-1969

Age Group	Total Deaths	Deaths and Proportional Mortality From Respiratory Cancers (%)			Deaths and Proportional Mortality From Gastrointestinal Cancers (%)			Deaths and Proportional Mortality From Cardiac Diseases (%)		
		No	Observed	Expected	No	Observed	Expected	No	Observed	Expected
< 40	3	0	0	1.6	0	0	2.5	1	33.3	21.1
40-59	47	4	8.5	5.2	3	6.4	5.7	11	24.4	44.2
60-79	54	9	16.6	3.6	4	7.4	7.2	17	31.5	47.8
80-84	4	0	0	1.1	1	25.0	5.3	1	25.0	47.1
Total	108	13	12.0	3.7	8	7.4	6.5	30	27.8	45.3

Table 3.— Causes of Death in 108 Talc Workers* During the Period 1940-1969

Cause of Death	1940-44	1945-49	1950-54	1955-59	1960-64	1965-69	Total
Malignancies							
Lung and Pleura	—	2	1	5	3	2	13
Stomach	—	1	—	1	—	1	3
Liver	1	—	—	1	—	—	2
Colon	—	—	1	—	—	—	1
Pancreas	—	—	—	—	1	1	2
Peritoneum	—	—	—	1	—	—	1
Other Malignancies	—	—	2	—	—	1	3
Cardiac Diseases	3	6	—	6	8	7	30
Pneumoconiosis and Complications	2	4	2	8	9	4	29
Accidents and Suicides	1	1	1	2	2	1	8
Others	—	3	1	1	5	6	16
Total	7	17	8	25	23	23	108

* who had at least 15 or more years of exposure to talc dust.

Table 4. — Deaths and Expected Mortality from Cancer of the Lung and Pleura and of the Gastrointestinal Tract and Peritoneum Among Talc Workers 1940-1969

	Lung and Pleura			Gastrointestinal Tract and Peritoneum		
	Deaths	Proportional Mortality (%)		Deaths	Proportional Mortality (%)	
		Observed	Expected		Observed	Expected
1940-44	0	0	2.0	1	14.3	7.8
1945-49	2	11.7	3.1	1	5.8	7.8
1950-54	1	12.5	4.3	1	12.5	7.1
1955-59	5	20.0	5.7	3	12.0	6.7
1960-64	3	10.7	6.7	1	3.6	6.3
1965-69	2	8.7	7.7	2	9.5	6.1
Total	13			9		

posure to death in this group averaged 30.9 years, with a range of 15 to 46 years. All 29 had their initial exposures prior to 1945 at which time more effective engineering controls, including wet drilling in the talc mines, were introduced.

All Other Causes. — In addition to 8 accidents and suicides, there were 16 additional deaths in this category. Three were due to cerebrovascular accidents, 4 to pneumonia, and the remaining 9 to one of the following causes: bleeding duodenal ulcer, strangulated inguinal hernia, perforated diverticulum with peritonitis, acute glomerulonephritis, mesenteric arterial occlusion, intestinal obstruction, uremia, and gunshot wounds.

Environmental Exposure. — Environmental exposure data was available in 97 of the 108 death cases. The mean duration of exposure for this group was 24.1 years, with a range of 15 to 47 years. The dust exposure was predominantly to talc, tremolite, anthophyllite, carbonate dusts and a small amount of free silica. Comparative dust counts at the talc mines and mills prior to 1945 and between 1946 and 1969 are shown in Table 6. Table 7 shows the deaths from respiratory and gastrointestinal malignancy, cardiac disease and from all causes among the talc workers by years of exposure to commercial talc dust.

Comments

Malignancies. — The data on carcinoma of the lung and pleura show the overall proportional mortality to be approximately four times that expected. Consistent with our previous observation¹ a significant increase appears to occur in the age group of 60 to 79

years rather than in the 40 to 59 year age group. As has been mentioned, this finding among talc workers is at variance with what the authors have observed among asbestos insulators where the observed values in both the 40 to 59 and 60 to 79 year age group were significantly different from the expected values. Kiviluoto and Meurman³ also reported the occurrence of lung cancer among younger anthophyllite miners (45-54 year age group) who had more than 10 years of exposure, with a mean of approximately 20 years, to pure anthophyllite asbestos. Two explanations are offered. One is that the mixed dust to which the talc workers were exposed, namely, talc, tremolite and anthophyllite, is less carcinogenic than chrysotile dust to which the asbestos insulators were exposed. The second is that the talc workers were exposed to a lesser concentration of dust compared to the asbestos insulators and anthophyllite miners. One or both of these factors may account for the difference in the mortality experience of the talc and asbestos workers groups. In the absence of adequate smoking data, one cannot

assess the role played by smoking in accounting for the differences in the occurrence of malignancies.

When carcinoma of the lung and pleura are related to each of the six 5-year periods, as shown in Table 4, it is noteworthy that the observed proportional mortality from carcinoma of the lung was approximately four times as much as the expected mortality during the years 1945 to 1959 and dropped to approach the expected mortality in 1960-64 and 1965-69. The differences between the observed and expected mortality rates were significant in 1950-54 ($P < 0.01$) and insignificant in 1960-64 and 1965-69 ($P > 0.05$). The improved mortality experience between 1960 and 1969 in the case of lung and pleural cancers is particularly pertinent since environmental controls have resulted in an appreciable reduction in the dust counts in the mines and mills, although the fiber counts still remain high (Table 6). This finding indicates that the present threshold limit for tremolite and anthophyllite needs reevaluation.

With regard to cancer of the gastrointestinal tract and peritoneum among the

Table 5. — Deaths and Expected Mortality From Cardiac Disease Among Talc Workers 1940-1969

	Deaths	Proportional Mortality (%)	
		Observed	Expected
1940-44	3	42.8	37.4
1945-49	6	35.3	41.0
1950-54	0	0	46.0
1955-59	6	24.0	46.5
1960-64	8	28.6	46.6
1965-69	7	30.4	49.9
Total	30		

Table 6.—Comparative Dust and Fiber Counts at the Various Talc Mining and Milling Operations

	Pre 1949 through 1969						1972		
	Dust Counts*						Dust Counts**	Fiber Counts*	
	Pre 1945		1946-1965		1966-1969		Ave.**	Med.**	
	Ave.**	Med.**	Ave.**	Med.**	Ave.**	Med.**			
Drilling	818	413	5	3	19	19	7	7	3
Mucking	120	30	5	5	9	9	3	3	2
	Pre 1948		1948-1965						
Crushing	180	69	42	13	28	20	35	15	62
Screening	69	61	37	37	—	—	—	—	—
Milling	92	75	25	20	40	24	7	7	25
Garnering & Separating	278	70	27	27	—	—	13	9	27
Pulverizing	—	—	28	28	—	—	—	—	—
Bagging	151	129	27	23	29	25	27	27	47
RR & Truck Loading	—	—	73	63	43	20	36	28	24
Blow Room	1227	1196	—	—	—	—	—	—	—
Open Chutes	125	83	—	—	—	—	—	—	—

Dust counts in mppcf; fiber counts in no. fibers/ml. >5µ in length
 Ave. - average; Med. - median
 --- Operation discontinued after 1948

talc workers, we did not find any significant difference between the observed and expected values in the overall and specific age groups studied. Nor did Kiviluoto and Meurman find an increased incidence of gastrointestinal cancer among the anthophyllite workers they studied.³ These findings differ from those observed in asbestos insulators where a significant increase in the observed incidence of gastrointestinal malignancy was found in the overall and specific age groups studied.¹ Our findings among asbestos insulators were similar to those reported by Selikoff, Hammond and Churg.⁴

Deaths Due to Pneumoconiosis and its Complications.— A previous study has shown that cor pulmonale is a major complication of talc pneumoconiosis

and is a major cause of death among talc workers.¹ The findings in this study confirm the previous report. However, as shown in Table 3, the percentage of deaths due to pneumoconiosis and its complications has decreased by more than 50% in the last 5-year period studied (1965-69) as compared to the preceding period. The number of deaths probably reflects the greater exposures which occurred in the earlier years of employment. A longer interval must elapse, however, before the effect of controls on the incidence of pneumoconiosis can be appraised more definitively in the plant studied. In another study of a different plant⁵ processing a similar mixture of talc, tremolite and anthophyllite but wherein controls were installed at the inception

of operations in 1948, only one of 39 workers had a chest roentgenogram consistent with pneumoconiosis. The mean exposure of the 39 workers was 16.2 years with a range of 11 to 22 years. The worker whose chest roentgenogram was consistent with pneumoconiosis was a 75-year old man who had a non-productive cough, a Grade 1 dyspnea and who worked as a janitor for 11 years. The low incidence of pneumoconiosis was found despite the presence of relatively high fiber and dust counts. The fiber counts exceeded by 2 to 6 times the present threshold limit value of 5 fibers/ml with a length greater than 5 microns. In terms of time weighted averages, Murphy and associates⁶ found no asbestosis among workers exposed less than 60 mppcf-

Table 7.—Deaths From Respiratory and Gastrointestinal Malignancy, Cardiac Disease and From All Causes Among Talc Workers by Years of Exposure to Talc Dust

Cause of Death	Exposure in Years						Unknown	Total
	15-19	20-24	25-29	30-34	35-39	40+		
Malignancy of the Respiratory Tract	3	7	1			1	1	13
Malignancy of the Gastrointestinal Tract	2	1	1	1	2	1	1	9
Cardiac Disease	9	8	4	2	2	1	4	30
All Causes	24	35	15	12	6	5	11	108

years to chrysotile and amosite in ship construction. In the study of the plant having controls since the start of operations, it was found that an appreciable number of workers exceeded the 60 mppcf-years, but did not show any evidence of pneumoconiosis as determined by the criteria of Murphy and associates. The authors⁵ concluded from the study of the plant having controls from the outset of operations that tremolite and anthophyllite were less fibrogenic than chrysotile or amosite at comparable dust exposures.

Deaths from Cardiac Disease. — Rather surprising was the observation that the observed proportional mortality from cardiac disease was lower than the expected mortality in all 5-year periods except the first, namely, 1940-1944 (Table 5). No valid conclusion could be drawn regarding this period since the authors could find records of only 3 deaths in the period 1940-1944. However, it seems reasonable to state on the basis of the remaining data that the overall observed proportional mortality from cardiac disease among talc workers was lower than the expected mortality. The decreased mortality from cardiac disease among talc workers cannot be attributed to a predisposition to lung cancer which generally results in the death of these workers at earlier ages before they might be expected to succumb to cardiac disease. As Table 2 demonstrates, the decreased proportional mortality from cardiac disease is present in both the 40

to 59 as well as the 60 to 79 year age group. If malignancy of the lung was a factor, one would have expected a difference in incidence between these two age groups. Deaths in the age group under 40 and 80 to 84 are too few to warrant any comments with regard to cardiac disease. The true explanation is open to conjecture. The rural environment in which the talc workers lived, as well as the possibility that they smoked less, may account for the lower mortality due to cardiac disease as compared to the national rate.

Correlation of Malignancy with Age and Years of Exposure. — The data shown in Table 7 indicate that the majority of the malignancies of the respiratory tract occurred in the workers exposed 15 to 24 years. During this period 10 of the total of 13 died from malignancy of the respiratory tract. In this group the elapsed time from onset of exposure to death was similar to the duration of exposure. The finding suggests that the carcinogenic effect of the commercial talc dust is manifested mainly after exposure of 15 to 24 years and that very prolonged exposure, 25 years plus, does not appear to carry with it a significantly increased risk for cancer production. One plausible explanation is that a more susceptible group will develop cancer between 15 and 24 years and that after 24 years there is a group which is relatively less susceptible to cancer production in spite of added years of exposure. However, confirmative findings in the study of a larger

group are needed to validate this explanation. With regard to malignancy of the gastrointestinal tract, the deaths were distributed over all periods of exposure. The small number of deaths does not lend itself to provide any conclusion regarding the risk of developing malignancy in the gastrointestinal tract and years of exposure. With regard to deaths from cardiac disease, Tables 5 and 7, there does not seem to be any difference regarding the years of exposure and the exposure pattern in the total group.

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