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THE OCCURRENCE OF ASBESTOSIS AMONG INSULATION WORKERS IN THE UNITED STATES

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although some described experiences in asbestos mills,[12,13] asbestos-cement works,[14] or factories producing a variety of asbestos products.[15] Such studies had the advantage of having available for investigation sufficiently large numbers of individuals to allow for statistical evaluation of the observations made. There was the added advantage that in many of the factories there were a considerable number of individuals with extended periods of exposure, allowing for analysis of the effect of prolonged exposure.

An important area of industrial asbestos exposure has been asbestos insulation work. The first asbestos factory opened in Great Britain in 1871[16] with the expansion of the asbestos textile industry beginning 10 years later consequent upon the availability of high grade spinning asbestos from Canada.[17] Yet asbestos was used for heat insulation in 1866.[18] Asbestos cement was introduced as a boiler covering about 1870 and other asbestos insulation products were introduced in the next three decades. Commercial production of asbestos insulation materials was recorded at least in 1874.[19]

Just as in Great Britain, early studies concerning asbestosis in the United States did not mention asbestos insulation workers. Neither Pancoast[20] nor Hoffman[21] characterized the asbestos trade in which the workmen referred to by them were engaged. The first official claim for compensation associated with asbestos in the U. S. was in 1927 and, again, the nature of the work was not stated.[22]

Ellman[23] in 1934 mentioned a case of asbestosis in an insulation worker. Other cases were subsequently reported,[24-26] and in the annual report of the Chief Inspector of Factories for the year 1936,[27] "lagging," or insulation work, was recognized as hazardous. Similarly, Hervieux in France drew attention in 1962 to the dangers of such end product use as insulation work.[28] The only large scale survey of asbestos insulation workers was undertaken in the U. S. by Fleischer *et al.* in 1945. They found only three cases of asbestosis and concluded that "asbestos pipe covering of naval vessels is a relatively safe operation."[29] Unfortunately, 95 per cent of those examined by them had worked for less than 10 years at the trade and, as we shall see, evaluation of the risk of insulation workers limited to study of men with relatively short durations of exposure may be misleading.

Asbestos Insulation in the United States

Asbestos, as a mixture of fiber and sodium silicate, was first used as an insulation material in 1866 and as asbestos cement about 1870. Magnesia with asbestos as a binder soon followed and air-cell covering, made with corrugated asbestos paper, was introduced in 1898.[18] These materials are still in use, with others.

The first union of insulation workers in the United States was formed in New York City in 1884 under a charter issued by the Knights of Labor

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(predecessor of the American Federation of Labor), as "The Salamander Association of Boiler and Pipe Felters."[30] In 1910, the present union of insulation workers in this country was chartered by the A. F. of L., as the International Association of Heat and Frost Insulators and Asbestos Workers, with the amalgamation of the Salamanders' Association of New York and other independent locals through the country.[31] The members of this union are insulation workers, primarily employed in the building trades doing construction insulation work but also employed as insulation workers in shipyards and powerhouse construction and repair. Much of their work is in the open air but it sometimes is, as aboard ship, in rather tight quarters with poor ventilation. The men generally work at all parts of the trade; few are specialists at one part of it or limit themselves to one material. Conditions of work vary from job to job and from company to company. Among the 1,117 men we have examined (see below), fewer than nine per cent of those with 20 years of work experience or more had worked for one employer primarily — even after four years of work experience less than half had remained with their original employer. Review of work practices with insulation workers from various parts of the United States and with knowledgeable officials of the union and insulation employers indicates that techniques, materials and practices are rather the same through the country. Similarly, data published concerning the work practices in other countries[32] suggest that asbestos exposure in insulation work is approximately the same the world over.

The asbestos exposure to which insulation workers are subject is limited and intermittent. Some of the materials used contain no asbestos. Seventy-five years ago, the magnesia pipe coverings had shredded rope as a binder, with no asbestos. Later, much work was undertaken with hair-felt, wool-felt, cork, rock-wool. In the past three decades, fibrous glass products have come into increasing use and these have been supplemented recently with foamed and expanded plastics for certain applications. Of the asbestos-containing products which are widely used by these men, magnesia block insulation was and remains perhaps the most important. This usually contains approximately 15 per cent asbestos. While asbestos cement has a varying asbestos content depending upon its manufacture, it also generally has 15-20 per cent or less of asbestos. Asbestos paper products such as air-cell have a higher asbestos content but are used in much smaller quantities.

We have studied the insulation materials with which these men worked in the past, in several ways. First, review of old trade and technical publications from the early part of the century to about 1930[33] indicates that the major asbestos-containing materials have remained about the same, especially insofar as the amount and nature of the asbestos content is concerned. As expected from knowledge of sources of U. S. imports of as-

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bestos, chrysotile asbestos was largely used.[1] This has been confirmed by analyses of magnesia block obtained during repair work. In later specimens so obtained, crocidolite has also been found. Moreover, materials used for ship insulation, while containing the same amounts of asbestos as above, began in 1931 to have significant amounts of amosite in addition to chrysotile, because of the lighter weight of the material.[27] Marr[13] has recently brought shipyard insulation experience up to date, comparing it with the observations of Fleischer and colleagues,[7] and concludes that ". . . insulation materials and work methods have remained essentially the same" since 1945.

Measurement of dust exposures of insulation workers have been but infrequently reported and have been hampered by the varied nature of the work. As in other asbestos work, peak counts are met which are excessively high but generally counts for asbestos fibers have been within the five mppcf. M.P.C. of the A.C.G.I.H.[7,33] Such counts as have been available, made during work engaged in by the men studied by us, have shown a range similar to that of published counts.[34]

Present Investigation

We undertook to study the question whether asbestos exposure during insulation work in the U. S. was associated with the hazard of asbestosis and its complications. Our investigations have been concerned with the 1522 members of the insulation workers union in the New York (Local 12)-New Jersey (Local 32) metropolitan area. The New York Local of the Union is a direct lineal descendant of the Salamanders' Association, and is the oldest Union of insulation workers in the U. S. The 1522 men studied by us include all members of these Locals from 1942 to 1962. On December 31, 1942, there were 692 members and 830 men subsequently joined between 1942 and December 31, 1962. This includes every man who was a member of either of these locals at any time in this period, whether or not he remained in the trade as an insulation worker. It is believed that the experience of these men fairly represents a cross section of the experience of insulation workers during the history of this trade in the U. S. Records of the union indicate that these locals had 335 members in 1914 and that 1738 members were admitted to these locals from 1915 to 1963. In the United States as a whole, the Insulation Workers Union in 1914 had 1487 members and 28,338 were admitted from 1915 to 1963. The adequacy of our sample can be gauged by reference to these figures (see TABLE 1). However, our data does not include information concerning nonunion insulation workers, maintenance insulation workers, insulation work as part of other trades or undertaken by insulation workers in other unions. The number of men involved in insulation work in these areas is not known to us.

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TABLE 1
STUDY OF ASBESTOS INSULATION WORKERS IN THE UNITED STATES: ADEQUACY OF SAMPLE

Total U. S. Membership,	IAHFIAW, 1963 . . .	14,803
Total NY-NJ Membership,	IAHFIAW, 1963 . . .	1,258
Examined NY-NJ Membership,	IAHFIAW, 1963 . . .	1,117

Following insulation workers not studied:

1. Nonunion insulation workers.
2. Some maintenance insulation workers.
3. "Sprayed insulation" workers.
4. Insulation work as part of other trades.
5. Insulation workers in other unions.

From January 1, 1943 to December 31, 1962, 264 men died. At the start of this study on January 1, 1963, 1258 men were alive. We attempted to locate and examine every man alive on that date, whatever his employment status. For this purpose, invitation for examination was voluntary. The cooperation of the union and its membership was freely given. Union records were made available and were very valuable. The union is a stable one. Its members are well-paid, skilled craftsmen, with little turnover among these workmen. Accurate, detailed employment records, collected weekly, are maintained by the union and from these records it was possible to obtain the entire work history of each man. This data was used to supplement the work histories obtained from the men during their examinations (see below), and was utilized to provide employment data sufficient to establish onset of employment and duration of work experience for those men not examined. From the health and welfare records, information was available concerning every death among the members of these locals during the period covered by our study and, utilizing these records, death certificates were obtained, facilitating the location of hospital records, autopsy protocols, histological material, etc.

Of the 1258 men alive at the start of this study, 1086 were active working members of the union, 63 were retired (principally because of age), 34 were not working because of illness and 75 had withdrawn from the union and were no longer engaged as insulation workers, but were otherwise employed (TABLE 2).

One thousand one hundred and seventeen of the 1258 living members (89.9 per cent) presented themselves for examination. This included 984 of the 1086 of the working members, 50 of the 63 retired members, 28 of

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TABLE 2
ASBESTOS WORKERS UNION SURVEY 1963-1964

Years from onset	Deceased	Retired	Ill	Withdrawn	Working members	Total alive
50+	25	22	8	1	5	36
40-49	79	35	17	10	43	105
30-39	107	6	5	22	185	218
20-29	39	0	2	7	75	84
10-19	9	0	2	24	385	411
0-9	5	0	0	11	393	404
	264	63	34	75	1086	1258

1,522 members January 1, 1943-December 31, 1962

the 34 who were ill and 55 of the 75 members who had withdrawn from insulation work (TABLE 3). TABLE 4 contains an analysis of the 1258 men according to lapsed time from onset of their employment. It will be seen that the very large majority of men in each lapsed time category was examined. This inclusiveness of the survey was very gratifying for two reasons. First, it will be seen from an analysis of TABLE 2 that a high proportion of the older members, with long work experience and with longer periods of lapsed time from onset of employment are included among the "retired," "ill," or "withdrawn" classifications. To have omitted these men would have led to inaccurate, selected data. It would certainly have made

TABLE 3
ASBESTOS WORKERS UNION N.Y.-N.J. 1943-1962

Status January 1, 1963 (1,522 members)

1. Deceased 264
2. Alive 1,258

Status	No.	Examined	% Examined
Retired	63	50	79.3
Ill	34	28	82.4
Withdrawn	75	55	76.4
Working	1,086	984	90.6
	1,258	1,117	89.9

632 Members Dec. 31, 1942 890 admitted Jan. 1, 1943 to Dec. 31, 196
Status of men examined during survey 1963-1964.

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TABLE 4
EXAMINATION OF ASBESTOS INSULATION WORKERS

Onset of exposure Prior to examination (yrs.)	No.	Examined
50+	36	28
45-49	41	39
40-44	64	54
35-39	92	83
30-34	126	111
25-29	18	16
20-24	66	61
15-19	186	174 (91.6%)
10-14	225	205
5-9	184	154
0-4	220	192 (87.6%)
	1,258	1,117

Analysis by group, according to onset of work exposure.

difficult the establishment of the effect of a long lapsed period from onset of exposure or the effect of a long duration of exposure.

Second, in addition to data concerning onset of employment, information was obtained detailing the actual number of years worked during the period from onset of employment. While in many cases the two periods more or less coincided, in some cases the number of years worked was significantly less than the elapsed time from onset of exposure. The comparison of such data is of interest when attempting to separate the effect of actual work exposure from the effect of mere passage of time from the initial exposure with inhalation and retention of asbestos fibers.

Examination of each man included a detailed occupational history. Data were recorded concerning onset of employment, interruptions for whatever cause, number of employers, use of protective respirators, materials handled and employment in particularly suspect areas of insulation work such as shipyard work and powerhouse construction work. Health experience was noted, including previous illnesses and hospitalizations, as were current symptoms such as dyspnea, cough, sputum, hemoptysis, gastrointestinal complaints. Smoking habits were recorded in detail including age at onset, number of cigarettes smoked, and pipe and cigar smoking. If the individual was no longer working, the reason for this was ascertained. Physical examination was particularly directed to the chest, but included examination of the skin, nose and throat, finger clubbing and cyanosis. Chest expansion was measured, hemoglobin and urine were routinely ex-

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amined. Vital capacity was measured in all cases and in many, additional measurements such as M.E.F.R. TVC and MBC were also made. In many cases, sputum was examined for asbestos bodies and in almost half, blood was drawn for special serological studies. In selected cases, extended pulmonary function investigations were undertaken, including arterial gas studies, lung compliance, pulmonary airway resistance, measurement of ventilatory parameters and diffusion studies.

X-ray studies were perhaps the most important part of the examination. In each case, a standard posteroanterior film was taken but, in addition, another posteroanterior film utilizing a slightly more penetrating kilovoltage technique was also exposed. Our experience indicates that this maneuver is valuable in X-ray examinations in this disease. The standard technique is required since over-penetration may well result in the loss of fine reticular fibrosis and, indeed, in individuals with relatively brief work histories, it is sometimes advantageous to take a third posteroanterior film with a slightly under-penetrating technique if such minimal fibrosis is suspected. However, in the men with longer work experience, increased penetration may be required. First, these men do a good deal of manual labor and are often heavily muscled. Second, pleural fibrosis is common and parenchymal fibrosis usually coexists, both decreasing radiopenetrability. Third, such increased penetration is often required to demonstrate calcification, especially when it coexists with extensive pleural thickening or is located in such areas as the posterior diaphragmatic sulcus, behind the heart, in the mediastinal pleura, etc.

Oblique films in both anterior oblique positions were also routinely taken in each case. While this has obvious applicability in a disease with such lower lobe preponderance as asbestosis, we have found it particularly valuable in the demonstration of pleural calcification.

Results

Among the asbestos insulation workers examined by us, evidence of pulmonary asbestosis was present in almost half the men examined. In this evaluation, radiological change has been used as the sole criteria (TABLE 5). We understand, of course, that evaluation of the presence and extent of asbestosis limited only to X-ray findings tends to result in underestimation of the incidence of asbestosis, but few instances of disabling disease will be so overlooked. Analysis of our data indicates that radiologically evident pulmonary asbestosis varied directly with the duration of exposure. Insulation workers with relatively short periods of exposure have a significantly lower incidence of pulmonary asbestosis and this, when present, was generally of minimal extent.

Of 346 men whose exposure had begun less than ten years before examination, only 36 or 10.4 per cent showed any radiological abnormality

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TABLE 5
X-RAY CHANGES IN ASBESTOS INSULATION WORKERS

Onset of exposure (yrs.)	No.	% Normal	% Abnormal	Asbestosis (grade)		
				1	2	3
40+	121	5.8	94.2	35	51	28
30-39	194	12.9	87.1	102	49	18
20-29	77	27.2	72.8	35	17	4
10-19	379	55.9	44.1	158	9	0
0-9	346	89.6	10.4	36	0	0
	1,117	51.5	48.5	366	126	50

each of these cases, the reticular infiltration was minimal in extent and in none was there evidence of pleural calcification. In only four was pleural fibrosis seen. Of 379 men whose exposure had begun from 10 to 19 years before examination, more than half still had normal X-rays. Some abnormality was seen on X-ray in 167 of these cases but in only nine was the asbestosis greater than minimal. In 35 of these men there was some pleural fibrosis and in five, evidence of calcification.[33]

On the other hand, among the 392 men with more than 20 years elapsed from onset of exposure, the very large majority had X-ray evidence of pulmonary asbestosis. Among the 77 whose exposure began from 20 to 29 years prior to examination, 56 showed abnormal films. Among 194 whose examination took place from 30 to 39 years following onset of exposure, almost 9 of 10 showed abnormal films while, of those with more than 40 years from onset of exposure only one in 20 showed no abnormality. Moreover, the asbestosis in these cases tended to be considerably more extensive and severe and pleural calcification and fibrosis were commonly seen.[33]

Pulmonary asbestosis has been called a monosymptomatic disease, with dyspnea the essential complaint. Analysis of our data concerning this symptom among the men studied by us indicates that it was uncommonly seen in those men with less than 20 years from onset of exposure but was an important symptom after that. Thus, of 725 men with less than 20 years from onset of exposure, only one had significant dyspnea although 32 others complained of minimal dyspnea on exertion (TABLE 6). On the other hand, of the 392 men with more than 20 years from onset of exposure, 134 had dyspnea of some degree, 61 of them with disability of greater or lesser extent.

There was incomplete correlation between the roentgenographic findings (considered as parenchymal fibrosis) and dyspnea on exertion. Two cases were seen with no roentgenographic evidence of parenchymal fibrosis but

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TABLE 6
DYSPNEA AMONG ASBESTOS INSULATION WORKERS

Onset of exposure (yrs.)	No.	% Normal	% Dyspnea	Dyspnea (degree)		
				1	2	3
40+	121	52.1	47.9	26	17	16
30-39	194	70.6	29.4	35	14	8
20-29	77	76.6	23.4	12	3	3
10-19	379	92.6	7.4	27	1	0
0-9	346	98.6	1.4	5	0	0
	1,117			105	35	27

with complaints of significant dyspnea, but discrepancy of this extent was rare (TABLE 7).

On the other hand, of 99 cases with more than 20 years from onset of exposure, and with evidence of moderate or extensive parenchymal fibrosis, moderate or severe dyspnea was present in little more than one of four. Thus, significant disability may be present with relatively little to be seen on X-ray and, conversely, X-ray changes may be extensive with little functional difficulty. Similar incomplete correlation has been recorded between the results of pulmonary function studies and roentgenographic appearances.[9]

We have been able to obtain lung tissue for examination from 45 asbesto insulation workers, primarily from the 307 men who died from 1942 t 1964, although in a few cases operative specimens were available. In n

TABLE 7
CORRELATION OF DYSPNEA AND ROENTGENOLOGIC EVIDENCE OF PULMONARY FIBROSIS AMONG 392 ASBESTOS INSULATION WORKERS WITH AT LEAST 20 YEARS FROM ONSET OF EXPOSURE

Grade of parenchymal fibrosis	No.	Per cent Grade 2-3 dyspnea	Years from onset of exposure					
			35+			20-34		
			Grade of dyspnea			Grade of dyspn		
			0	1	2-3	0	1	2
0	53	2%	15	0	1	31	5	
1	240	11%	75	20	27	86	28	
2	77	21%	27	8	16	14	8	
3	22	27%	4	5	6	3	3	
	392		121	33	50	134	44	

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...se did we fail to find typical pulmonary asbestosis, with fibrosis and ...lestos bodies present. However, our material is inadequate to evaluate ...rly changes since in only one case was there a history of less than 15 ...ars from onset of exposure. In 15 cases, the pulmonary fibrosis was ...rade I, in 16, Grade II and in 14, Grade III. We have the impression that ...e asbestosis suffered by these asbestos insulation workers is less severe ...an that occurring in workers exposed in factories. We have had the op...portunity of examining lung tissue from 11 men working in a factory ...aking asbestos insulation material (one of the brands actually utilized ... the members of the Asbestos Workers Union). Although the data are ...mited and conclusions perhaps unwarranted, analysis of the findings sug...gests that the pulmonary fibrosis among these men was significantly greater

TABLE 8
PULMONARY FIBROSIS ON HISTOLOGICAL EXAMINATION

	No.	Fibrosis (grade)			
		0	1	2	3
1. Asbestos insulation building trades workers					
a. Less 15 years from onset	1	0	1	0	0
b. Over 15 years from onset	44	0	14	16	14
	45	0	15	16	14
2. Asbestos insulation factory workers					
a. Less 15 years from onset	5	0	0	2	3
b. Over 15 years from onset	6	0	0	2	4
	11	0	0	4	7

than among the Building Trades Union Insulation Workers. TABLE 8 summarizes these pathological studies.

Mortality experience in this group of men will be separately reported.[37] It may be remarked here, however, that the incidence of lung cancer and mesothelioma of the pleura and peritoneum was found to be considerably beyond that expected.[38,39] In addition, the incidence of carcinoma of the stomach and colon was also found to be elevated.

In the roentgenological survey, because of the known increased risk of lung cancer among workmen exposed to asbestos, particular attention was paid to this finding among the men examined. In 10 men, lung cancer was found, and in one, pleural mesothelioma. In each, histological verification was obtained. In six cases, thoracotomy was undertaken. Three men are currently alive following apparently successful removal of neoplasms. As

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with significant pulmonary asbestosis, positive findings insofar as lung cancer and pleural mesothelioma were concerned occurred among the 392 men in the 20 years from first exposure group (TABLE 9). The importance of including the men with longer work experience in a survey of workers exposed to asbestos is well-illustrated by these findings. Similarly, the importance of including all members of an original cohort is also demonstrated. TABLE 9 provides an analysis of the occurrence of lung cancer according to status of the individuals examined. Of the 1086 working members, 984 were examined and among these, seven were found to have lung cancer (0.7 per cent). There were 172 men no longer actively at work, being retired, ill or having withdrawn from the group to work at other trades. One hundred and thirty-three were examined and four were found to have lung cancer (three percent).

TABLE 9
LUNG CANCER FOUND DURING EXAMINATION OF 1,117 ASBESTOS INSULATION WORKERS

Years from onset of exposure	Number examined	Working members		Others	
		Number	Cancer	Number	Cancer
40+	121	45	1	76	2
30-39	194	168	3	26	2
20-29	77	72	3	5	0
10-19	379	362	0	17	0
0-9	346	337	0	9	0
	1,117	984	7	133	4*

*Includes one instance of pleural mesothelioma.

It will be seen from TABLE 9 that we found no cancer of the lung among those men examined whose work had begun less than 20 years before the date of examination.

We find it difficult to compare the results of this investigation with previously reported surveys of workers exposed to asbestos. In many instances, the conditions of the studies do not allow for such comparisons. In Merewether's study,[7] 363 men were analyzed but only 133 were X-rayed. All were at work, except one, on the day of examination. Only 21 or 5.8 per cent had 20 years or more of work experience. The 126 men studied by Lanza[8] were "selected at random" and were at work at the time of examination. Smith[9] has drawn attention to the dangers of drawing conclusions from men at work, pointing out that examination of 323 Joachimstal miners failed to reveal any lung cancer, yet 43 of 89 post-mortems

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among these men showed this neoplasm. The cases studied by Stone[41] were weighted in another direction, since they were individuals, "applying for compensation." Wegelius[42] studied 126 cases of 476 men at work and details of employment are not given in this report. It is likely that the group contained few men with prolonged experience since the industry being studied was in existence for "about 20 years."

In the study by Horai in Japan,[43] of the 329 men surveyed, only 10 had more than 20 years of work experience. As mentioned, in the study undertaken by Fleischer *et al.*,[27] only 51 of the 1074 men examined had more than 10 years of work experience and in this study, too, it was the men at work who were examined. Frost[25] *et al.* studied 31 of 34 asbestos insulation workers in Copenhagen with more than 20 years of asbestos exposure, but this survey was limited to currently active men who represented a residual of approximately one-third of an original cohort of "about 100." Even the study by Doll[42] is not comparable. The 105 consecutive autopsies reviewed by him were "coroners' necropsies." These are not necessarily consecutive cases since these necropsies are ordered by the coroner when, in his opinion, there may be a question of asbestosis being a contributory cause of death. There were 18 cases of lung cancer found in this group of men, 15 among 75 cases with asbestosis and three among 30 cases without asbestosis. However, this series excludes those individuals whose death did not, in the opinion of the coroner, include the possibility of asbestosis being a contributory cause. In the second part of this study, Doll traced all men who had worked in one particular factory for at least 20 years. Of 113 such men there were 39 deaths, 11 due to lung cancer, all with asbestosis, while 0.8 was expected. However, these men included only those who had worked in heavily exposed areas and may in this regard be considered as a select group.

With reference to comparison with findings in other surveys, primarily of asbestos textile workers, it appears evident that asbestosis is an important risk among insulation workers exposed to asbestos. This is particularly true of those men who have at least 20 years from onset of exposure. This risk includes lung cancer and mesothelioma associated with the pulmonary asbestosis. It might be added, parenthetically, that other neoplasms were also found during the survey. Scleral jaundice led to the provisional diagnosis of abdominal neoplasm in one case, later confirmed at laparotomy to be a carcinoma of the pancreas. Marked hypochromic anemia in another led to hospitalization during which an inoperable carcinoma of the stomach was found. Other carcinomas present in men appearing for examination included carcinoma of the tongue, carcinoma of the nasopharynx, carcinoma of the colon, and carcinoma of the bladder.

Scattered case reports have previously been recorded of neoplasms among insulation workers, including both lung cancer[41-45] and mesothelioma[46-52]

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of both the pleura and peritoneum. A lung cancer has also been reported in a workman in a factory making asbestos insulation.[37] However, these reports, while interesting and valuable, could not establish an association between the two conditions. It is possible that additional lung cancers and mesotheliomas have occurred and may even have been reported but such reports do not state the nature of the asbestos exposure and such instances may be included among cancers in "asbestos workers."

Our experience that the lapsed period from onset of exposure is generally prolonged before the appearance of lung cancers in asbestos insulation workers coincides with the general experience of long "latent periods" in such cases. Indeed, in the infrequent cases in which very short periods have elapsed from onset of exposure, it might well be that the lung cancer found is coincidental. Such long latent periods would correspond to similarly prolonged periods associated with lung cancer in chromate workers,[4] nickel[5] cancers, arsenical lung cancers[6] and the increased incidence of lung cancer among regular cigarette smokers.[7] In Doll's series,[2] a long latent period was noted in all cases.

Neoplasms have also been reported among individuals indirectly exposed to asbestos insulation work, as carpenters,[38] steam fitters,[39] and other building trade workers.[39]

Summary

An investigation involving 1522 asbestos insulation workers in the New York-New Jersey metropolitan area has been conducted. Among 392 individuals examined more than 20 years from onset of exposure, radiological evidence of asbestosis was found in 339. In half of these, the asbestosis was moderate or extensive. In individuals with less than 20 years of exposure, radiological evidence of asbestosis was less frequent and when present, much less likely to be extensive.

Neoplastic complications of asbestos exposure were studied among 307 consecutive deaths in this group of men. Lung cancer was found to be at least seven times as common as expected and cancer of the gastrointestinal tract three times as common as expected. There were 10 instances of mesothelioma of the pleura or peritoneum.

Of the 1258 men alive at the start of this survey, 1117 were examined. Eleven cancers of the lung or pleura were found during this survey of the living members, all among the 392 men with more than 20 years from onset of exposure. No cancers were found in those men, the onset of whose work experience was less than 20 years.

We may conclude that asbestosis and its complications are significant hazards among insulation workers in the United States at this time.

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