Relation of cigarette smoking to risk of death of asbestos-associated disease among insulation workers in the United States

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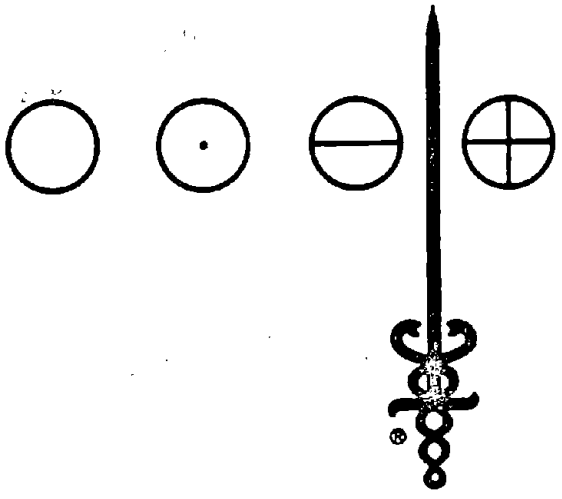

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Clinical studies are reported indicating that cigarette smoking greatly increases the risk of death by lung cancer among asbestos insulation workers. It has not been established that employment in asbestos insulation industries increases the risk of lung cancer among nonsmokers. Cigarette smoking also may increase the risk of death from asbestosis, although to a much lesser extent than from lung cancer. The risk of death among nonsmoking asbestos insulation workers is greater for asbestosis than for lung cancer. This indicates that even if asbestos workers stop cigarette smoking, it will still be necessary to reduce dust exposure levels below those concentrations associated with the occurrence of asbestosis. No definitive conclusions are reached in regard to the incidence of pleural mesothelioma and peritoneal mesothelioma associated with cigarette smoking. Studies do indicate, however, that radiologically evident pulmonary fibrosis is augmented in asbestos workers by cigarette smoking. There seems to be a definite, although limited, association between employment in asbestos insulation work and increased risk of death from cancer of the stomach, colon-rectum, and esophagus. Statistical data are tabulated in regard to exposure versus age, age versus smoking habbits, and mortality rates.

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Relation of cigarette smoking to risk of death of asbestos-associated disease among insulation workers in the United States*

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Data have been reported indicating that cigarette smoking greatly increases the risk of death of lung cancer among asbestos insulation workers (Selikoff, Hammond and Churg, 1968). It was calculated that asbestos insulation workers with a history of regular cigarette smoking had eight times the risk of lung cancer deaths compared with cigarette smokers who did not do such work, and approximately ninety times the risk of men who neither worked with asbestos nor smoked cigarettes.

We have obtained further evidence on this matter, bearing on aspects of asbestos associated disease for which data were previously scant or incomplete.

Lung cancer among cigarette smoking asbestos insulation workers.

Recent experiences have confirmed that lung cancer among insulation workers is largely confined to those men with a history of cigarette smoking. Data are derived from observation of two cohorts of insulation workers. Since they differ in age distribution and work experience, it is advantageous to consider them separately.

First, we have followed a group of 370 insulation workers from Jan. 1, 1963. These were survivors of 632 men who were members of the insulation workers union in the New York area on Jan. 1, 1943 (Selikoff,

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Churg and Hammond, 1964). Therefore, in 1963 these men were all at least 20 years from onset of employment (indeed, 333 had reached thirty or more years from onset) (Table 1). 283 of these men had a history of regular cigarette smoking; by April 30, 1967, 24 had died of lung cancer although, given their smoking habits, only 2.98 such death had been expected. No deaths of lung cancer occurred among the 87 men with no history of cigarette smoking. (Selikoff, Hammond and Churg, 1968).

The cohort has now been traced for an additional 56 months. Table 2 shows findings for the nine-year period January 1, 1963 - December 31, 1971. Of 283 men who smoked cigarettes regularly 41 died of lung cancer while of 87 men who never smoked cigarettes regularly only 1 died of lung cancer. This man was a cigar smoker. Expected number of deaths shown in Table 2 are based upon United States mortality data for white males disregarding smoking habits. We are presently unable to calculate smoking-specific expected rates for this group, since death rates related to smoking are not yet available for the period 1967-1971*

We have obtained data in a second far larger study of insulation workers. On January 1, 1967, we registered all members of the insulation workers union in the United States and Canada (including the New York - New Jersey locals mentioned above).** There were 17,800 men so enrolled on that day.

*We have reported smoking-specific death rates, 1959-1965, in a prospective study of 1,000,000 people (Hammond, 1966). This cohort is now being retraced, and rates, 1966-1971, will be available.

**International Association of Heat and Frost Insulators and Asbestos Workers, AFL-CIO.

(Table 3.) 11,656 completed a questionnaire providing, among other details, information concerning their smoking habits (Table 4). We have followed this cohort through December 31, 1971 (Selikoff and Hammond, 1972). Although the total group differed from the cohort described above in being, on the average, significantly younger and with shorter duration of exposure, its lung cancer experience has been very much in the same direction.

1,092 deaths occurred during the period January 1, 1967 - December 31, 1971 (See Table 5). Of these, 213 were due to lung cancer; whereas only 44.4 were expected, had the experience of these men been the same as other U.S. white males of the same age distribution. Among the 9,590 men with a history of regular cigarette smoking, there were 596 deaths, 134 of which were due to lung cancer. Again, we are at this time unable to calculate smoking-specific expected and observed rates because, as noted, death rates related to smoking habits of individuals are unavailable for this period of years.

Lung cancer deaths among insulation workers who do not smoke cigarettes.

At the time of our initial report, we had had limited opportunity of studying the incidence of lung cancer among insulation workers with no history of cigarette smoking. There were 87 such men in our 1963 New York-New Jersey group, and by 1967, only 16 deaths had occurred, none of lung cancer. Only 0.18 lung cancer deaths were expected, however, and with such scant experience we concluded that our information "...does not prove that exposure to asbestos dust has no influence on the risk of lung cancer among nonsmokers. However, it does suggest that exposure to asbestos dust does not lead to an extremely high risk of lung cancer among nonsmokers." (Selikoff, Hammond and Churg, 1968.) Obviously, it was important to obtain further information on the lung cancer risk among nonsmoking insulation workers. This is now available, from experience of the cohort described above.

Among the 2,066 non-cigarette smokers in the nation-wide study, 73 deaths occurred January 1, 1967 - December 31, 1971. Two were due to lung cancer. One of these two men was a cigar and pipe smoker and the other never smoked regularly. (Table 5)

It seems clear, then, that lung cancer is uncommon among asbestos insulation workers who have no history of cigarette smoking and that if the risk is increased, such increase is not great.

Pleural Mesothelioma.

In our previous report, we were unable to suggest whether or not pleural mesothelioma was related to cigarette smoking. Only three deaths occurred of this disease in our New York-New Jersey group from 1963 through April 1967. While all three of these men were cigarette smokers, the number was too small for reliable evaluation. Since then 2 more deaths of pleural mesothelioma have occurred, again among cigarette smokers. (Table 2)

In the larger cohort (see Table 5) there were 1,092 deaths of which 26 were due to pleural mesothelioma. Of these 26 men, 17 had a history of regular cigarette smoking, 1 was a pipe smoker, 1 never smoked regularly and 7 were unknown as to smoking habits. We still refrain from drawing definite conclusions because of small numbers.

Peritoneal Mesothelioma

As with pleural disease, no definitive statement could be made in 1968 concerning the relation of peritoneal mesothelioma to cigarette smoking. Of seven deaths of peritoneal mesothelioma, two occurred among men with no history of cigarette smoking.

In the large cohort (See Table 5) there were 51 deaths of peritoneal mesothelioma; 9 among the 2,066 never smoked cigarettes regularly, and 29 among the 9,590 cigarette smokers. 13 occurred among 6,144 insulation workers for whom smoking histories were not available (Table 5).

These experiences suggest that cigarette smoking does not increase the already high risk of peritoneal mesothelioma among asbestos insulation workers.

Asbestosis.

Studies indicate that radiologically evident pulmonary fibrosis is augmented in asbestos workers by cigarette smoking (Weiss, 1971, Selikoff, 1972).

Data now at hand suggest that the risk of death of asbestosis (respiratory insufficiency and cor pulmonale) may be increased by cigarette smoking. These data are reported with the realization that there must be a mixture of cigarette smoking effects in such cases, including increased asbestotic fibrosis, and the emphysema, bronchitis and smoking - associated fibrosis associated with cigarette smoking in general (Auerbach, Stout, Hammond and Garfinkel, 1963). These effects could be additive or less than additive, or multiplicative, in specific cases. Complex histological and physiological variations are possible.

In the nationwide study, of the 73 deaths among the 2,066 nonsmokers, 4 were due to asbestosis, as were 45 of the 596 deaths among the 9,590 smokers. (Table 5). We computed expected numbers of asbestosis deaths from age specific death rates for the total study population disregarding smoking habits. The ratio of observed to expected asbestosis deaths was almost three times as high for men with a history of cigarette smoking as for men without a history of cigarette smoking. This was of borderline statistical significance.

Gastro-intestinal cancer.

There seems to be a definite, albeit limited, association between employment in asbestos insulation work and increased risk of death of cancer of stomach, colon-rectum, and esophagus. Data in this regard were first reported in 1963. (Selikoff, Churg and Hammond, 1964.)

Experiences since 1963 continue in the same direction with increased death rates of approximately the same magnitude. In the large cohort (See Table 5) there were 16 observed vs 6.62 expected deaths from cancer of the stomach, 26 observed vs 17.51 expected deaths from cancer of the colon-rectum, and 13 observed vs 3.21 expected deaths from cancer of the esophagus. Because of small numbers of expected and observed deaths from cancer of these sites among the 2,066 men with no history of cigarette smoking, we will draw no conclusion concerning the possible interaction of cigarette smoking and asbestos exposure. However, these data are consistent with findings in other studies of high degree of relationship between smoking and the occurrence of cancer of the esophagus.

Comment

We conclude that employment in asbestos insulation work greatly increases the lung cancer risk of cigarette smokers. It is uncertain whether such employment increases the risk of lung cancer among nonsmokers. Cigarette smoking may also increase the risk of death from asbestosis, although to a much lesser extent. It is of interest that the risk of death among nonsmoking asbestos insulation workers is greater for asbestosis than for lung cancer. This indicates that even if asbestos workers were to stop cigarette smoking, it would still be necessary to reduce dust exposure below those concentrations associated with the occurrence of asbestosis.

Table 1

Members of New York-New Jersey Locals of Insulation Workers Union Classified by Age as of Jan. 1, 1963, and by Years From First Occupational Exposure to Asbestos Dust up to Jan. 1, 1963

Age, Yr.	Total No. of Members	No. of Years Since First Exposure to Asbestos						
		20-24	25-29	30-34	35-39	40-44	45-49	50+
35-39	2	2	....	...	...	...	...	...
40-44	13	12	1	...	...	...	...	...
45-49	32	17	2	13	...	...	...	...
50-54	109	...	1	80	28	...	...	...
55-59	60	...	1	16	34	8	1	...
60-64	42	...	1	3	11	19	8	...
65-69	49	...	...	1	10	18	18	2
70-74	38	...	...	...	3	12	6	17
75-79	21	...	...	...	...	1	5	15
80-84	4	...	...	...	...	1	1	2
Total	370	31	6	113	86	59	39	36

Members Classified by Age and by Smoking Habits on or about Jan. 1, 1963

Age, Yr.	Total No.	Never Smoked Regularly	Pipe, Cigar, Only	Ex-Cigarette Smokers*	Current Cigarette Smokers*			
					1-9 A Day	10-19 A Day	20-39 A Day	40+ A Day
35-39	2	1	...	1	...	...	...	...
40-44	13	2	...	2	...	...	5	4
45-49	32	2	1	5	...	...	12	12
50-54	109	12	6	26	3	5	33	24
55-59	60	6	5	16	...	3	20	10
60-64	42	7	4	15	1	...	11	4
65-69	49	6	8	17	...	4	9	5
70-74	38	7	7	12	1	4	4	3
75-79	21	3	7	6	...	1	3	1
80-84	4	2	1	1	...	...	...	...
Total	370	48	39	101	5	17	97	63

* Includes cigarette smokers who also smoked pipes or cigars.

Table 2.

Expected** and Observed Deaths among 370 New York New Jersey Asbestos Insulation Workers, Jan. 1, 1963- Dec. 31, 1971

	Total	No history of cigarette smoking*	History of cigarette smoking
Number of men Jan. 1, 1963	370	87	283
Person years of observation	2,520	608	1,912

	Expected deaths	Observed deaths	Expected deaths	Observed deaths	Expected deaths	Observed deaths
Cancer all sites	15.74	94	4.75	15	10.99	79
Lung cancer	4.57	42	1.26	1	3.31	41
Pleural mesothelioma	***	5	***	-	***	5
Peritoneal mesothelioma	***	20	***	7	***	13
Cancer of stomach	0.94	6	0.30	2	0.64	4
Cancer of colon, rectum	2.15	6	0.69	2	1.46	4
Cancer of esophagus	0.37	-	0.11	-	0.26	-
Asbestosis	***	21	***	5	***	16
All other causes	69.22	53	22.28	15	46.94	38
Total deaths	84.96	168	27.03	35	57.93	133

* Included 39 men who smoked pipe or cigars.

** Expected deaths based upon age specific U.S. mortality for white males, disregarding smoking habits. Lung cancer estimates based upon U.S. rates for cancer of lung, pleura, bronchus and trachea, categories 162 and 163.

*** United States data not available, but these are rare causes of death in the general population.

Table 3.

Membership of Asbestos Insulation Workers' Union,* Jan 1, 1967
Classified by Age and by Years from First Exposure to Asbestos Dust

Age-Yr.	Total No. of Members	Number of years since first exposure to asbestos							
		0-9	10-14	15-19	20-24	25-29	30-34	35-39	40-49	50+
15-19	244	244								
20-24	1,695	1,695								
25-29	2,412	2,066	345	1						
30-34	2,762	1,065	1,356	341						
35-39	2,987	313	1,140	1,342	192					
40-44	2,260	79	424	1,026	591	139	1			
45-49	1,589	49	131	433	442	487	47			
50-54	1,297	27	88	214	332	377	182	77		
55-59	983	12	49	129	206	176	146	193	72	
60-64	704	1	21	59	131	126	87	100	179	
65-69	417		6	18	40	57	46	28	200	22
70-74	255			6	14	22	21	16	105	71
75-79	111		1		4	8	4	7	37	50
80-84	52					2	1	2	16	31
85+	32							2	8	22
Total	17,800	5,551	3,561	3,569	1,952	1,394	535	425	617	196

* Membership in the United States and Canada of the International Association of Heat and Frost Insulators and Asbestos Workers, AFL-CIO.

Table 4.

Smoking Habits of 17,800 Asbestos Insulation Workers in the United States and Canada, on Jan. 1, 1967.

Age	Total	No History of Cigarette Smoking*	History of Cigarette Smoking	Smoking history not known
<25	1,939	281	782	876
25-29	2,412	285	1,182	945
30-34	2,762	314	1,435	1,013
35-39	2,987	309	1,640	1,038
40-44	2,260	223	1,395	642
45-49	1,589	172	964	453
50-54	1,297	134	821	342
55-64	1,687	201	965	521
65-74	672	122	314	236
75+	195	25	92	78
Total	17,800	2,066	9,590	6,144

*Included 609 men who smoked pipes or cigars.

Table 5.

Expected and Observed Deaths among 17,800
U.S. and Canada Asbestos Insulation Workers,
Jan. 1, 1967- Dec. 31, 1971*

	Total		No history of cigarette smoking**		History of cigarette smoking		Smoking habits not known	
Number of men Jan.1,1967	17,800		2,066		9,590		6,144	
Person-years of observation	86,300		10,163		46,615		29,522	
	Expected deaths	Observed deaths	Expected deaths	Observed deaths	Expected deaths	Observed deaths	Expected deaths	Observ deaths
Cancer all sites	144.09	459	19.92	33	79.58	265	44.49	161
Lung cancer	44.42	213	5.98	2	25.09	134	13.35	77
Pleural mesothelioma	***	26	***	2	***	17	***	7
Peritoneal mesothelioma	***	51	***	9	***	29	***	13
Cancer of stomach	6.62	16	0.95	1	3.60	8	2.07	7
Cancer of colon, rectum	17.51	26	2.52	4	9.53	14	5.46	8
Cancer of esophagus	3.21	13	0.44	0	1.80	7	0.97	6
Asbestosis	***	78	***	4	***	45	***	29
All other causes	661.54	555	92.67	36	356.67	286	212.20	233
Total deaths	805.63	1,092	112.59	73	436.25	596	256.79	423

*Expected deaths based upon age specific U.S. mortality rates for white males, disregarding smoking. Lung cancer estimates based upon U.S. rates for cancer of lung, pleura, bronchus and trachea, categories 162 and 163.

**Included 609 men who smoked pipes or cigars.

***United States data not available, but these are rare causes of death in the general population.

References

1. Auerbach, O., Stout, A.P., Hammond, E.C., and Garfinkel, L. (1963) Smoking habits and age in relation to pulmonary changes: rupture of alveolar septums, fibrosis, and thickening of walls of small arteries and arterioles. New Engl. J. Med.; 269, 1045-1054.

2. Hammond, E.C. (1966) Smoking in relation to the death rates of 1,000,000 men and women, in Epidemiological Study of Cancer and Other Chronic Diseases, Bethesda, Md., National Cancer Institute. monograph 19, pp. 127-204.

3. Selikoff, I.J. (1972) Asbestos exposure and cigarette smoking: Synergism in carcinogenesis. Proc. Skytop Conference on Respiratory Disease in Industry. In press.

4. Selikoff, I.J., Churg, J. and Hammond, E.C. (1964) Asbestos exposure and neoplasia. J. Amer. Med. Assoc., 188, 22-26.

5. Selikoff, I.J. and Hammond, E.C. (1972) Cancer risk of insulation workers in the United States. This conference

6. Selikoff, I.J., Hammond, E.C. and Churg, J. (1968) Asbestos exposure, smoking and neoplasia. J. Amer. Med. Assoc., 204, 106-112.

7. Weiss W. (1971) Cigarette smoking, asbestosis and pulmonary fibrosis. Amer. Rev. Resp. Dis. 104, 223-227.