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LUNG CANCER AND MESOTHELIOMA DURING PROSPECTIVE SURVEILLANCE OF 1249 ASBESTOS INSULATION WORKERS, 1963–1974 *

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INTRODUCTION

In 1963, it was found that a large group of asbestos insulation workers in the New York metropolitan area had experienced unusual mortality during 1943–1962.[1] Six hundred and thirty-two men had been on the union's rolls on January 1, 1943. By December 31, 1962, 262 men had died, nine before reaching 20 years on the job. Of those who died after 20 years from first employment, lung cancer was found in marked excess; 6.02 such deaths had been expected, and 42 occurred. In addition, there were several deaths due to pleural or peritoneal mesothelioma and a modest increase in deaths due to gastrointestinal cancer, where 9.71 were expected and 29 were observed. There were 12 deaths due to pulmonary asbestosis (TABLE 1).

TABLE 1

EXPECTED AND OBSERVED DEATHS AMONG 632 ASBESTOS INSULATION WORKERS, NEW YORK-NEW JERSEY, 20 OR MORE YEARS AFTER ONSET OF WORK, JANUARY 1, 1943 TO DECEMBER 31, 1962

	Expected *	Observed
Total deaths, all causes	196.16	253
Total cancer, all sites	31.44	95
Lung cancer	6.02	42
Pleural mesothelioma	†	3
Peritoneal mesothelioma	†	1
Cancer of stomach, colon, rectum	9.71	29
All other cancers	15.71	20
Asbestosis	†	12
All other causes	164.72	146

* Nine men died before reaching 20 years from first employment. Expected deaths are based upon white male age-specific death rate data of the U.S. National Office of Vital Statistics from 1949 to 1962. Rates were extrapolated for 1943–1948 from rates for 1949–1955.

† Rates are not available, but these diseases are rare causes of death in the general population.

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PLAINTIFF'S EXHIBIT
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It had previously been established that lung cancer was a formidable hazard
asbestos factory workers[2] and that termination of employment did not abort
ie risk; apparently, once sufficient exposure had occurred with continued reten-
on of asbestos within the lung, risk remained. This factor was of considerable
oncern, because a significant number of men were known to have worked as
bestos insulation workers in the New York metropolitan area, and many were
ill in the trade. In addition to the 370 survivors of the original 1943 cohort,
90 men had joined the insulation union † during the period 1943–1962, and
79 of them were alive on January 1, 1963. Together, the two groups consti-
ted a total of 1249 men who were either working regularly as asbestos insula-
on workers in 1963 or who had been recorded as having worked regularly at
is trade for shorter or longer periods in previous years.

TABLE 2

EMBERS OF ASBESTOS WORKERS' UNION ON JULY 1, 1963, ADMITTED TO THE NION BEFORE DECEMBER 31, 1942. CLASSIFICATION BY AGE AND SMOKING HABITS ON OR ABOUT JANUARY 1, 1963

ge yr)	Total No.	Never Smoked Regularly	Pipe, Cigar Only	Ex-cigarette Smokers*	Current Cigarette Smokers*			
					1–9/ Day	10–19/ Day	20–39/ Day	40+/ Day
-39	2	1	—	1	—	—	—	—
-44	13	2	—	2	—	—	5	4
-49	32	2	1	5	—	—	12	12
-54	109	12	6	26	3	5	33	24
-59	60	6	5	16	—	3	20	10
-64	42	7	4	15	1	—	11	4
-69	49	6	8	17	—	4	9	5
-74	38	7	7	12	1	4	4	3
-79	21	3	7	6	—	1	3	1
-84	4	2	1	1	—	—	—	—
tal	370	48	39	101	5	17	97	63

* Includes cigarette smokers who also smoked pipes or cigars.

Before 1963, there had been no regular surveillance of these asbestos
rkers, because they were not aware of their special risk. It was considered
at potential benefit might be obtained if a program of regular medical sur-
illance could be initiated, with special focus on the principal risks that had
en identified, namely, bronchogenic carcinoma, pleural and peritoneal meso-
elioma, gastrointestinal cancer, and asbestosis. Of these risks, lung cancer
ok first place. In addition to the risk associated with asbestos exposure, a
ajority of the men had been regular cigarette smokers (TABLES 2 & 3). Such
story, even in the absence of asbestos exposure, carried a lung cancer risk of
own.[3] (It was later to be learned that the combination of the two factors,
estos exposure and cigarette smoking, resulted in many more lung cancers
an would be assumed from mere summation of the two effects, with asbestos
posure sharply increasing the lung cancer risk of cigarette smoking.[4, 5])

† International Association of Heat and Frost Insulators and Asbestos Workers, AFL-CIO, CLC, Locals 12 and 32.

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TABLE 3

MEMBERS OF ASBESTOS WORKERS' UNION ON JULY 1, 1963, ADMITTED TO THE UNION JANUARY 1, 1943 TO DECEMBER 31, 1962. CLASSIFICATION BY AGE AND SMOKING HABITS ON OR ABOUT JANUARY 1, 1963

Age (yr)	Total No.	Never Smoked Regularly	Pipe, Cigar Only	Ex-cigarette Smokers*	Current Cigarette Smokers				Smoking Habits Not Known
					1–9/Day	10–19/Day	20–39/Day	40+/Day	
15–19	25	9	0	0	0	4	8	3	1
20–24	118	19	1	7	4	11	54	17	5
25–29	173	38	4	15	1	11	72	22	10
30–34	235	36	9	23	6	19	74	46	22
35–39	151	16	5	24	2	6	45	41	12
40–44	101	3	7	15	3	2	40	26	5
45–49	40	5	1	4	0	3	19	7	1
50–54	20	2	1	1	0	1	6	5	4
55–59	9	1	0	2	1	1	1	3	0
60–64	7	2	0	1	0	1	3	0	0
60–69	0	0	0	0	0	0	0	0	0
70–74	0	0	0	0	0	0	0	0	0
75–79	0	0	0	0	0	0	0	0	0
80–84	0	0	0	0	0	0	0	0	0
Total	879	131	28	92	17	59	322	170	60

TABLE 4

X-RAY CHANGES IN ASBESTOS INSULATION WORKERS*

Onset of Exposure (yr)	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
0–9	346	55.9	44.1	158	0	0
	1117	51.5	48.5	366	126	50

* From Reference 7.

PROSPECTIVE CLINICAL SURVEILLANCE

The program of clinical surveillance that was instituted was based on the realization that the chest x ray offered the best method for early detection of lung cancer then available.[6] An initial pilot survey had demonstrated that the cooperation of the workers involved could be expected.[7] Examination facilities, including x-ray equipment, were set up in the union halls to facilitate attendance of the men; it is not known whether equal cooperation would have as readily been achieved had it been necessary to site the survey in hospital-based facilities.

The nature of the disease under surveillance required several modifications in usual chest x-ray survey design. First, it was considered that the standard "yearly" chest film would be inappropriate for many of the group (as it was later to be shown to be inadequate for many other individuals as well[8]). In the preliminary survey, chest x-ray examination had shown that many of the men, especially those with more than 20 years from onset of exposure, already had considerable asbestosis (TABLE 4).[7] If cancer were found, it would be best to discover it at a stage at which limited resection, as lobectomy or even segmental resection, was possible. Diminished respiratory reserve might make pneumonectomy unavailable, even if the neoplasm was otherwise resectable. Therefore, serial chest x rays were advised at 6-month intervals for workers with more than 20 years from onset of exposure, yearly for those 15–19 years from onset, and every 1–2 years for those with shorter histories of duration from onset. Further, rather than the usual posteroanterior film alone being taken, four films were made at each examination, two in the posteroanterior projection (one with increased penetration) and one in each of the two oblique projections. With x-ray changes of asbestosis predominantly to be seen in the lower lung fields, and with a known predilection for asbestos lung cancer to be found in these areas, it was considered advisable to visualize the lower lung fields as well as possible.

Other studies were simultaneously undertaken. Physical examination, with particular reference to the chest, abdomen, and oropharynx,[9] was supplemented by careful occupational, clinical, and smoking histories; fingers were examined for clubbing, although it was recognized that this finding would have far less diagnostic utility in the presence of asbestosis than it would for lung cancer in general; urine, hematocrit, and serum for rheumatoid factor[10] were examined, and pulmonary function studies, including FVC and FEV_1 were performed.

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After evaluation of the findings, each man was informed of the results of the examination, and, when requested, a detailed review of the data was sent to the individual's personal physician. Confidentiality of examination results was carefully guarded, with none of the individual findings made known either to the employer or to the union, although statistical summaries of results were made available to both.

In some instances, in which it was difficult for the worker to attend for the examination (some retired and were living in California, Florida, or other distant states, and others were residing up to 150 miles from the unions' headquarters), the worker was encouraged to regularly visit his personal physician for similar examination and to send the films obtained for review. Also, a union health plan included opportunity for regular examination of the worker and his family in a program of general medical surveillance, and the advantages of participation in such surveillance were stressed.

When an abnormality was suspected or found, immediate review with the worker's personal physician was sought, and details were provided. Close cooperation during the ensuing special studies was offered, and, in many instances, the diagnostic and treatment facilities of the Mount Sinai Hospital were requested and utilized.

Lung Cancer and Mesothelioma, 1963–1974

From January 1, 1963 to December 31, 1974, 198 of the 370 survivors of the original 1942 cohort died. The distribution of causes of death was very much the same as that in the previous 20 years, but the percentages within each category and the ratios between observed and expected deaths were appreciably altered (Table 5). Three factors influenced this change. First, as the indi

Table 5

Expected and Observed Deaths among 370 New York-New Jersey Asbestos Insulation Workers, January 1, 1963 to December 31, 1974

	Expected *	Observed
Total deaths	109.04	198
Total cancer, all sites	20.58	105
Lung cancer	6.18	47
Pleural mesothelioma	†	7
Peritoneal mesothelioma	†	21
Cancer of stomach	1.17	7
Cancer of colon, rectum	2.75	7
All other cancers	10.48	16
Asbestosis	†	25
All other causes	88.46	68
Number of men	370	
Person-years of observation	3075	

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* Expected deaths are based upon age-specific white male death rate data of U.S. National Office of Vital Statistics from 1963 to 1973. Rates were extrapolated for 1973–1974 from rates for 1968–1972.

† U.S. death rates not available, but these diseases are rare causes of death in general population.

TABLE 6

DEATHS AMONG 879 ASBESTOS INSULATION WORKERS, FIRST REGISTERED IN THE INSULATION WORKERS' UNION JANUARY 1, 1943 TO DECEMBER 31, 1962, DURING JANUARY 1, 1963 TO DECEMBER 31, 1974

		Number of Deaths
Total deaths		54
Total cancer, all sites		18
Lung cancer	9	
Pleural mesothelioma	2	
Peritoneal mesothelioma	1	
Gastrointestinal cancer	3	
All other cancers	3	
Asbestosis		5
All other causes		31

viduals in the cohort aged, the distribution of death by cause would also be expected to change, even in the absence of an occupational disease influence. Second, many of the individuals were still at work in 1963 and continued their employment. The influence of total exposure on mortality would therefore be evident; this factor might be of particular importance among individuals with clinical asbestosis,[11] for whom additional dust exposure would be particularly disadvantageous. Third, and perhaps most important, the lapsed period from onset of effective exposure progressively lengthened, with increasing likelihood of clinical onset of malignant disease. Because the periods of clinical latency between onset of exposure and evidence of disease vary among the several neoplastic risks of occupational asbestos exposure, it would be expected that there would be differences in incidence of these neoplasms during the decade of observation. In the event, 47 deaths of lung cancer occurred, while 6.18 had been expected; there were seven instances of pleural mesothelioma and 21 of peritoneal mesothelioma, in addition to 25 deaths due to asbestosis. Also, more deaths due to cancer of the esophagus, stomach, colon, and rectum occurred than were anticipated.

We have not yet analyzed the mortality experience of the 879 workers who first joined the union between 1943 and 1962 and were still alive on January 1, 1963. These men were young, most with considerably less than 20 years from onset of exposure, and their risk of death during 1963–1974 was likely to be limited. Observation showed that 54 deaths occurred, and TABLE 6 provides categorization by cause. Observation of these men continues, and it is anticipated that analysis of their mortality experience by cause, contrasting expected and observed deaths, will be able to be usefully undertaken within the next several years.

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OCCURRENCE OF LUNG CANCER AND MESOTHELIOMA

Altogether, 59 instances of bronchogenic carcinoma occurred among the 1249 asbestos insulation workers under our observation in the New York metropolitan area from January 1, 1963 to December 31, 1974. Forty-nine cases occurred among the 370 individuals who had already been members of

TABLE 7

LUNG CANCER IN NEW YORK-NEW JERSEY ASBESTOS INSULATION WORKERS JANUARY 1, 1963 TO DECEMBER 31, 1974

	Admitted to Union	
	Before 1943	1943–1962
Number as of January 1, 1963	370	879
Lung cancers to January 31, 1974	49	10
Deaths due to lung cancer	48	9

the Insulation Workers' Union in 1942, and 10 cases occurred among th 879 younger men who first became members of the union at some time fron January 1, 1943 to December 31, 1962 (TABLE 7).

Review of the clinical status of these 59 men on January 1, 1975 showe that 57 were dead; two were alive. One, a member of the 1942 cohort, ha been found to have a bronchogenic carcinoma during the clinical survey unde taken in 1963. Lobectomy was performed, and observation since has yielde no evidence of recurrence. He still works actively at his trade. The second ma joined the union in 1946. In 1972, he suffered hemoptysis, underwent lobe tomy, and has remained well. Both men had been regular cigarette smoker no instance of lung cancer was seen among workers without history of regul smoking. Analysis is now underway to study the causes of this dismal recor It is already evident that the usual causes for failure in the management bronchogenic carcinoma were also present here; in addition, there were oth factors, such as peripheral location of the neoplasm and early pleural involv ment, important respiratory insufficiency, and occasional difficulty in radiolo diagnosis due to concomitant pleural and parenchymal asbestosis.

Twenty-eight instances of pleural and peritoneal mesothelioma occurred the 1942 cohort, and three cases of these diseases occurred in the men w joined the trade more recently. All are dead (TABLE 8). There was no effect therapy available.

TABLE 8

MESOTHELIOMA AMONG NEW YORK-NEW JERSEY ASBESTOS INSULATION WORK JANUARY 1, 1963 TO DECEMBER 31, 1974

	Admitted to Union	
	Before 1943	1943–
Number of men	370	87
Pleural mesothelioma	7	
Deaths	7	
Peritoneal mesothelioma	21	
Deaths	21	

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Summary and Conclusions

Fifty-nine cases of bronchogenic carcinoma were observed among 1249 bestos insulation workers followed prospectively from January 1, 1963 to ecember 31, 1974 in the New York metropolitan area. Despite the fact that ese men, and their medical attendants, were well aware of their risk of such sease, and despite the availability of a standard program of radiologic and inical surveillance, 57 of the 59 men died. It is clear that surveillance pro-ams as utilized were insufficient to appreciably improve the prognosis among ich individuals. At best, early diagnosis of late disease can be said to have been :hieved during the surveillance. Far more effective measures of preclinical agnosis are needed if anticipated disease in this group at high risk of cancer to be effectively treated.

The important influence of the lapsed period from onset of exposure was ident. Forty-nine lung cancers occurred among the 370 workers who were in e union in 1942, and 10 lung cancers occurred among the 879 men who first ined the Insulation Workers' Union in the New York metropolitan area during)43–1962.

Nine cases of pleural mesothelioma and 22 of peritoneal mesothelioma ere seen. Effective treatment was absent, and all 31 were dead at the end of ie study period. Prospective surveillance with the likelihood of earlier diag-)sis failed to appreciably improve prognosis in this disease.

Acknowledgments

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