REVIEW OF ASBESTOS-HEALTH LITERATURE

Over the past decade, the occupational and environmental health hazards of asbestos have received as much if not more attention from the worldwide medical profession than any other toxic substance known to man, with the possible exception of automobile emissions and the by-products of cigarette smoking. While the medical literature now contains more than 4,000 articles and learned papers on asbestos-related disease, only a small percentage of this vast accumulation can be considered of significance in our understanding of the problem. It is the purpose of this review to identify those papers that are of special importance, to briefly report on the findings contained therein, and to provide a cross-reference of the papers with regard to the general areas of the problem with which they deal. No attempt will be made to comment critically on the contents of the papers reviewed.

General Reviews

While numerous comprehensive reviews of the asbestos-health problem have appeared in the popular press (Brodeur, Sherrill, Porter, etc.), these have all been argumentative in tone and cannot in any way be considered scientific papers. Only three general reviews of the overall issue have been published in learned journals or by scientific organizations of high repute. These are Dr. George Wright's "Asbestos and Health in 1969,"[1] the National Academy of Sciences pamphlet "Asbestos: The Need For and Feasibility of Air Pollution Controls,"[2] and the rather abbreviated "Report of the Advisory Committee on Asbestos Cancers to the Director of the International Agency for Research on Cancer."[3] A fourth general review,

"Preliminary Air Pollution Survey of Asbestos,"[4] was prepared in 1969 by Litton Systems Incorporated for the old National Air Pollution Control Administration (predecessor to the EPA), but it is merely a non-critical literature review and cannot be placed in the same category as the above three papers and documents. It was, in essence, superseded by the NAS document, which was also prepared for the EPA.

The Wright, NAS and IARC documents all examine the various aspects of the problem, and in general agree that the occupational health hazards of asbestos are serious but controllable, and that the general public is not presently in danger from exposure to asbestos in the environment.

Early Studies and Asbestosis

As some critics of the industry are fond of pointing out, the first mention of asbestos-related disease in the literature occurred nearly 70 years ago.[5,5a] By 1930 asbestosis was a generally recognized occupational hazard of asbestos exposure,[6] but it was not until 1947 that the first major link between asbestos and lung cancer was established.[7] Mesothelioma, on the other hand, was identified as an asbestos induced occupational disease even later, the first important study on this disease appearing in 1960.[10]

Asbestos and Lung Cancer

In 1947, E.R.A. Merewether, Chief Inspector of Factories in the United Kingdom, reported 31 lung cancer deaths among 235 persons known to have died with asbestosis between 1924 and 1946.[7] This discovery of a high incidence of lung cancer among

asbestosis sufferers lead to the launching of one of the most important of all asbestos-health investigations. Commonly referred to as the Knox-Doll studies, this research centered on employees at a single asbestos textile factory in Great Britain. The first results were published by Doll in 1955,[8] with subsequent updates being issued in 1965, 1966 and 1968, the last being entitled "Mortality from Lung Cancer and Other Causes among Workers in an Asbestos Textile Factory."[9]

Since Knox-Doll, numerous other investigators have reported a lung cancer link with asbestos, the work of Dr. Irving J. Selikoff being the most widely quoted.

Mesothelioma

In 1960, Dr. J. C. Wagner et al published "Diffuse Pleural Mesothelioma and Asbestos Exposure in the North Western Cape Province," in which they reported finding 33 cases of this rare tumor in a part of South Africa important for crocidolite mining.[10] Of considerable significance was the fact that 16 of the cases had not worked at the mines, but had only lived in the vicinity or had had household exposure. Wagner's paper is considered to be the first major evidence linking mesothelioma with asbestos exposure, although a number of earlier obscure German papers had also noted the relationship.

Because many of the cases reported by Wagner had not been occupationally exposed, a number of investigators launched studies to determine if the general public was at hazard to mesothelioma from asbestos in the general environment. The most important of these were by Newhouse and Thompson[11] (the case of the woman who developed mesothelioma from washing her husband's clothes comes from this study), Stumphius and Meyer,[12] Borow et al,[13] Lieben and Pistawka,[14] and McDonald et al.[15] Both Newhouse and

Lieben found numerous non-occupational mesotheliomas; Stumphius found a number of cases among non-asbestos handling shipyard employees; Borow found two non-occupational cases out of 17 (now increased to two out of more than 50) in the Manville area; and McDonald, whose study involved the entire Canadian population, found no cases in the neighborhood of Canadian chrysotile mines nor in the household of people working in those mines, although he did find non-occupational cases associated with insulation work. McDonald also reported that only 14-16% of the cases had "definite" or "probable" asbestos exposure.

From the strictly occupational standpoint, the most important studies have been those of Newhouse on a British asbestos textile factory;[16] Selikoff on the insulation workers,[17] on an amosite insulation plant,[17] and on the J-M Manville plant (unpublished); Mancuso on American textile workers;[18] and McEwen on shipyard workers in Scotland (it is this study upon which Selikoff has based his predictions of an epidemic of mesotheliomas among U.S. World War II shipyard workers).[19]

GI Cancer

Selikoff was the first to report an increased rate of GI cancer among occupationally exposed employees.[17] Since then a number of other investigators, such as McDonald[20] and Newhouse,[16] have also reported increased rates, while still others, such as Knox-Doll,[9] have not. The NAS document considers the evidence inconclusive, while the IARC report considers that a "small excess risk" exists from this disease.

Asbestos (Ferruginous) Bodies

The general public health scare re asbestos arose out of two events: (1) the finding of non-occupationally exposed mesotheliomas in the vicinity of asbestos mines and

factories, and (2) the discovery of coated asbestos fibers (asbestos bodies) in the lungs of city dwellers.[21] Approximately five years ago, there was widespread controversy over "asbestos bodies." Some researchers claimed that we were all in peril because of this fact,[22] while other investigatiors sought to place the issue in its proper perspective by showing that not all asbestos bodies actually had a core of asbestos,[23] and should therefore more properly be called ferruginous bodies.[24] The controversy largely subsided when Selikoff,[25] Gross and others found uncoated free asbestos fibers in human lungs, yet could find no link to disease. Selikoff further found no increase in the number of asbestos bodies in human lungs in New York City between the 1930's and the 1960's, despite the growth in the use of asbestos.[26] In Great Britain, on the other hand, Um did find an increase over the years.[26a] Today, the presence of small amounts of asbestos in the lungs of most members of the general public is accepted as fact without attributing to it any particular importance.[2]

Asbestos Mining and Milling

While no epidemiological studies have been conducted of employees in the United States asbestos mining and milling industry, the Canadian, South African, Italian and Finish industries have all been examined, with varying degrees of detail. Certainly the most comprehensive mining study has been that of McDonald et al in the chrysotile producing region of Quebec.[20] Studying more than 10,000 past and present miners, McDonald established that the overall mortality rate of the cohort was less than that of the general Canadian population, that mesothelioma was not a significant cause of death among the miners, and that an excess of lung cancer was limited to those workers that have the highest cumulative exposure. In South Africa, Webster[27] and Sluis-Cremer[28]

looked at both the crocidolite and amosite mining industries, the most striking discovery being the relative absence of mesotheliomas among amosite and crocidolite miners in the Transvaal district as compared to the large number found in the crocidolite producing region of the South West Cape. Vigiliani has studied chrysotile miners in Italy[29] and Kiviluoto and Meurman have examined the Finish anthophyllite mining industry.[30]

Textile Manufacturing

In the asbestos manufacturing industry, the production of asbestos textiles has received more attention than all other segments of the industry combined. The reason for this is relatively simple -- textile production was in the past probably the dustiest of all asbestos manufacturing operations and hence the most likely to result in substantial cases of disease among the employees exposed. The most important studies have been those of Knox-Doll,[9] Newhouse,[16] Mancuso[18] and Enterline.[31] All reported greatly increased rates of asbestos-related disease among the cohorts studied. Selikoff's unpublished study of Manville workers and Enterline's study of J-M retired employees[32] both included textile workers in the cohorts, but no attempt has been made to separate their mortality rates from the rest of the employees studied. Of special interest in Enterline's study was the fact that maintenance workers showed a greater excess mortality from asbestos-related disease than did production line employees.

Asbestos-Cement Manufacturing

Dr. Hans Weill's ongoing study of asbestos-cement workers in two plants in New Orleans is the first large scale investigation of this most important segment of the industry.[33] The results of this research are as yet preliminary but seem to indicate a risk considerably less than has been demonstrated in the textile manufacturing and insulation application and removal industries.

In a report given at the Lyon conference in October 1972, Enterline presented a breakout of data from his retired employee study on workers in rigid shingles and sheet and asbestos-cement pipe operations. Both subgroups from the larger study showed excess mortality from asbestos-related disease.(34)

In an earlier paper, Enterline reported on his study of more than 12,000 United States asbestos "Building Products" workers, in which he found an excess of lung cancer and respiratory disease (asbestosis) but no overall mortality excess.(31)

Asbestos Friction Materials

Enterline studied 7,500 asbestos friction materials workers from 11 U.S. plants and found an excess of lung cancer, GI cancer, and respiratory disease, but no overall mortality increase.(31) No other papers have been produced in this area.

Insulation Manufacturing

Selikoff's study of amosite insulation workers (the famous Patterson study),(17) in which he demonstrated high rates of all asbestos-related diseases, is the only research conducted in this segment of the industry thus far.

Other Manufacturing

The vinyl-asbestos floor tile, packings and gaskets, asbestos felts, asbestos paper, and asbestos reinforced plastics segments of the industry have not been examined thus far.

Insulation Application Trades

The asbestos insulation workers are the only major group of end product users that have been examined extensively, Selikoff's two ongoing studies being the prime examples.(17)

As a subgroup of the overall insulation application and removal trades, shipyard workers have received special attention. The most important research conducted in this area has been that of Selikoff,[17] McEwen,[19] Harries[35] and Murphy.[36] The special attention paid to this group has stemmed from the supposition that the uncontrolled use of asbestos insulations during the Second World War contaminated entire shipyard areas, thus extending the hazard of asbestos inhalation to many more individuals than merely those handling the material. The McEwen and Harries studies have been important in this regard.

Dust Levels and Disease

Because asbestos-related disease is both dose and time related, the disease being found today is a result of conditions existing 20-30 years ago and longer. Efforts to determine the highest level of exposure that will result in no disease, i.e. to find a "safe" exposure level, are hampered by two factors:

1. Very few dust counts were taken before the mid-50's. Thus, most studies have estimated past exposure levels in relative terms, i.e. "low, medium or high."
2. Within the past 10 years, the accepted method for determining exposure has changed from particle to fiber counting. Efforts at determining a conversion factor for converting past particle counts to their equivalent in fibers per cc have been generally unsuccessful.[36a, 36b] Thus, it has not been possible to accurately translate past dust data into modern terms for the purpose of setting standards. Gibbs, using data from the McDonald studies, has suggested that standards based on particle counts should be established in those industries where sufficient past dust data of this type is available.[36b]

Attempts at determining safe exposure levels have, thus, been relatively few.

Selikoff et al have concluded that the time weighted average exposure of insulation workers is less than 5 fibers of asbestos per cubic centimeter of air. However, no dust counts were taken by the Mount Sinai group earlier than 1969 nor has the data leading to this conclusion been published in a scientific journal for professional scrutiny.

The most important study yet published in this area has been the 1968 report of the Sub-Committee on Asbestos of the Committee on Hygiene Standards of the British Occupational Hygiene Society. Entitled "Hygiene Standards for Chrysotile Asbestos Dust," the paper recommended the establishment of the now famous "two fiber standard."[36c] The United States two fiber standard, scheduled to go into effect in 1976, is based largely on this report.

Among those studies that have sought to establish a relationship between past particle counts and disease are those by McDonald,[20] Murphy,[36] Enterline[32] and Weill.[33]

Asbestos in the Environment

Various investigators have demonstrated the existence of asbestos in ambient air and water.[37,38] None of this research has established a link between the quantity of asbestos discovered and any increase of disease among the general public. Speculation on this point, however, has run rampant. The concensus of both the NAS and IARC reports is that current levels of asbestos in the environment present no hazard to health.

One possible source of asbestos in the environment that has been thoroughly investigated is emissions from brake lining wear. Lynch in 1968[39] and Jacko et al in 1973[40] reported that brake lining wear was an inconsequential factor in ambient asbestos air pollution.

The use of asbestos-containing spray insulations has also been investigated by the Mount Sinai Environmental Sciences Laboratory. However since this practice has been banned by the EPA, the study is now of only academic importance.[37]

The natural action of wind and water on serpentine rock formations release small though detectable amounts of asbestos into ambient air and water, but precise data as to the contribution of these "natural sources" to ambient concentrations is unavailable.[37]

Selikoff has investigated the asbestos content of parenteral drugs.[41] Other studies on asbestos ingestion and injection are due for publication shortly.

Variables on Pathogenicity

One difficulty in finding a solution to the asbestos-health probelm has been the scarcity of data relating to the manner in which asbestos causes disease, especially the various types of cancer associated with asbestos exposure. Selikoff has established a synergistic relationship between cigarette smoking, asbestos inhalation and lung cancer, but has not discovered the mechanism whereby the relationship operates.[42] Cralley et al have suggested that trace metals attached to the fiber are the prime cause of carcinogenisis.[43]

Many researchers have concluded that crocidolite is more hazardous than either chrysotile or amosite, and that amosite is perhaps more hazardous than chrysotile.[3] Timbrell suggested that the varying aerodynamic properties of the different types of asbestos fiber in the human lung may account for their differing biological potency.[44]

Stanton[45,45a] and Gross,[46] on the other hand, believe that fiber size is of primary importance in the carcinogenicity of asbestos and other fibrous materials, the smaller EM sized fibers being less, if at all, hazardous.

Research Needs

Despite the tremendous amount of data that has been published on the health effects of asbestos, most studies do little more than confirm observations already reported upon by previous investigators. A number of vital questions still remain unanswered. Among these are:

1. Is there a safe exposure level for protection against the various asbestos-related diseases? If so, what is it? Does it vary from disease to disease or from type of asbestos to type of asbestos?
2. What is the true relationship between asbestosis and lung cancer (some researchers believe asbestos-related lung cancer will occur only in individuals who already have asbestosis, while others maintain that it doesn't matter)?
3. What are the relative cancer risks following exposure to only one variety of asbestos?
4. How does asbestos cause or contribute to the causation of disease, especially cancer?
5. What other causes of mesothelioma are there, in addition to asbestos exposure?
6. Can asbestos cause other diseases in addition to asbestosis, lung cancer, mesothelioma and GI cancer (it has been suggested that asbestos can cause ovarian cancer in women and also cancer of the larynx and esophagus)?
7. Is it possible to detect asbestosis early enough so that it is reversible?

Conclusion

According to Dr. Premysl Pelnar of the Institute of Occupational and Environmental Health in Montreal, approximately 90 percent of all information and data now available on asbestos-health is the result of medical studies undertaken within the past ten years. Nonetheless, major sections of the asbestos manufacturing industry have not been investigated at all, or have been investigated by only one researcher, whose results are therefore not comparable with other studies nor, consequently, are they refutable. Until we have answers to all the unanswered questions, and until we know through scientific investigation that this or that use of asbestos is safe or unsafe, the asbestos industry will continue to be plagued by its own uncertainty and the unfounded speculation of those who would question the unknowns rather than examine them.

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NOTE ON REFERENCES: (1) In some cases, Dr. Selikoff's study of the insulation workers being a prime example, numerous papers have appeared over the years dealing with the same study. The paper or presentation referenced above is not necessarily the first to appear on the study, but will more often be the most recent or the most comprehensive of those that have been published. (2) Even in a short review of this nature, the number of references is extensive. For this reason, papers and presentations of primary importance are marked with an asterick.