

Mortality Experience in a Group of Asbestos Workers

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THE TERM "asbestos" is used to identify a group of fibrous silicates. Prolonged inhalation of significant amounts of asbestos dust over an extended period of time can produce in certain individuals a respiratory disorder known as asbestosis. It is characterized primarily by cough, dyspnea, basal crepitations, and reticulonodular shadowing of chest roentgenograms. Clubbing and cyanosis are usually seen in the more advanced stage of this disorder. Chronic bronchitis and emphysema are associated with this disease, the emphysema being more of a localized than a diffuse obstructive type. Cor pulmonale is the major complication and usual cause of death from this disease. This is particularly true in those with excessive dust exposure. There is an increased incidence of lung carcinoma and mesothelioma of pleura and peritoneum associated with sustained asbestos exposure. The most consistent pathological finding is a dense fibrosis containing macrophages with absorbed dust particles which in many areas obliterates the pulmonary architecture. A pattern of endarteritis with intimal hyperplasia consistent with pulmonary hypertension and bronchiolectasia are associated major findings. Rather striking is the presence of elongated, terminally clubbed bodies, both segmented and unsegmented, in the respiratory bronchioles or imbedded in the fibrous tissues or both. The pleura often shows dense fibrotic thickening, and not infrequently there are

calcified pleural plaques over the pleural surfaces. The clinical and pathological features are indicative of a pronounced dysfunction of the respiratory mechanism. This has been confirmed by studies of pulmonary function which have shown a disturbance in both ventilatory function and diffusion capacity. The main physiologic alteration is a reduced diffusion capacity.^{1,2}

The purpose of the present study was to obtain mortality data in a group of asbestos workers and to compare the observed mortality experience from specific diseases with the expected mortality among a similar basic population.

Material and Methods

The study group consisted of 152 asbestos workers who had 15 or more years of asbestos exposure by 1945 or had achieved 15 years of exposure to asbestos dust between 1945 and 1965.

Source of Data.—Personal data were obtained from union records, and the occupational history obtained for each man included operations performed and dates and places of employment. For those who had died, records of the health and welfare fund provided date and place of death. Copies of death certificates were examined in all instances when available. The records of the physicians attending the workers privately were reviewed. Hospital records and histological specimens were examined whenever available. Autopsy records were obtained in 17 of the 46 deaths.

Statistical Analysis.—Total number of deaths were distributed in the following categories: malignancies, cardiac, pneumoconiosis or complications or both, accidents, and all other causes. The observed mortality from cancer of the lung and pleura and of the gastrointestinal tract and peritoneum were compared with

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Table 1.—Causes of Death in 46 Asbestos Workers From 1945 to 1965

Cause of Death	Number	%
Malignancies	23	50
Lung and pleura	12	26.1
Gastrointestinal and peritoneum	7	15.2
All other malignancies	4	8.7
Cardiac deaths (other than cor pulmonale)	13	28.3
Asbestosis and complications	2	4.3
Accidents	2	4.3
All other causes	6	13.1
Total	46	100

the expected mortalities due to the above causes in the various age groups. The expected mortality represents the proportion of deaths among US white males due to the specific causes in the year 1948. This particular year was chosen as standard because it is the median year of death among the 46 deaths. The differences between the observed and the expected frequencies were detailed for significance, using the normal curve for large numbers and the Fisher's exact probability test for small frequencies.

Findings

Total Deaths.—There were 46 deaths in the group of 152 asbestos insulators. The causes of death in the various categories are shown in Table 1. A distribution of the deaths according to age group showed that there was 1 less than 40 years, 21 between 40 and 59 years, 23 between 60 and 79 years, and 1 over 80 years (Table 2). The average age of death of the 46 asbestos workers was 60.3 years with a range of 33 to 81. The average age for the overall group of 152 asbestos workers was 53.7 years with a range of 33 to 81.

Malignancies.—Of the 46 deaths, the observed and expected number of deaths due to cancer of the lung and pleura, gastrointestinal tract and peritoneum are shown in Table 2. Of the 12 malignancies of the lung and pleura, ten were carcinomas of the lung, and two were pleural tumors, one a mesothelioma and the other a fibrosarcoma. Of the seven malignancies of the gastrointestinal tract and peritoneum, two were cancers of the stomach; one, a lymphosarcoma of the small intestine; one, a cancer of the colon; and three were peritoneal tumors, two of which were mesotheliomas and one a mesenteric sarcoma. The malignancies involving other sites included one case of chronic lymphatic leukemia, and one retroperitoneal reticulum cell sarcoma and one metastatic carcinoma, primary site unknown.

Cardiac Deaths.—Of the 13 cardiac deaths excluding cor pulmonale, eight had coronary artery disease, three had hypertensive heart disease, one rheumatic heart disease and one syphilitic heart disease.

Asbestosis or Complications or Both.—Of the 46 deaths, two had asbestosis complicated by cor pulmonale.

All Other Causes.—Of the six in this category, there was one each of the following: cerebrovascular accident, pulmonary tuberculosis, acute peritonitis, chronic arthritis, gangrenous appendicitis with peritonitis, and Laennec cirrhosis.

Environmental Exposure.—The mean duration of exposure for the 152 asbestos workers was 26 years with a range of 15 to 56 years, while that for the 46 death cases was 31.8 years with a range of 15 to 47 years. Although fiberglass was introduced into the industry during the past ten years, it is fairly certain that all of these asbestos insula-

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

Age Group	Total Deaths	Deaths From Malignant Causes		Proportional Mortality			
		Lung & Pleura	GI ^a and Peritoneum	Lung & Pleura		GI and Peritoneum	
				Observed	Expected	Observed	Expected
40	1	1	0	1		0	
40-59	21	5	4	23.8	7.4†	19	5.6†
60-79	23	6	3	26.1	3.8†	13	5†
80+	1	0	0	0		0	
Total	46	12	7	26.1	3.1†	15.2	3.9†

^a GI indicates gastrointestinal tract.

† Difference between observed and expected values is statistically significant ($P = < 0.01$).

tors had a minimum of five years' exposure to asbestos dust. Even though fiberglass eventually became the primary component of the insulating material, some asbestos was nevertheless incorporated.

Comments

Malignancies.—The data on carcinoma of the lung and pleura show an overall mortality from carcinoma of the lung and pleura to be approximately nine times that expected. Selikoff et al.,³ who studied a similar group of asbestos insulators, found that the death rate from cancer of the lung and pleura was approximately seven times as high among the asbestos group as in the US white male population. As shown in Table 2, the increase is significant both in the 40- to 59- and 60- to 79-year age groups. This is at variance with what was observed among talc workers exposed to mixed silicate dusts where the significant increase in cancer of the lung and pleura occurred in the 60- to 79-year age group rather than in the 40- to 59-year age group.⁴ The talc group consisted of 220 talc millers or miners or both who had 15 or more years of exposure in 1940 or achieved 15 years between the period of 1940 and 1965. The overall mortality in the talc workers was 41.4%. The reason for an increased incidence of lung or pleural cancers in the younger age group among the asbestos workers as compared to the talc workers may be partly due to the greater carcinogenicity or longer duration of exposure to asbestos or both. The asbestos workers with lung or pleural cancers were exposed on the average for 28.2 years, while the talc workers had an average exposure of 23.3 years. In addition, it is possible that other components such as the metallic cations present in the asbestos dust may also account for the difference in incidence of lung or pleural cancers between the two groups. In view of the meager history available on smoking, one cannot assess the role played by this factor in the causation of pulmonary carcinomas among either the talc or asbestos workers. In four of the 12 asbestos workers where a smoking history was obtainable, one smoked two packs per day for 29 years; one, one pack a day for 24 years; one, half a pack a day for over 20 years; and one

smoked only two cigars per day for 18 years.

With regard to carcinoma of the gastrointestinal tract and peritoneum among the asbestos workers, a significant difference was found between the observed and expected frequencies in the overall and specific age groups studied. The present findings among the asbestos workers are similar to those reported by Selikoff et al.³ No significant differences were found between the observed and expected frequencies in the overall and specific age groups among the talc workers. If a clear-cut etiological relationship is subsequently established between exposure to asbestos dust and carcinoma of the gastrointestinal tract, then one may attribute the difference in incidence between the asbestos and talc groups to the reasons given for carcinoma of the lung and pleura.

Deaths Due to Asbestosis and Complications.—Previous studies have reported that cor pulmonale is a major complication of asbestosis and a major cause of death among asbestos workers.⁵ The findings in this study, however, are not consistent with the previous reports, and this may be explained by a lower concentration of asbestos dust exposure over a prolonged period of time. The mean duration of exposure of those who developed lung or pleural cancer was 28.2 years with a range of 15 to 40 years. This is consistent with the observation of Gilson⁶ who recently pointed out that a reduction in asbestos dust exposure is less likely to produce chronic lung disease, but the risk of neoplasia increases with sustained exposure to relatively lower concentrations.

In 26 of the deaths where roentgenographic data were available, 12 showed changes consistent with asbestosis. In only two of the 12, death was related to the asbestosis, cor pulmonale being the primary cause in both. Of the 12 that died of malignancy of the lung or pleura, five had asbestosis, and three did not, and no information was available on the remaining four.

Correlation of Carcinoma of Lung or Pleura With Age, Duration of Exposure, or Asbestosis.—The mean age of the group of 12 workers who developed carcinoma of the lung or pleura was 56.5 years with a range of 33 to 71 years. This is slightly below the mean age of 60.3 years with a range of 33 to 81 years for the overall group of 46 death

cases. The mean duration of exposure of those that had cancer of the lung and pleura was 28.2 years with a range of 15 to 40 years. The average years from onset of exposure to death in this group was 29.5 years with a range of 15 to 40 years. The mean duration of exposure for the overall group of 46 deaths was 31.8 years with a range of 15 to 47 years. The differences in mean age and mean duration of exposure for the 46 deaths cases and the group that developed cancer of the lung or pleura are not statistically significant. With regard to carcinoma of the lung and asbestosis, the data indicated that five of the 12 individuals with carcinoma of the lung had asbestosis, three did not, and in four no information was available. The small number of cases plus the absence of information in four cases precludes the making of any correlation.

Summary and Conclusions

Mortality data on 46 asbestos insulators in New York state who has 15 or more years of exposure to asbestos dust by 1945 or had achieved 15 years of exposure between 1945 and 1965 were reviewed. The average age at death was 60.3 years with a range of 33 to 81 years. There were 12 deaths due to malignancies of lung or pleura. The differences in the mean age and mean duration of exposure for the 46 deaths and the group that developed cancers of lung or pleura were not statistically significant.

Proportional mortality from carcinoma of the lung and pleura among asbestos workers studied was nine times that expected in US

white males. The observed mortality was significantly higher in the 40- to 59- as well as in the 60- to 79-year age groups. This was at variance with authors' previous findings among talc workers who had a similar duration of exposure covering a similar period but where the observed incidence increased significantly only in the 60- to 79-year age category. The occurrence of malignancy of lung and pleura in the younger age group of asbestos workers may be attributed to the greater carcinogenicity of asbestos or the longer duration of exposure to asbestos dust or both as compared to talc dust exposure. The mean duration of exposure of the asbestos workers with lung or pleural cancers was five years longer in duration than that found in the talc group with similar malignancies. In addition, other components in the asbestos dust exposure such as the presence of metallic cations may also be a factor to account for the difference in incidence between the two groups. Carcinoma of the gastrointestinal tract and peritoneum, of which there were seven cases, showed a significantly greater incidence in the observed as compared to the expected in US white males. Death due to cor pulmonale was observed in only two individuals. The low incidence of cor pulmonale as a cause of death as compared to the high incidence of pulmonary and gastrointestinal carcinoma may be ascribed to a lower level of asbestos dust exposure occurring over a longer period of time.

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