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Mortality Among Talc Miners and Millers in New York State

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SINCE 1940, the Division of Industrial Hygiene has carried out a number of studies on talc miners and millers in the northern part of New York state. The prime purpose of these studies was to ascertain the health hazards associated with the exposure to dust in talc mining and milling. In 1940, a chest x-ray survey of 221 talc miners and millers employed in several plants in this region disclosed pulmonary fibrosis in 32 workers, 18 of whom had had no other occupational dust exposure. This survey clearly indicated that exposure in these talc mines and mills was capable of producing a fibrogenic type of pneumoconiosis.[1] In 1954, a follow-up study of the 32 workers with pulmonary fibrosis disclosed that the pneumoconiosis was progressive and disabling but that the progression was slow and the disability occurred primarily in the older age group.[2] A report on the clinical, roentgenographic, and pathological findings in six patients who had an average exposure to talc dust of 26 years with a range of 20 to 33 years was reported in 1963.[3] The major clinical features were chronic productive cough, dyspnea, diminished breath sounds, limited chest expansion, diffuse rales, and clubbing. The chest roentgenogram disclosed pulmonary infiltration both basally and in the midlung fields. In some instances obscuration of the cardiac borders or costophrenic sinuses, or both, were present. The most frequent pathological change was a diffuse fibrosis containing macrophages with absorbed dust particles. A pattern of endarteritis with intimal hyperplasia was frequently noted. Distention of bronchi and bronchioles with formation of cystic spaces was common. Rather characteristic was the presence of elongated, terminally clubbed bodies indistinguishable from asbestos bodies as seen in asbestosis. The pleura showed dense fibrotic thickening. Cor pulmonale was the major complication in four of the six cases and was the mechanism of death in three. A comparative clinical, roentgenographic, and physiologic study of workers exposed to fibrous and granular talc dust was made in 1964.[4] The two groups were similar with regard to age, sex, degree of exposure, and smoking habits. There were no significant differences in the clinical and roentgenographic findings between the two groups. However, the number of abnormal values for each parameter of pulmonary function measured (VC, VC_1, MBC, RV, TLC, RV/TLC and DL_{CO}) was appreciably greater in those exposed to fibrous than to the granular variety of talc. In 1965, pulmonary function tests were performed on 43 workers engaged in the milling of the fibrous variety of talc.[5] The mean duration and weighted average of exposure was 19 years and 62.3 million particles per cubic foot, respectively. An appreciable number of the workers had abnormal pulmonary function measurements. This was particularly evident in the vital capacity, total lung capacity, and diffusing capacity. There were 16 who showed pulmonary infiltration on their chest roentgenograms as compared to 27 without such evidence. Those with positive radiologic findings had a proportionately greater number of respiratory symptoms and signs and abnormal pulmonary function values as compared to those with-

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out. In general, the correlation between the degree of pulmonary function impairment and the clinical and roentgenographic findings was poor.

The purpose of the present follow-up study was twofold: (1) to obtain an estimate of the incidence of disease among this select group of talc workers, and (2) to compare the observed mortality experience from specific diseases with the expected mortality among a similar basic population.

Materials and Methods

All talc miners and millers employed in 1940 who had 15 or more years of exposure to talc dust as well as those who achieved a minimum of 15 years of such exposure between 1940 and 1965 were included in this study. The group totalled 220 workers, and it is believed that the overall number of 220 constituted the total work force in the category 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 when available. The records of the physicians attending the workers privately were reviewed. Substantial medical information on the majority of the workers was available in the Division's files and was used as an additional source of data. Hospital records including autopsy reports and histological specimens were examined wherever available. Autopsy records were obtained in 35 of the 91 deaths.

Statistical Analysis.—The total number of deaths was distributed in the following categories: malignancies, cardiac, pneumoconiosis or complications or both, accidents or suicides, and all other causes. The proportions of mortality from cancer of the lung and pleura and of the gastrointestinal tract and peritoneum, out of the total mortality, were compared with the expected mortalities due to the above causes in the various age groups. The expected mortality represents the proportion of deaths among white men in the United States, due to the specific causes in the year 1957. This particular year was chosen as standard because it is the median year of death among the 91 deaths. Differences between observed and expected frequencies were tested for significance using the normal curve with large numbers and the Fisher's exact probability test for small frequencies.

Findings

Total Deaths.—There were 91 deaths in the group of 220 talc workers. The causes of death in the various categories are shown in Table 1. A breakdown of the deaths according to age group showed that two workers under 40 died, 38 workers who were between 40 and 59 years died, 47 between 60 and 79 years, and four died who were 80 years and over (Table 2). The average age at death of the 91 talc workers was 60.4 years with a range of 38 to 84 years.

Malignancies.—Of the 91 deaths, the observed and expected number of deaths due to cancers of the lung, pleura, gastrointestinal tract, and peritoneum are shown in Table 2. Of the ten malignancies of the lung and pleura, nine were carcinomas of the lung and one was a fibrosarcoma of the pleura. Of the seven malignancies of the gastrointestinal tract and peritoneum, two were cancers of the stomach, and one each of carcinoma of the colon, rectum, and pancreas. There was one primary hepatoma of the liver, and the remaining case was a peritoneal mesothelioma. The malignancies involving other sites included one case of retroperitoneal reticulum cell sarcoma and one of chronic lymphatic leukemia.

Cardiac Deaths.—Of the 25 cardiac deaths excluding cor pulmonale, 19 subjects had coronary artery disease, three had hypertensive heart disease, and three had rheumatic heart disease.

Pneumoconiosis or Complications or Both.—Of the 91 deaths, 28 were due to pneumoconiosis or complications or both. Nineteen of the 28 were due to cor pulmonale, five to advanced tuberculosis, and four

Table 1.—*Causes of Death in 91 Talc Workers During Period of 1940 to 1965*

Cause of Death	No.	%
Malignancies	19	20.9
Lung and pleura	13	14
Gastrointestinal and peritoneum	7	7.7
All other malignancies	2	2.2
Cardiac deaths (other than cor pulmonale)	25	27.5
Pneumoconiosis and complications	28	30.7
Accidents or suicides	8	8.8
All other causes	11	12.1
Total	91	100

Table 2.—*Deaths and Expected Mortality From Cancer of the Lung and Pleura and Gastrointestinal Tract and Peritoneum Related to Age in Talc Workers*

Age Group	Deaths From Malignant Causes: Total Deaths	Lung and Pleura	GI and Peritoneum	Proportional Mortality: Lung and Pleura: Observed	Theoretical	GI and Peritoneum: Observed	Theoretical
<40	2	0	0	0		0	
40-59	38	7	2	5.3	5.5†	5.3	5.5†
60-79	47	8	4	17	1.9	8.5	6.9‡
80+	4	0	1	0		25	4.3
Total	91	15	7	11	3.2‡	7.7	5.3‡

* Gastrointestinal tract.
† Difference between observed and theoretical values is not statistically significant.
‡ Difference between observed and theoretical values is statistically significant ($P < 0.01$).

to bronchopneumonia. The lapsed time from first talc exposure to death from pneumoconiosis or complications, or both, averaged 25.9 years, with a range from 15 to 39 years. In this group there were 11 talc millers, seven talc miners, and nine who had been both millers and miners. All 28 had their initial exposure before 1945 when more effective engineering controls, including wet drilling in the talc mines, were introduced.

All Other Causes.—Of the 11 deaths in this category, four were due to cerebrovascular accidents, two to lobar pneumonia, and the remaining five, to one of the following: bleeding duodenal ulcer, strangulated inguinal hernia, perforated diverticulum with peritonitis, acute glomerulonephritis, and mesenteric arterial occlusion.

Environmental Exposure.—Of the 91 death cases, data on environmental exposure were available in 80. The mean duration of exposure for this group was 24.7 years with a range of 15 to 47 years. The dust exposure consisted predominantly of talc admixed with other silicates such as serpentine and tremolite, carbonates, and a small amount of free silica. The comparative dust counts in the talc mines and mills prior to 1945 and between 1946 and 1965 are shown in Table 3.

Table 3.—*Comparative Dust Counts in Talc Mines and Mills, Northern New York**

Work Type	Before 1945: Low	Medium	High	Average	1946-1965: Low	Medium	High	Average
Mines								
Drilling	83	413	2800	918	0	3	10	5
Mucking	2	30	475	120	3	5	9	5
Scraping	No Dust Counts Made				5	8	13	9
Mills	(up to 1948)				(1949-1965)			
Crushing	22	69	690	180	3	13	260	42
Screening	43	61	136	69	8	37	68	37
Milling	32	75	271	92	5	20	70	25
Garnets and separators	50	70	728	278	5	27	60	27
Pulverizers	No Dust Counts Made				25	28	51	28
Bagging	26	179	520	151	5	23	69	27
R R car and truck load	No Dust Counts Made				18	63	169	73
Blow Room	115	1196	2480	1227	Discontinued			
Open chutes	21	83	440	125	Discontinued			

* Concentration in millions of particles per cubic foot of air.

Comment

Malignancies.—The data on carcinoma of the lung and pleura shows an overall mortality from carcinoma of the lung and pleura to be approximately four times that expected. However, the significant increase appears to occur in the age group of 60 to 79 years rather than in the 40 to 59 year age group. This is at variance to what we have observed among workers exposed to asbestos dust where the observed values in the 40 to 59 as well as 60 to 79 year age groups were significantly different from the expected values (Table 4). The asbestos group consisted of 152 asbestos insulators who had 15 or more years of exposure in 1945 or achieved 15 years between the period of 1945 to 1965. The overall mortality was 46 or 30.3%. The reason for the earlier occurrence of an increased incidence of lung or pleural cancers in the asbestos workers com-

Table 4.—Deaths and Expected Mortality From Cancer of the Lung and Pleura and Gastrointestinal Tract and Peritoneum Related to Age in Asbestos Workers

Age Group	Deaths From Malignant Causes: Total Deaths	Lung and Pleura	GI and Peritoneum	Proportional Mortality: Lung and Pleura, Observed	Lung and Pleura, Theoretical	GI and Peritoneum, Observed	GI and Peritoneum, Theoretical
<40	1	1	0			0	
40-59	21	5	4	23.8	7.4*	19	5.6†
60-79	23	6	3	26.1	8.6*	13	5.1
80+	1	0	0	0		0	
Total	46	12	7	26.1	8.1†	15.2	3.9*

* Difference between observed and theoretical values is statistically significant ($P < 0.01$)
† Statistical analysis not performed because of small number in group

pared to the talc workers may be partly due to the greater carcinogenicity of asbestos dust or to an increased level of exposure to asbestos dust or both, as compared to commercial talc which is a mixture of silicates and carbonates with a small amount of free silica. In the absence of adequate smoking data one cannot assess the role played by smoking in the causation of the pulmonary carcinomas in both series. In three of the ten talc workers where a smoking history was obtainable, two smoked at least one pack daily for over 28 years and one smoked ten cigars daily for 55 years.

With regard to carcinoma of the gastrointestinal tract and peritoneum among the talc workers, we did not find any significant difference between the observed and expected values in the overall and specific age groups studied. However, in the asbestos group (Table 4) a significant difference between the observed and expected values was found in the overall categories. Our findings in the asbestos workers are similar to what has been reported by Selikoff, Churg, and Hammond.[6] If a clear-cut etiological relationship is subsequently established between exposure to asbestos and carcinoma of the gastrointestinal tract, then one may attribute the differences in incidence between the asbestos and talc groups to the reasons given for carcinoma of the lung and pleura.

Deaths Due to Pneumoconiosis or Complications or Both.—Previous studies have reported that cor pulmonale is a major complication of talc pneumoconiosis and is a major cause of death among talc workers.[3] The findings in this study are consistent with the previous reports.

Peptic Ulcer.—Among the death group of 91 cases, there were ten subjects who had a duodenal ulcer, and in one of the ten the ulcer was the cause of death. In the 129 workers who are still alive, 19 had a diagnosis of duodenal ulcer. This is a total of 29, or 13.2%. According to the health statistics of the US Department of Health, Education, and Welfare, the prevalence of peptic ulcer found between 1957 to 1959 for males of all ages is 21.4 per thousand population, or 2.1%.[7] Despite the fact that the figures obtained through the National Health Survey represent point prevalence in contrast to the period prevalence figures of our study, it appears that the incidence of peptic ulcers among talc workers is higher than among the general population. A significant increase in incidence of peptic ulcer varying between 20% to 25% has been found in patients with chronic obstructive pulmonary disease.[8] Since the talc workers have primarily a restrictive rather than an obstructive lung disorder, one may speculate that both types may be associated with an increased incidence of peptic ulcer.

Correlation of Carcinoma of Lung With Age, Duration of Exposure or Pneumoconiosis or Both.—Relating carcinoma of the lung with duration of exposure, it might be relevant that all the individuals with carcinoma of the lung or pleura had their initial exposure prior to the institution of wet drilling. The average duration of exposure prior to the introduction of wet drilling was 14.6 years. Although this was a period of heavy exposure (Table 3) there is no evidence to indicate that there was a direct relationship between the duration of exposure prior to the onset of wet drilling and the occurrence of pulmonary carcinoma. The mean age of