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**Paper Presented at the Metal and Nonmetallic Mine Health
and Safety Symposium on Talc Dust Hazards Held in
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My former colleagues in the Division of Industrial Hygiene of New York State and I have had the opportunity to conduct numerous studies of talc workers in New York State, including, clinical, physiological, radiological and environmental observations⁽¹⁾. In addition, we have also studied the mortality experiences among workers in talc mining and milling. In most instances, we have had the invaluable opportunity to correlate the clinical with the environmental data. In general, we have found that sustained inhalation of significant amounts of commercial talc dust over an extended period of time, or where there was a significant elapsed time from initial exposure, can produce a symptomatic form of pneumoconiosis. The commercial talc to which the talc workers were exposed contained not only the mineral talc, but also other silicates such as serpentine, tremolite, anthophyllite and other ingredients, predominantly carbonates. Moreover, free silica was often present in the dust in variable amounts, usually not averaging more than 3 percent.

Specifically with regard to our mortality experiences among talc workers, we found in an earlier study of talc workers (miners and millers) who had 15 or more years of exposure to talc dust 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, those in the 60 to 79 year age group, rather than in the 40 to 59 year age group⁽²⁾. 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⁽³⁾. 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 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 than that of the general population. We 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 commercial talc dust which was admixed with appreciable amounts of tremolite and anthophyllite asbestos. Our observations favored the first factor. The earlier study⁽²⁾ also showed an increased incidence of deaths due to talc pneumoconiosis and/or its complications.

A follow-up study was made to bring our mortality data among the talc workers up to date and to provide additional information not reported in the earlier study. The pertinent data is indicated below.

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 follow-up 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. 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 files of the Division of Industrial Hygiene and was used as an additional source of

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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.

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 was 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.

In the group of 260 talc workers studied, there were 108 deaths. There were a total of 25 deaths from malignancies. Of these 25 deaths, 13 were due to lung and pleural malignancies; 9 were due to gastrointestinal and peritoneal malignancies and 3 were due to other malignancies. Thirty deaths resulted from cardiac disease, other than cor pulmonale, and 29 deaths were attributable to pneumoconiosis and its complications. Accidents and suicides accounted for 8 deaths and there were 16 deaths due to other causes (Table 1). The average age at death of the 108 talc workers was 60.3 years, with a range of 38 to 84 years. 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 were obtained (Table 6).

With regard to the deaths due to malignancies, 12 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 (Table 3). The overall proportional mortality of carcinoma of the lung and pleura was four times that expected. Consistent with our previous observation, a significant increase appeared to occur in the age group of 60 to 79 years rather than in the 40 to 59 year age group (Table 2). As I have already mentioned, this finding among talc workers was at variance with what we had observed among asbestos insulators where the observed values in both the 40 to 59 and 60 to 79 year age groups were significantly different from the expected values. 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 was related to each of the six 5-year periods, namely, from 1940 to 1969, it is important to note 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 1949 and dropped to approach the expected mortality in the years 1960 to 1964 and 1965 to 1969 (Table 4). The differences between the observed and expected mortality rates were significant in 1950-54 and insignificant in 1960-64 and

1965-69. The improved mortality experience between 1960 and 1969 and to date (1973) 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 exceed the present threshold limit value for asbestos dust by approximately four to five times (Table 6). This finding indicates that the present threshold limit value of 5 fibers/ml with a fiber length greater than 5 microns for fibrous talc, including tremolite and anthophyllite, is basically adequate.

With regard to cancer 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 (Table 2) and are consistent with findings reported by Kiviluoto and Maurman⁽⁴⁾ among anthophyllite workers. 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⁽²⁾. Our findings among asbestos insulators were similar to those reported by Selikoff, Hammond and Churg⁽⁵⁾.

Of the 29 deaths due to pneumoconiosis and its complications, 20 were due to cor pulmonale, 5 to advanced tuberculosis and 4 to bronchopneumonia. The lapsed time from the first commercial talc dust exposure to death in this group averaged 30.9 years with a range of 13 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. The percentage of deaths due to pneumoconiosis and its complications has decreased by more than 50 percent in the last 5-year period studied, namely, 1965-69, as compared to the preceding period (Table 3). 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. It is noteworthy, however, that in another study of a different plant processing a similar mixture of talc, tremolite and anthophyllite, but wherein controls were installed at the inception of operations in 1948, only 1 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 in this plant⁽⁶⁾. The fiber counts exceeded by two to six 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 associates⁽⁷⁾ found no asbestosis among workers exposed less than 60 mppcf-years to chrysotile and amosite in ship construction. In the study of the plant having controls since the start of operations⁽⁶⁾, 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 findings from the study of the plant having controls from the onset of operations suggest that tremolite and anthophyllite are less fibrogenic than chrysotile or amosite at comparable dust exposures.

Of the 30 cardiac deaths, excluding cor pulmonale, 22 had coronary artery disease, 5 had hypertensive heart disease and 3 had rheumatic heart 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). 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 demonstrated, the decreased proportional mortality from cardiac disease was present in both the 40 to 59 as well as the 60 to 79 year age groups (Table 2). If malignancy of the lung was a factor, one would have expected a difference in incidence between these two age groups. The true explanation for the lower incidence of cardiac disease 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.

I trust that the information I have submitted this morning will provide the Bureau of Mines with essential data relating to the occupational hazards of exposure to talc, fibrous talc and tremolite dusts in order to evaluate the adequacy of the existing threshold limit values for pure talc and talc mixed with tremolite and anthophyllite.

References

1. SOURCE: RESEARCH

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Intermittent

1. Kleinfeld, M., Massite, J., Shapiro, S. and ...
Talc Dust Inhalation on Lung Function. Arch Environ Health ...
431-37, 1961.

Table 1

2. Kleinfeld, M., Massite, J., Kocyman, C. and ...
Talc Miners **Causes of Death in 108 Talc Workers**
During Period of 1940 to 1969
653-67, 1967.

3. Kleinfeld, M., Massite, S. and Kocyman, C.: ...
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

6. Kleinfeld, M., Massite, J. and ...
Exposed to ...
...
7. ...
...

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	2.8	45.8

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	28	23	108

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

Table 3

Deaths and Expected Mortality from Cancer of the Lung and Pleura and of the

Gastrointestinal Tract and Peritoneum Among Talc Workers 1940-1969

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

P = probability

S = significant

NS = not significant

Table 3

**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	2	30.4	45.5
Total	30		

Table 6

Comparative Dust and Fiber Counts at the Various Talc Mining and Milling Operations

	Pre 1945 through 1969						1972		
	Dust Counts*						Dust Counts*		Fiber Counts*
	Pre 1945 Ave.** Med.**	1946-1965 Ave.** Med.**	1966-1969 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. > 5 µ in length

**Ave. - average; Med. - median

***Operation discontinued after 1948