W. Barclay, J. Craighead, et al., "A Physician's Guide to Asbestos-Related Diseases," JAMA, 1984.

Concludes that household contamination by asbestos, carried on the work clothes of family members may result in other family members developing asbestosis. Mesotheliomas may also develop in such scenarios. Environmental exposure is another danger.

Council Report

A Physician's Guide to Asbestos-Related Diseases

Council on Scientific Affairs

IN RECENT years, public concern over the health effects of asbestos has sharply escalated. According to Walker et al (*J Occup Med* 1983;25:409), **as many as 65,000 industrial workers in this country may now have clinically diagnosable asbestosis, and mesothelioma may develop in 19,000 before the end of this century. Asbestos also increases the occurrence of bronchogenic carcinoma among exposed workers. Disease frequency of this magnitude consequent to a common environmental pollutant is unprecedented and of critical public health importance.**

In May 1982, the Council on Scientific Affairs commissioned a select panel of experts to prepare a report on the diseases attributed to asbestos exposure. There are already a number of excellent reviews on the subject for specialists in the fields of radiology, pathology, pulmonary medicine, and oncology. This report is organized as a series of answers to some of the more common questions asked of or by physicians regarding asbestos and health. **A selected list of references is provided for the reader who requires more comprehensive knowledge.**

From the Council on Scientific Affairs, Division of Personal and Public Health Policy, American Medical Association, Chicago.

Report F of the Council on Scientific Affairs, adopted by the House of Delegates of the American Medical Association at the 1983 Interim Meeting.

This report is not intended to serve as a standard of medical care; standards of medical care that are determined locally and are constantly subject to change are established on the basis of all the facts of the individual case.

Reprint requests to Division of Personal and Public Health Policy, Council on Scientific Affairs, American Medical Association, 535 N Dearborn St, Chicago, IL 60610 (Robert H. Wheeler).

INTRODUCTION

The term *asbestos* refers to a family of naturally occurring silicate minerals with a fibrous structure. Endowed with unique properties of heat and corrosion resistance, asbestos has long played a prominent role in our industrial society. **Chrysotile is the most important commercial type of asbestos, accounting for more than 90% of the asbestos consumed in the United States today.** Two other types, crocidolite and amosite, were used extensively in the past. In the 1940s and 1950s, worldwide consumption of asbestos increased dramatically. In recent years it has declined, in large part because of concerns about the adverse effects of asbestos on health.

Medical knowledge regarding the outcome of exposure to the mineral has expanded greatly since the first published report of asbestos-associated lung disease in 1924. But only in the past few years has the general public become aware of the extent to which asbestos exposure can cause disease. The long latency before the appearance of clinical manifestations delayed the emergence of a significant number of new cases until the 1960s and 1970s. At the same time, the media has publicized a burgeoning number of damage claims filed by persons alleging disease and disability from asbestos exposure.

Occupational exposure to asbestos may occur during (1) mining and **milling of the ore, (2) the manufacture and use of asbestos-containing products, and (3) the repair and demolition of structures containing asbestos. Insulators and other construction workers, such as painters and electricians, are particularly at risk.** Countless industrial and consumer products (eg, electrical appliances and equipment; brake and clutch linings; fireproof paper and textiles; water pipes; siding and insulation materials; floor and ceiling tiles; and spackling, patching, and taping compounds) have asbestos incorporated in their manufacture.

Recently, the US Environmental Protection Agency (EPA) has directed special attention to the inte-

riors of schools and other public buildings that could contain friable asbestos. In 1982, the EPA mandated that all elementary and secondary schools be inspected and the information be provided to school employees and parent-teacher associations. Asbestos is ubiquitous in the urban environment; it can be detected in the dust on streets and in public buildings. Thus, the general public is invariably exposed to small amounts of material.

The asbestos-related pulmonary diseases progress insidiously. Many years elapse from first exposure to the appearance of symptoms. The pathological sequelae of asbestos exposure are irreversible and can progress after exposure ceases. At present, there is no satisfactory treatment; prevention is the only practical way to avoid the disease.

QUESTIONS AND ANSWERS

What Are the Major Pathological Responses to Asbestos Exposure?

Interstitial pulmonary fibrosis (asbestosis) is one of the major adverse health consequences of asbestos exposure. Pleural fibrosis and "plaques" often accompany but may occur independently of the parenchymal disease. They serve as markers of exposure. **Malignant mesotheliomas of the pleural and peritoneal cavities and bronchogenic carcinoma are linked to asbestos inhalation. In some studies, carcinomas of the larynx and gastrointestinal tract (ie, the buccal cavity, oropharynx, esophagus, stomach, and colon) and lymphoplasmocytic malignant conditions have been associated with asbestos exposure.**

How Does Asbestosis Differ From Other Forms of Pulmonary Fibrosis?

Pulmonary fibrosis has many causes, but in all cases asbestos should be considered a possible causal factor. Asbestosis has distinctive histological features, particularly during its early stages. The lesion begins in the respiratory bronchioles; fibrosis then progresses to adjacent pulmonary units until the lungs are extensively involved. Typically, the lower lobes are more severely affected, and fibrous thickening of the visceral pleura frequently is found. A small proportion of fibers in the lung become encapsulated with an iron-protein coat and are referred to as "asbestos bodies." Large numbers of uncoated asbestos fibers are commonly found in lung tissue of those who are occupationally exposed to asbestos. Fibers are also present in the lungs of the general population, although industrially exposed persons tend to have higher concentrations. Quantitative counts of fibers in lung tissue cannot be used as a measure of disease.

What Are the Clinical Features of Asbestosis?

The diagnosis of asbestosis is facilitated if there is a history of exposure. The patient's lifetime employment should be reviewed, with special attention to the individual tasks performed by the patient in the remote past. The early stages of the disease usually are asymptomatic. As it progresses, complaints generally include the usual respiratory symptoms of dyspnea and cough, with or without sputum production, as well as fatigue, weight loss, and chest pain. In the advanced stages, expansion of the thorax is limited, and there are inspiratory crackles on auscultation of the chest, clubbing of the digits, and cyanosis of the extremities. Chest roentgenograms at this stage show fibrosis of the lungs, particularly of the lower lobes. Pulmonary function tests do not differentiate between asbestosis and other forms of pulmonary fibrosis. Cigarette smoking often complicates interpretation of the results of pulmonary function tests. The major adverse effects of cigarette smoking on lung function is expiratory airflow obstruction, whereas reduced lung volumes and impaired gas diffusion are found in patients with asbestosis.

What Exposure Is Required for the Development of Asbestosis?

Brief exposure to a high concentration of the fiber in ambient air occasionally results in disease. Generally, however, one must inhale relatively large amounts of asbestos for an extended period. Fibrotic lesions usually are not roentgenographically evident until at least five years after the onset of exposure; much longer periods usually are required. Workers handling insulation or other asbestos-containing products and others in the immediate area are particularly at risk. Casual and sporadic exposures to relatively small amounts of the fibers do not generally produce pulmonary fibrosis; however, **contamination of the household environment through work clothes has resulted in asbestosis among family members. Nonfriable products, which do not release fibers into the air, are not dangerous.**

Is There Any Relationship Between Fiber Size and the Development of Asbestos-Related Disease?

Asbestos fibers vary considerably in length and diameter. The bulk of evidence indicates that long fibers (equal to or greater than 8 μm) play an important pathogenic role in asbestosis and mesothelioma. Most fibers in commercial products are relatively short; their importance as a cause of disease is controversial. The techniques currently used to monitor the environment ignore fibers less than 5 μm in length. The current Occupational Safety and Health Administration standards do not require monitoring of the short fibers.

Does Asbestosis Develop In All Those Who Are Heavily Exposed for Extended Periods?

Humans appear to differ markedly in their response to asbestos fibers, which suggests that host factors may be important determinants in "resistance" to the development of pulmonary fibrosis. Various immunologic abnormalities are noted in persons with asbestosis; hence, immune mechanisms might be involved in the pathogenesis. Inasmuch as genetic mechanisms have been shown to play a role in immunologic responsiveness, it is conceivable that heritable traits influence susceptibility to the pathological effects of asbestos.

What Effect Does Asbestos Have on the Immune System?

A variety of immunologic abnormalities have been demonstrated in subjects with asbestosis. Cell-mediated immunity is impaired, as evidenced by cutaneous anergy for certain recall and de novo antigens. Furthermore, decreased numbers of circulating suppressor T cells and an increase in the ratio of T-helper to T-suppressor cells has been found in some

patients with asbestosis. Patients often have elevated serum and secretory immunoglobulin levels, serum rheumatoid factors, and antinuclear antibodies. Although immunologic reactions might play a role in asbestosis, the evidence is circumstantial.

What Is the Role of Pulmonary Biopsy in the Diagnosis of Asbestosis?

In most cases, persons with a prolonged exposure to asbestos will have physical findings and roentgenographic evidence that are sufficient to establish the diagnosis. However, many workers are exposed to a variety of inhalants, and often the history of exposure is either unknown or vague. Thus, when the nature of the lesion is obscure or when there is a suggestion of other complicating, treatable conditions, pulmonary biopsy is indicated. Under these circumstances, histologic examination of a specimen of lung tissue can help to establish the diagnosis. The lesions of asbestos often have a spotty distribution when the disease is either mild or moderately serve. Adequate sampling of the lung parenchyma is critical, and open lung biopsy is recommended. Transthoracic needle aspiration and transbronchial biopsies usually do not yield sufficient tissue to permit a diagnosis.

What Features in the Pulmonary Biopsy Permit the Specific Diagnosis of Asbestosis?

Discrete foci of fibrosis in the walls of respiratory bronchioles associated with accumulations of asbestos bodies are the minimal pathological features that permit the diagnosis of asbestosis. Although these early morphological findings are adequate to establish the pathological diagnosis, they do not necessarily result in functional and roentgenographically apparent alterations. The demonstration of asbestos bodies in the absence of fibrosis is insufficient evidence to justify the diagnosis of asbestosis. Conversely, a definitive diagnosis of asbestosis cannot be made in cases that show characteristic fibrosis in the absence of asbestos bodies, even patient with a history of exposure. Some investigators believe that asbestos bodies occasionally are not demonstrable in lungs with fibrosis caused by asbestos, but this claim has not been substantiated by systematic pathological studies.

Can the Diagnosis Be Established by Sputum Cytological Tests?

No. Asbestos bodies in sputum are evidence of asbestos exposure, but they are not diagnostic of asbestosis. Similarly, asbestos bodies in bronchopulmonary lavage specimens are not diagnostic. On the other hand, relatively large numbers of asbestos bodies often are found in the pulmonary secretions of patients with asbestosis. Thus, asbestos bodies in sputum strongly suggest past exposure to asbestos and reflect the presence of a significant asbestos burden in the lungs.

What Is the Treatment for Asbestosis?

The asbestos-related pulmonary diseases progress insidiously. There is a long latent period of many years from first exposure to the appearance of symptoms. The pathological sequelae of asbestos exposure are irreversible and can progress after exposure ceases. **At present, there is no specific treatment; prevention of exposure to friable asbestos is the only practical way to control the disease, and general measures for the management of any pneumoconiosis should be pursued.**

Is It Advisable to Change Jobs When Evidence of Asbestosis Develops?

Persons with asbestosis should eliminate further exposure to asbestos. This might require changing jobs, but improved hygienic standards in the workplace and the use of personal protective equipment, such as an approved face mask or a respirator, can make a change of occupation unnecessary.

Does the Disease Become More Severe After Exposure Ceases?

Roentgenographic changes in the lung parenchyma have been shown to progress in some persons after asbestos exposure ceases. This has been attributed to asbestosis, but progressive chronic bronchitis and decreasing pulmonary function may also relate to other factors, such as cigarette smoking and the natural decline in pulmonary reserve that occurs with aging.

What Changes in the Pleura Are Observed After Asbestos Exposure?

Asbestos is unique in its ability to produce isolated lesions of the pleura; these include effusion, fibrosis, plaques, and mesothelioma (Figure). The effusions generally are bilateral and can develop many years after cessation of asbestos exposure. They can be asymptomatic, but often they are associated with chest pain. Frequently, the fluid is blood stained and the protein content exceeds 3 g/dL. Many months may pass before spontaneous resolution of the lesions occurs, but recurrences are unusual. Asbestos bodies are seldom found in the pleura.

Pleural plaques are localized fibrotic lesions that originate just below the surface of the parietal pleura. They commonly occur on the lateral aspects of the rib cage and on the dome of the diaphragm. Calcification often is found in plaques of long duration. Adhesions between the visceral and parietal pleurae are seldom present. Roentgenographically, plaques appear as bilaterally symmetrical, localized areas of pleural thickening. They have characteristic pathological features. Diffuse pleural thickening, often involving the costophrenic angles, can develop with or without localized plaques. Postmortem studies show that pleural changes occur more frequently than is apparent in chest roentgenograms. Pleural thickening is highly suggestive of asbestos exposure when other possible causes, such as trauma, surgery, and infection, are excluded.

Pleural mesotheliomas invariably produce chest pain, usually before the appearance of other symptoms. Eventually, either large nodular or lobulated opacities appear at the lung margin. Roentgenographic evidence of pulmonary fibrosis is often not present and is not required to establish the diagnosis.

There is no satisfactory treatment.

How Is the Diagnosis of Mesothelioma Established?

Cytopathological evaluation of cells in pleural fluid is difficult, and the technique is not recommended for the definitive diagnosis of mesothelioma.

Incisional biopsies of a mass in the pleural and peritoneal cavities usually provide adequate material for pathological study. The histopathological diagnosis of mesothelioma can be difficult, since other neoplasms can mimic these tumors. In addition, these lesions exhibit a wide range of morphological features. Thus, the diagnosis must be one of exclusion. Special histochemical, immunochemical, and electron microscopic techniques occasionally are useful in the pathological evaluation of mesothelioma. Panels of pathologists have been established to assist in the diagnosis of mesothelioma.

Do Pleural Plaques Develop Into Malignant Mesotheliomas?

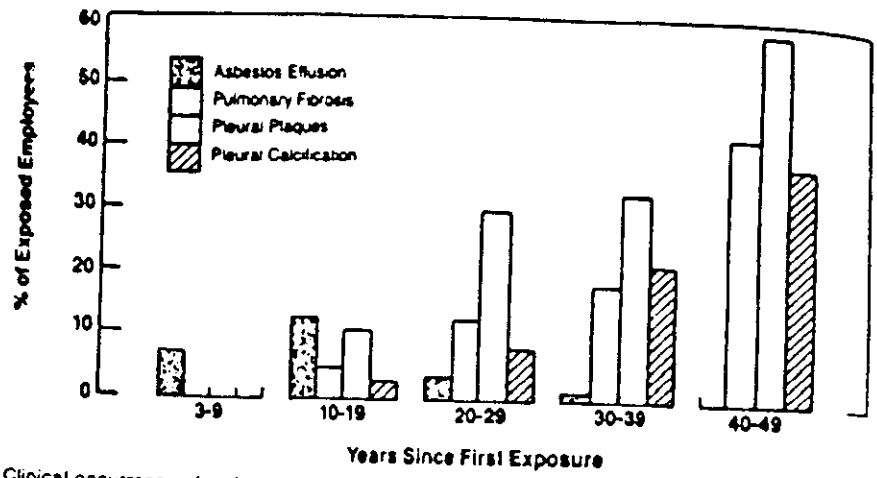
Persons in whom malignant pleural or peritoneal mesotheliomas develop frequently have coexistent pleural plaques. On the other hand, the majority of persons with pleural plaques do not experience the development of malignant mesotheliomas. Pleural plaques are not believed to be premalignant lesions.

Can Mesotheliomas Develop After Either Transient or Casual Exposure to Asbestos?

Mesotheliomas are a rare form of cancer. They have been reported in persons with only limited exposure to asbestos in nonoccupational settings. For example, on rare occasions these tumors have developed in household contacts of asbestos workers and in persons who have visited or resided near asbestos mines, mills, factories, and waste dumps. Although it is conceivable that asbestos exposure was brief in these cases, it may have been heavy. The development of mesothelioma is not associated with cigarette abuse. Most, but not all, cases of malignant mesothelioma are asbestos related. Nevertheless, in a published series of cases, from 11% to 16% of patients with mesothelioma do not have a history of exposure.

Are All Commercial Types of Asbestos Equally Hazardous to Humans?

It is generally accepted that the three major commercial types of asbestos (chrysotile, amosite, and crocidolite) are capable of causing pleural plaques and interstitial pulmonary fibrosis. There is, however, considerable debate regarding the relative carcinogenic potential of the different asbestos fiber types. The controversy stems from the fact that all commercial varieties of asbestos induce mesotheliomas in experimental animals, yet the carcinogenic risk appears to be much greater for crocidolite than for chrysotile, with the risk for amosite being intermediate in severity.



Clinical occurrence of various asbestos-associated lesions among industrial workers chronically exposed to airborne mineral fibers. Data are based on physical examinations and roentgenograms obtained systematically during 50-year period (from Epler et al[11]).

Age-Standardized Lung Cancer Death Rates for Cigarette Smoking and/or Occupational Exposure to Asbestos Dust Compared With No Smoking and No Occupational Exposure to Asbestos Dust*

Group	Exposure to Asbestos	History of Cigarette Smoking	Death Rate	Mortality Difference	Mortality Ratio
Control	No	No	11	0	1.0
Asbestos workers	Yes	No	58	47	5.2
Control	No	Yes	123	111	10.9
Asbestos workers	Yes	Yes	602	590	53.2

*Rate per 100,000 man-years standardized for age on the distribution of the man-years of all the asbestos workers. Number of lung cancer deaths based on death certificate information. Table reproduced with permission from the *Annals of the New York Academy of Sciences*.[12]

Does Cigarette Smoking Influence the Development of Asbestos-Related Disease?

There is no evidence that smoking predisposes a person to either the development or the progression of pulmonary fibrosis and mesothelioma. However, smoking can decrease pulmonary function and compromise overall health.

The synergistic effect of cigarette smoke and asbestos exposure greatly increases the risk of bronchogenic carcinoma, as evidenced by a comparison of the mortality ratios in the Table. Whereas the lung cancer death rate for the nonsmoking asbestos worker is five times that of the controls, the asbestos worker who smokes is subject to a 53-fold increase. A carcinogen in its own right, asbestos appears to act as a cocarcinogen with cigarette smoke in the pathogenesis of bronchogenic carcinoma. The effects of asbestos-related diseases and cigarette smoking are synergistic or multiplicative rather than additive.

Patients with asbestos exposure must be counseled on the risks of continued smoking.

What Is the Likelihood That Bronchogenic Carcinoma Will Develop in a Patient With Asbestosis?

Most epidemiologic studies of workers exposed to asbestos (Table) have failed to relate the occurrence of bronchogenic carcinoma specifically to the presence and severity of asbes-

tosis. Recent investigations in the United States and Great Britain have shown that about 20% to 40% of patients with asbestosis will die of cancer of the lung. As might be expected, the majority of these persons are smokers. In most case studies, there is an increased prevalence of adenocarcinoma in those with asbestosis.

What Risks Are Associated With Drinking Water Containing Asbestos?

Asbestoslike mineral fibers commonly are found in drinking water sources throughout the United States. The material comes from rock outcrops in watersheds and, to a variable extent, from refuse dumps and asbestos-containing water pipes. There is no evidence to indicate that ingested fibers are responsible for disease in man.

How Effective Are the Current Engineering Controls and Personal Protective Devices in Reducing the Risk of Contracting an Asbestos-Related Disease?

Attention to engineering controls such as ventilation and remote handling of asbestos as well as improved housekeeping in the workplace have made the federal standards for airborne fiber concentrations attainable. These approaches should be the primary means of control.

Face masks and respirators approved by the National Institute for Occupational Safety and Health reduce the risk of inhaling asbestos fibers if they are fitted and used properly. Too often the worker—and his supervisor—is unmindful of the importance of a good fit to the face and of the need to keep the interior of the mask clean. When masks and respirators are not used properly, they create a false sense of security. **Personal protective devices are essential when all other measures either fail or are impractical. They should not be used as the first line of defense.**

Are the Current Standards for Airborne Concentrations of Asbestos Fibers in the Workplace Sufficient to Prevent the Development of Asbestosis and Asbestos-Associated Neoplasms?

Health standards do not represent criteria for the absolute elimination of risk or the prevention of disease. There appears to be a rough dose-response relationship between asbestos exposure and the development of disease. It is likely that today's regulations protect the worker from asbestosis.

The existing standards of the federal and state regulatory agencies seek only to establish guidelines for a "reasonably safe" level of exposure that is not likely to produce disease during the lifetime of a worker. The basis for any standard is the available medical and scientific evidence and a consideration of the societal and economic impact of the standards. Technological feasibility of control measures and the availability of analytic procedures are other important considerations.

What Can the Physician and the General Public Do When They Become Aware of a Potentially Hazardous Source of Asbestos Exposure?

Workers should be advised of their rights under the Occupational Safety and Health Act of 1970. They, or their representatives, are entitled to request a hazard evaluation review by the National Institute for Occupational Safety and Health and an inspection of the work site by a federal or state compliance officer. Under the law, the person who initiates the report cannot be penalized by his employer for doing so.

The general public can seek assistance through the EPA, the Consumer Product Safety Commission, and the local or state public health department.

Do the Commonly Used Asbestos Substitutes, Such as Fibrous Glass and Mineral Wool, Cause Diseases Similar to or Different From Those Associated With Asbestos?

To date, there is no reason to believe that fibers of glass or mineral wool cause chronic pulmonary disease. The effects of inhaling these fibers are reversible. Since their introduction in 1960, ultrafine fibers (<5 μm in diameter) have gradually replaced those having a larger diameter (6 to 8 μm) and are now the standard of the fiberglass industry.

Suggested Reading

1. Becklake MR: Asbestos-related diseases of the lungs and pleura. *Am Rev Respir Dis* 1983;126:187-194.
2. Craighead JE, Abraham JL, Churg A, et al: Asbestos-associated diseases. *Arch Pathol Lab Med* 1982;106:544-596.
3. Craighead JE, Mossman BT: The pathogenesis of asbestos-associated disease. *N Engl J Med* 1982;306:1446-1455.
4. Enterline PE, Marsh GM, Esmen NA: Respiratory disease among workers exposed to man-made mineral fibers. *Am Rev Respir Dis* 1983;128:1-7.
5. Levine RV: *Asbestosis: An Information Resource*, Dept of Health, Education, and Welfare publication (NIH) 78-1981. Bethesda, Md, National Institutes of Health, 1978.
6. *Workplace Exposure to Asbestos*, Dept of Health and Human Services publication 81-103. New York, National Institute for Occupational Safety and Health, 1981.
7. Preger L (ed): *Asbestos-Related Disease*. New York, Grune & Stratton Inc, 1978.
8. Selikoff IJ, Hammond EC (eds): Health hazards of asbestos exposure. *Ann NY Acad Sci* 1979;330:91-116.
9. Selikoff IJ, Lee DHK: *Asbestos and Disease*. New York, Academic Press Inc, 1978.
10. Simpson W (ed): *Asbestos: Final Reports of the Advisory Committee on Asbestos*. London, Advisory Committee on Asbestos, 1980.
11. Epler GR, McCloud TC, Gaensler EA: Prevalence and incidence of benign asbestos pleural effusion in a working population. *JAMA* 1982;247:617-622.
12. Hammond EC, Selikoff IJ, Seidman H: Asbestos exposure, cigarette smoking and death rates. *Ann NY Acad Sci* 1979;330:473-490.