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MORTALITY AMONG TALC MINERS AND MILLERS IN NEW YORK STATE

MORRIS KLEINFELD, MD; JACQUELINE MESSITE, MD; OLIVE KOOYMAN, MD; AND MAHFOUZ H ZAKI, MD

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. Distension 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

From the Division of Industrial Hygiene, New York (Drs. Kleinfeld, Messite, and Kooyman), and the State University of New York, Downstate Medical Center, Brooklyn, NY (Dr Zaki)

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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 6.3 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 without. 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 work-

ers 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 55 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.

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

Work Type	Before 1945				1946-1965			
	Low	Medium	High	Average	Low	Medium	High	Average
Mines								
Drilling	83	413	2800	818	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	360	42
Screening	43	61	136	69	8	37	68	37
Milling	32	75	271	92	5	20	70	25
Garners and separators	58	70	728	278	5	27	60	27
Pulverizers	No Dust Counts Made				25	28	31	28
Bagging	26	129	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			

[a] 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 compared 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

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			Proportional Mortality					
	Total Deaths	Lung and Pleura	GI and Peritoneum	Lung and Pleura			GI and Peritoneum		
				Observed	Theoretical		Observed	Theoretical	
<40	1	1	0				0		
40-59	21	5	4	23.8	7.4	[b]	19	5.6	[b]
60-79	23	6	3	26.1	3.8	[b]	13	5.1	[b]
80+	1	0	0	0			0		
Total	46	12	7	26.1	3.1	[b]	15.2	3.9	[b]

[a] Difference between observed and theoretical values is statistically significant $P < 0.01$

[b] Statistical analysis not performed because of small number in group

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 tale workers where a smoking history was obtainable, two smoked at least one pack daily for over 20 years and one smoked ten cigars daily for 55 years.

With regard to carcinoma of the gastrointestinal tract and peritoneum among the tale 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 I) 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 tale 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 tale pneumoconiosis and is a major cause of death among tale 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 U. S. 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 tale 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 tale 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 the group of ten workers who developed carcinoma of the lung or pleura was 63.6 years with a range of 45 to 75 years. This is slightly above the mean age of 60.4 years with a range of 38 to 84 years for the overall group of 91 death cases. Since the life expectancy of white men born in the United States in 1920 is given as 54.4 years and since these workers were born in 1920 or earlier there does not seem to be a reduction in the life span from the exposure.[9] With regard to carcinoma of the lung and pneumoconiosis, our data indicated that eight of the ten persons with carcinoma of the lung had clearcut evidence of an associated pneumoconiosis. No confirmatory evidence was obtained in the remaining two, one of whom had a fibrosarcoma of the pleura and the other a bilateral massive pleural effusion.

Summary and Conclusions

Mortality data on 91 tale miners and millers in New York state who had 15 or more years of exposure to tale dust by 1940 or had achieved 15 years between 1940 and 1965 were reviewed. The average age at death was 60.4 years with a range of 38 to 84 years.

Proportional mortality from carcinoma of the lung and pleura among tale workers was four times that of the control population. However, the significant increase in incidence appeared in the 60 to 79 year age group rather than in the 40 to 59 year group. This was at variance with our findings in asbestos workers who had a similar duration of exposure covering a similar period where the increase in observed incidence was present in both age categories. The earlier occurrence in the asbestos workers was attributed to the greater carcinogenicity and possibly to exposure to asbestos dust of greater concentration as compared to commercial tale. Carcinoma of the gastrointestinal tract and peritoneum showed no significant difference in the tale and control populations. However, in the asbestos workers gastrointestinal and peritoneal malig-

nancies were elevated significantly. Death due to pneumoconiosis or its complications, or both, was recorded in 28 individuals, 19 of whom died from cor pulmonale. The cause of death in the remaining nine was tuberculosis (5) or bronchopneumonia (4). 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. Excluding cor pulmonale, there were 25 cardiac deaths, 19 of which were due to coronary artery disease, three to hypertensive heart disease, and three to rheumatic heart disease. 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.

Previous studies have indicated that cor pulmonale was a major cause of death among talc miners and millers. This was also found in the present study. However, what has not been previously brought out is the increase in observed incidence of carcinoma of the lung among these workers as demonstrated in this study.

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MORTALITY EXPERIENCE IN A GROUP OF ASBESTOS WORKERS

MORRIS KLEINFELD, MD; JACQUELINE MESSITE, MD; AND OLIVE KOOYMAN, MD

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 tissue 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]

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.

From the Division of Industrial Hygiene, New York (Drs. Kleinfeld, Messite and Kooyman).

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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 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.

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

Cause of Death	No.		%	
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	

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 mesentric 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 50 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 insulators 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.

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: Lung and Pleura	Deaths From Malignant Causes: GI* and Peritoneum	Proportional Mortality: Lung and Pleura: Observed	Proportional Mortality: Lung and Pleura: Expected	Proportional Mortality: GI and Peritoneum: Observed	Proportional Mortality: GI and Peritoneum: 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†

* GI indicates gastrointestinal tract

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

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.[2] 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.[1] 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 20 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 increase was found between the observed and expected frequencies in the overall specific age groups studied. The present findings among the asbestos workers are similar to those reported by Selikoff et al.[2] No significant differences was found between the observed and expected frequencies in the overall and specific age groups among the talc workers. If a cleat-cut etiological relationship is subsequently established between exposure to asbestos dust and can-

cinoma 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 Gilson[6] 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 cancer 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.

M. H. Zaki, MD, Department of Environmental Medicine, State University of New York Downstate Medical Center, New York, assisted in the statistical analysis of data.

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A NOTE ON "LET-GO" CURR

SAMUEL MOSKOWITZ, PH.D., P.E.

In an article entitled "Safety in the Use of Hand H
static Spray Coating Equipment," which was writte
author and published in the June, 1966 issue of this jou
statement was made that the so-called "let-go" level for a
pound adult is a current of 60 milliamperes of 60 cycle AC.
was also stated that "This will cause discoordination of heart ac-
tion in approximately the most sensitive 1/2 of 1% of adults sub-
jected to such current through the body."

Two readers of the article have objected to calling a flow of as much as 60 mA of 60 cycle AC a "let-go" current since that much *might be harmful*. This *objection* is well taken. Roberts (1), quoting Alexander (2), states that "With continued contact and flow of a 60 cycle alternating current, currents over 25 mA might be harmful, whereas currents of 70-90 mA could prove fatal." Dalziel (3) has pointed out that 30 milliamperes of 60 cycle AC is a "reasonable safe current" for a duration may induce a freezing hazard." He also has pointed out that "Currents of the let-go level if they flow for an appreciable time, are more than sufficient to produce deep burns, and both types (electric and thermal) may be produced simultaneously."

It is hoped that this note will be used in connection with the *article on electrostatic paint spraying*

References

1. Roberts, H. J.: Narcolepsy following injury by electric current, *Arch Environ Health* 13:125, 1966.

2. Alexander, L.: Electrical injuries to the central nervous system. *Med Clin North Amer* 22:663, 1958.

3. Dalziel, C. F.: Electric Shock, The Encyclopedia of Electronics, ed by Charles Susskind, pp. 205-208, Reinhold Publishing Co., New York, 1962.