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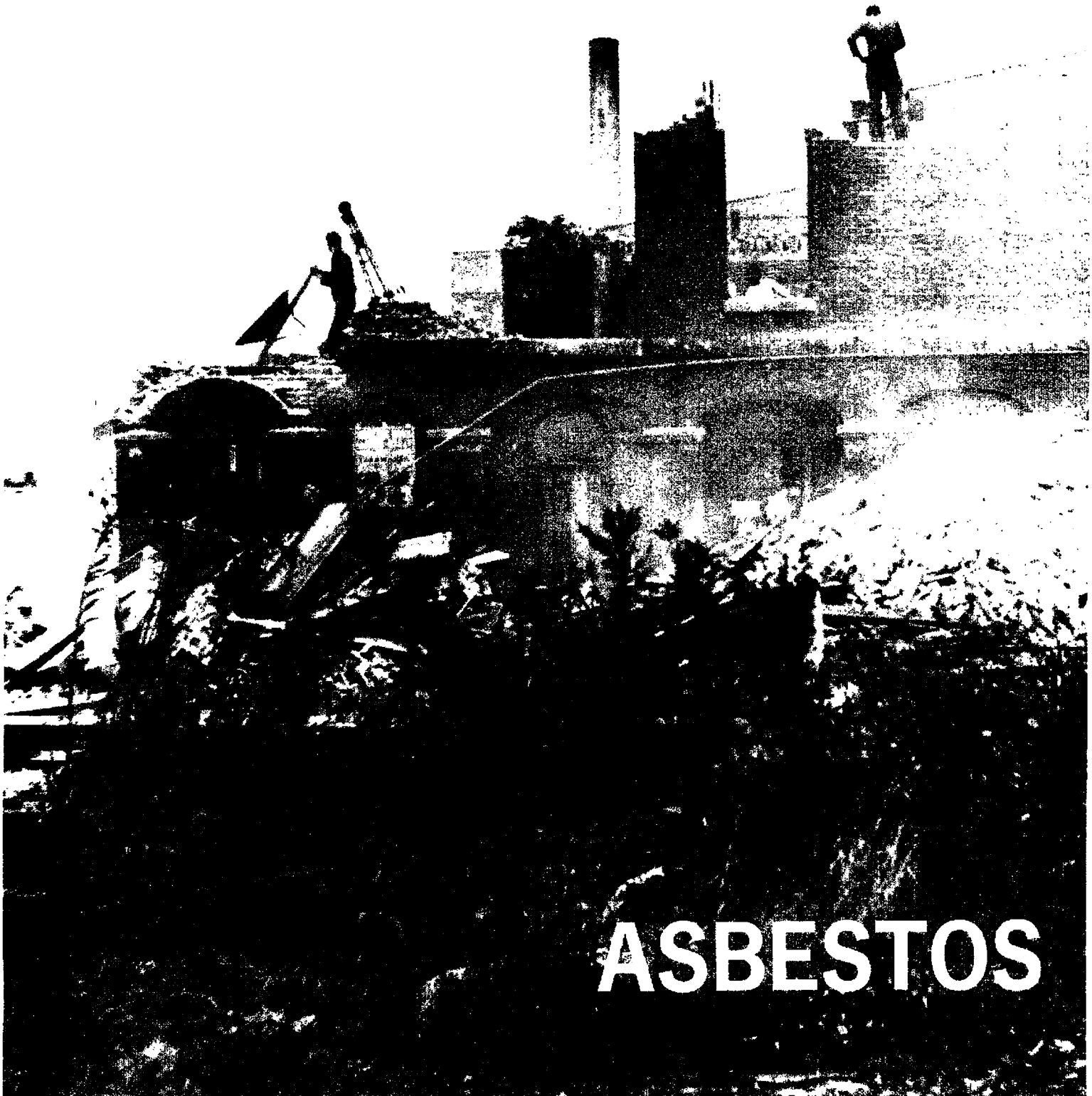


ASBESTOS

Presented at the Symposium on "Unanticipated Environmental Hazards Resulting from Technological Intrusions," convened by the American Association for the Advancement of Science Committee on Science in the Promotion of Human Welfare and the Scientists' Institute for Public Information, Dallas, Texas, December 28, 1968.

ASBESTOS

By I. J. Selikoff

I DO NOT KNOW if it is entirely appropriate to consider our current problems with asbestos an "*unanticipated* environmental hazard." As I look back, it would seem that we should have had some premonition.

For example, 70 years ago H. Montague Murray, then Senior Physician at the Charing Cross Hospital in London, examined a man of 33 suffering with pulmonary fibrosis. He had been working in the carding room of an asbestos textile factory. Of the ten men working in that room thirteen years before, he was the sole survivor. He, too, died a year later; at post mortem it was found that he had severely scarred lungs containing numerous asbestos fibers. Dr. Murray described this case to the Departmental Committee on Compensation for Industrial Disease which, after thanking Dr. Murray, noted that ". . . considerable trouble is now [in 1907] taken to prevent the inhalation of the dust, so that the disease is not so likely to occur as heretofore."

The disease which was referred to then had no name, nor did it when Auribault described numerous deaths among French workers in an asbestos textile factory in 1906, nor did it when Pancoast found abnormal X-rays of the chest in 1919 in a group of American asbestos workers. Surely, taxonomy has a particular virtue in science; individuals dying of this non-disease became much more evident when Cooke described another case in 1924 and 1927 and gave the illness its current name—asbestosis. We can now accurately record, for example, that ten percent of the deaths among asbestos insulation workers in New York in the past 25 years were due to asbestosis.

The new category was soon replete with cases. However, comfort was provided, this time in the Home Office Report put before the English Parliament in 1930. While pulmonary disease among asbestos workers in the past was acknowledged, it was simultaneously concluded that the outlook was good. "In the space of a decade, or thereabouts, the effect of energetic application of preventive measures should be apparent in a great reduction in the incidence of fibrosis."

Such optimism persisted for the next 30 years; asbestosis was acknowledged as a rather rare disease, occasionally occurring among a small group of workmen employed in an isolated, esoteric industry.

There were a few rumblings during this time whose echoes should perhaps embarrass us now. Thus, Kenneth Lynch reported a death from lung cancer in association with asbestosis in 1935, and several similar reports of this association between two then uncommon diseases followed. For the most part, however, these reports were categorized as bibliographical curiosities. Even the careful studies of Richard Doll reported in 1955 failed to disturb our calm, perhaps because of the reticence with which the statistician summarized his findings. Listing eighteen deaths due to lung cancer in 105 consecutive post mortem examinations at one asbestos works in England, he concluded that ". . . lung cancer was a specific industrial hazard of certain asbestos workers . . ." Even those who accepted Doll's conclusions—and there were some who did not—could point to a problem with a rather narrow spectrum. A single neoplasm (lung cancer) was (past tense) a specific industrial hazard (no hint that it could be more than this) of certain asbestos workers (the heavily exposed individuals in this factory).

In the past several years, the spectrum has widened considerably. First, it has been recognized that the hazard associated with direct occupational exposure to asbestos is by no means a narrow or infrequent one. The experiences of insulation workers in this country are instructive. These men, employed in the construction industry and often working out-of-doors and with materials containing only limited amounts of asbestos, are much less exposed than many factory workers had been. Yet their health experiences have been disastrous.

We have studied all members of the Insulation Workers Union in the New York metropolitan area. On December 31, 1942 there were 632 members of this Union. Calculations in studies by E. Cuyler Hammond, J. Churg and myself indicated that by December 31, 1962, according to life expectancy in the general population of U.S. white males, there should have been 203 deaths among these men. Instead, there were 255—an excess of twenty percent. Using age, year and sex-specific rates, there should have been six or seven deaths due to cancer of the lung or pleura. Instead, there were 45. There should have been nine or ten deaths due to cancer of the stomach or colon; there were 29. There should, of course, have been no deaths due to asbestosis; there were twelve.

Similar calculations to mid-1967 gave similar results. Whereas 47 deaths were expected, there were 94. Where eight or nine deaths due to cancer were predicted, there were 49. Again, there was a significant excess of specific types of cancer. While there should have been two or three deaths due to cancer of the lung or pleura, there were 27, and there were eight deaths due to gastrointestinal cancer against two expected. Once more, asbestosis claimed fifteen lives against none expected.

Studies are now under way in our laboratory of insulation workers in other parts of the country. Mortality data indicate that the New York findings are unfortunately true elsewhere, as well. It is not known exactly how many asbestos insulation workers are employed in the United States; estimates range from 50,000 to 100,000. In the face of the mortality information, one hopes the lower figure is more accurate.

Information is incomplete concerning the number of workmen in other trades in the United States with direct occupational asbestos exposure. Totals of 100,000 to 125,000 are often proposed. Again, the lower figure is hoped for, especially in view of the absence of satisfactory mortality information concerning such asbestos factory workers, and since Mancuso's findings are disquieting.

Analysis of these mortality experiences is disturbing from another point of view, in addition to its magnitude. I refer to the occurrence of pleural and peritoneal mesothelioma (tumors of the lining of the lung and abdominal cavities) among these workmen with direct occupational exposure. During the 1950's, there were several reports of deaths in asbestos workers caused by these diffuse tumors of the mesothelial surfaces. Such isolated cases would have received little notice had it not been for the fact that the tumor has always been considered extraordinarily rare. It is no longer rare among asbestos workers. Indeed, it is so common a cause of deaths among them now—while still rare among individuals not known to be exposed to asbestos—as to almost constitute a tumor specific to asbestos exposure. Several reviews of autopsy files suggest that this rapid increase, with hundreds of cases now known in Great Britain, South Africa, the United States and Canada, is not due to refinement in diagnosis. Thus, review of all possible cases in several major pathology departments in Scotland has demonstrated an increase from one or two cases a year in the 1950's to some twenty cases a year or more at the present time. Fourteen of the last 120 deaths in New York among asbestos insulation

TABLE 1

Observed and Expected Number of Deaths among 632 Asbestos Workers Exposed to Asbestos Dust Twenty Years or Longer, 1943-1962

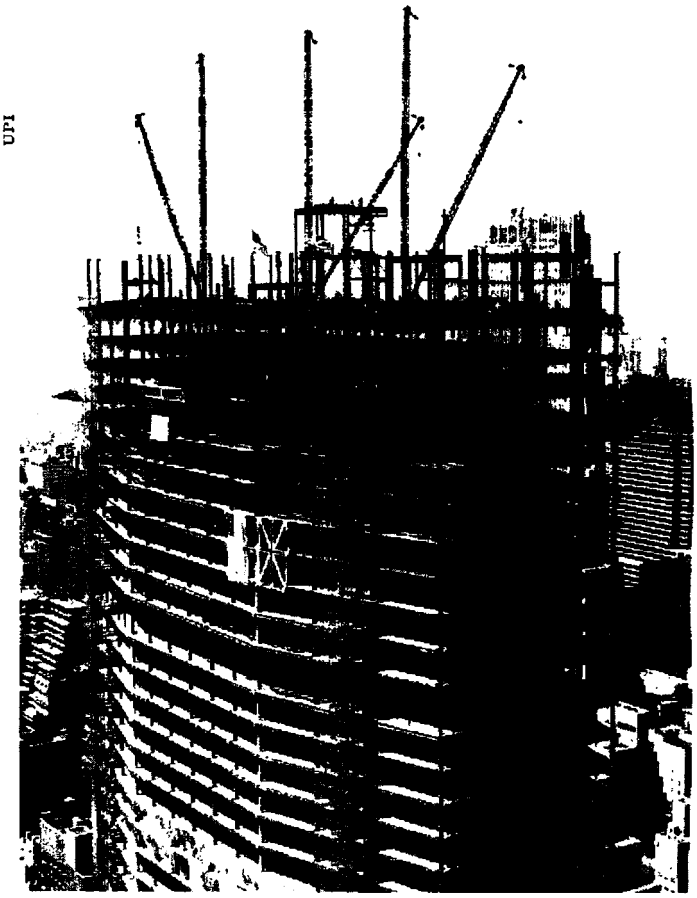
Cause of Death		1943-1947	1948-1952	1953-1957	1958-1962	Total 1943-1962
Total cancer, all sites	Observed	13	17	26	39	95
	Expected	5 7	8.1	13 0	9.7	36 5
Cancer of lung and pleura	Observed	6	8	13	18	45
	Expected	0.8	1.4	2.0	2.4	6.6
Cancer of stomach, colon, and rectum	Observed	4	4	7	14	29
	Expected	2 0	2.5	2 6	2.3	9 4
Cancer of all other sites combined	Observed	3	5	6	7	21
	Expected	2 9	4.2	8.4	5.0	20 5
Asbestosis	Observed	0	1	4	7	12
	Expected					less than 1
Total, all causes	Observed	28	54	85	88	255
	Expected	39.7	50.8	56 6	54.4	203 5

A pioneer in modern asbestos epidemiology, Dr. Irving J. Selikoff is Professor of Environmental Medicine at New York City University's Mount Sinai School of Medicine, Director of its Environmental Sciences Laboratory, and is also President of the New York Academy of Sciences. He was awarded the American Public Health Association's Albert Lasker Award in Medicine for his research on isoniazid, an antibiotic drug widely used in the treatment of tuberculosis.

workers have been due to mesothelioma. The problem has assumed sufficient importance to have warranted the establishment of Mesothelioma Reference Panels in a number of countries, by the International Union Against Cancer, and the recent establishment of a Mesothelioma Registry in this country by the National Institute of Environmental Health Sciences of the U.S. Public Health Service.

These experiences highlight one portion of the current spectrum of asbestos disease. It is now recognized that *direct occupational exposure* to asbestos results in a hazard much more significant than formerly appreciated. In the last several years, however, additional problems have been recognized which add another dimension: the possibility that the utilization of asbestos is associated with a much wider risk, perhaps one of the community at large. This is less well defined, much less well documented, but because of its potential importance, of considerable concern.

The recognition of this potentially wider spectrum of asbestos disease has been based upon three germinal observations. The first was the publication in 1960 by Wagner and his colleagues of 47 cases of mesothelioma in South Africa, all from the northwest Cape Province, an asbestos-rich area of the country. Analysis of the cases showed that few had worked directly with the mineral but that 45 of the 47 may have had contact with it, often indirect. They had lived in an area in which asbestos was mined, or had worked in an environment in which indirect, haphazard exposure was conceivable. In striking contrast, there were no cases of mesothelioma in the rest of South Africa reported in the same period, and none in 10,000 consecutive autopsies of individuals with silicosis. This report unequivocally raised the question of whether asbestos-associated mesothelioma was limited to direct occupational exposure, or whether much less intimate contact could produce the same result.



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Insulation workers employed in the construction industry have had disastrous health experiences even though their work is often outdoors and involves only limited contact with asbestos. Up until the past several years, it was thought that lung cancer from asbestos was an industrial hazard limited to the heavily exposed individuals in asbestos factories.

In the same year, 1960, Kiviluoto raised an analogous question. Pleural calcification had been known to occur frequently in characteristic form among asbestos workers. In our experience, indeed, the majority of older asbestos workers may be expected to show these changes when X-rayed. It was, therefore, striking to find typical "asbestotic" pleural calcification in 499 of 6,312 individuals X-rayed in one county in Finland while the neighboring county had none in 7,101. Kiviluoto astutely noted that the first county contained an asbestos mine and while none of the individuals with pleural calcification had worked in this mine, they had lived nearby. His countrymen, Laamanen and his colleagues, later demonstrated the presence of asbestos fibers in the air in the vicinity of the mine and while this may not reflect the true explanation for Kiviluoto's findings, the question of environmental contamination was strongly suggested.

The third observation was equally sobering. It had long been known that asbestos fibers, when

TABLE 2

Observed and Expected Number of Deaths among 370 Asbestos Workers from January 1, 1963 to April 30, 1967

Cause of Death	Observed Deaths	Expected Deaths*
Total cancer (all sites)	49	8 6
Cancer of lung, pleura, bronchus, and trachea	27	2 3
Bronchogenic carcinoma	24	**
Pleural mesothelioma	3	***
Peritoneal mesothelioma	7	***
Cancer of stomach	3	0 6
Cancer of colon and rectum	5	1 2
Cancer of all other sites combined	7	4 5
Asbestosis	15	
Heart and circulatory disease including stroke	22	28.5
All other causes of death	8	10 4
Total, all causes	**94**	**47.5**

*Based upon U S mortality data disregarding smoking habits
**United States data not available, but figure should be only slightly less than 2 3
***United States data not available, but these are rare causes of death in general population

inhaled into the human lung, may become coated with an iron-rich characteristic golden brown material, forming an "asbestos body." These are found, for example, in very large numbers in the lungs of asbestos workers. In 1963, Thomson reported that he found bodies with the same appearance in the lungs of people who were *not* asbestos workers. Smears of the lung bases allowed him to demonstrate these bodies in 26 percent of 500 consecutive autopsies in Capetown. His conclusion was that asbestos had indeed become a modern urban hazard, and he predicted that asbestos-induced mesothelioma might become as frequent as cigarette-associated lung cancer is at the present time.

Thomson's observations have been widely confirmed, and particles having the appearance of asbestos bodies have been reported in similar percentages in Montreal, Milan, London, Newcastle, Glasgow, Belfast, Dresden, Pittsburgh and Miami. In New York City, using a somewhat more sensitive technique, we find that approximately half of the lungs in 1,975 consecutive autopsies examined by us show these particles. When one considers that we examine only one square centimeter of lung tissue 0.0175 centimeter in thickness, it is obvious that these particles are now very common among city dwellers at this time.

Opportunity for non-occupational contact with asbestos at the present time can easily be discovered. There are, for example, some three thousand products which currently utilize this valuable material. To the present, lack of recognition of the potential of non-occupational exposure has led to the absence of appropriate safeguards during industrial use. Demolition of buildings, often rich in asbestos-containing materials, is suspect, while sheer carelessness and ignorance may explain its

TABLE 3

Asbestos Bodies in New York City Dwellers Without Occupational Exposure—1,975 Cases

Male				Female			
Age	Total cases	Total with asbestos bodies	Percent with asbestos bodies	Age	Total cases	Total with asbestos bodies	Percent with asbestos bodies
0-1	40	0	—	0-1	34	0	—
2-9	2	1	—	2-9	2	0	—
10-19	4	0	—	10-19	8	3	38%
20-29	22	4	18%	20-29	12	4	33%
30-39	50	14	28%	30-39	18	7	39%
40-49	178	83	47%	40-49	58	18	31%
50-59	280	149	53%	50-59	85	38	45%
60-69	359	205	57%	60-69	147	57	39%
70-79	321	180	56%	70-79	151	65	43%
80-89	105	62	59%	80-89	80	40	50%
90+	7	4	57%	90+	12	8	66%
Total	**1368**	**702**	**51%**	**Total**	**607**	**240**	**39%**

TABLE 4

Asbestos Bodies in Shipyard and Construction Workers: Quantitative Results

	Blue Collar (no Shipyard or Construction)	Shipyard and Construction	White Collar Males
Total Number of Workers	246	129	206
Workers Having Asbestos Bodies	121 (49%)	90 (70%)	87 (42%)
Workers Having No Asbestos Bodies	125	39	119
Workers Having Five or More Asbestos Bodies	20 (8%)	29 (23%)	10 (5%)

recommendation and use as playroom material in kindergartens or in toy cosmetics.

Indirect occupational exposure is suggested by recent observations in our laboratory. We find, for example, that while approximately 30 percent of housewives examined at post mortem had asbestos bodies demonstrated, comparable figures are 40 percent for white collar males and 50 percent for blue collar males. This rises to over 70 percent for men with any history whatsoever of having worked either in the construction industry or in shipyards. The latter, moreover, are much more likely to have numerous asbestos bodies than any of the other groups.

A special hazard may be present as the result of an interaction recently described. We have found that there is a special risk of cigarette smoking among asbestos workers. Since January 1, 1963 we have observed 87 experienced insulation workers who were not regular smokers or who were pipe or cigar smokers; we have yet to see a death from bronchogenic carcinoma among these men. On the other hand, of 283 equally experienced workmen who smoked cigarettes and who were watched for the same period of time, we have seen 24 such cancers, although only three were expected. We have calculated that the risk of dying of lung cancer is approximately 92 times greater for an asbestos worker who smokes cigarettes than a man of the same age who neither works with asbestos nor smokes cigarettes.

These observations naturally raise the question whether the inhalation of asbestos fibers among individuals in the general population might carry a special risk among the cigarette smokers in that population.

Wagner's observations have been extended by two recent studies. Muriel L. Newhouse investigated 76 consecutive cases of mesothelioma examined at the London Hospital, the majority within the last several years. She found, to no one's surprise, that

31 had been asbestos workers. Much more unexpected, however, was her discovery that nine had merely lived in the household of an asbestos worker, raising the serious question of a special hazard of family exposure. Then, of the 36 who neither worked with asbestos nor had relatives who worked with asbestos, eleven had lived within a half mile of an asbestos plant. The latter cases, of course, suggested a special risk associated with neighborhood contact with asbestos.

Similar findings were reported by Jan Lieben last year in Pennsylvania. Of 42 cases of mesothelioma reviewed by the Pennsylvania State Department of Health, twenty had identifiable occupational exposure. In addition, eight individuals had lived within the vicinity of an asbestos plant and three had had family contact.

We have confirmed that family contact is a distinct possibility. Sampling of both ambient air and settled dust in the homes of New York insulation workers has shown characteristic asbestos particles to be present, presumably brought home on the clothes of the workmen.

It is obvious that the spectrum of asbestos disease has considerably widened in the last several years. In addition to lung cancer and asbestosis, a number of other tumors are now recognized as constituting a hazard. Rather than a small number of heavily exposed workmen, a large number are involved in less intense direct occupational exposure or even in indirect occupational exposure. The latter may represent a real problem; there are, for example, 3,500,000 men employed in the construction and shipbuilding industries, or five percent of the total employed population in the United States. Significant exposure may even extend to the families of these men and perhaps to residents in the neighborhoods surrounding their places of employment. Finally, this ubiquitous material may well be found to permeate the community at large. What such exposures may bring is not now known. Disease associated with asbestos is rarely seen sooner than 20 to 30 years from the onset of exposure. Thus, among our insulation workers in New York, I have yet to see a mesothelioma in a man who began work after 1930 or a case of lung cancer in an asbestos worker who had worked in that industry less than twenty years. Our concern is with the future.

At the outset of this presentation, I questioned whether asbestos might properly be included as an *unanticipated* environmental hazard. Yet the less iconoclastic among us might have countered with: it must have been—we could not have knowingly allowed this to come to pass! Surely the explanation lies in the length of the period that elapses between exposure and disease which kept us from really knowing the problem until now.

Perhaps so. Indeed, I do not share the demonological theory of industrial hygiene history, in which industry is seen as callously exchanging human disease for profits. Rather, I would say industry shared the ignorance and lethargy of us all.

The answer will come in these next several years. We have some reason for optimism. First, we have the law of averages on our side—sooner or later, *some* important environmental hazard is bound to be controlled. I suspect asbestos will be one. We have reason to believe that the dose-disease relationship is on our side—to the present, disease has been uncommon except with significant exposure. And our data suggest further that such significant exposure can be prevented, that we can learn to live and work with asbestos. All it will take is the doing —but herein lies another tale. □

NOTES

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