ASBESTOS

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EXECUTIVE SUMMARY

Asbestos has received much attention in the the media in recent years, leading the American public to fear asbestos as a significant cause of cancer and death. The object of this ACSH report is to examine some of the issues surrounding the health risks from asbestos and to offer a more scientific rationale as to what should be done about the asbestos present in our homes, schools and public buildings.

Asbestos is a naturally occurring mineral which, because of past commercial use, may be found in the ambient air in minute quantities, especially in urban environments. While the use of asbestos is now quite limited, it was for many years incorporated into thousands of common products. When asbestos is in place and in good condition, it does not pose a threat to health. Friable asbestos, that is prone to fragmentation or reduction to powder by hand pressure, can pose some threat to health under particular conditions. The occupational groups which should be monitored for risk of developing asbestos-related diseases are fire fighters, custodians, maintenance workers and asbestos abatement contract workers. Reducing the risk of disease among these groups should be the prime concern to legislators who are formulating regulations regarding asbestos.

Whenever asbestos deteriorates and becomes friable, or when building renovation or demolition is necessary, removal or encapsulation may be required. By contrast, non-occupational exposure to asbestos which is in place and intact in public buildings does not appear to pose a significant health risk. Massive efforts to remove all asbestos from office buildings, schools and homes, even when it is in good repair, can result in the introduction of additional fibers to the ambient air. Such misguided “public health” measures may actually cause more harm than good. Asbestos removal is an expensive and serious undertaking. Improper removal methods can create more of an asbestos risk than existed before removal.

INTRODUCTION

The perception of asbestos has changed radically since it was first used commercially over a century ago. Today, the mere mention of asbestos is enough to evoke a negative reaction in most people. Asbestos, however, remains a common and very useful construction material. However, it has now acquired the status of a toxic waste. Consumer advocacy groups and the Environmental Protection Agency (EPA) have proposed the banning of manufactured asbestos-containing materials in all but a fraction of products for sale in the United States. The events which led to this drastic change in public opinion and EPA policy are complex and still remain controversial.

BACKGROUND

Asbestos is a remarkably versatile, naturally-occurring mineral. Asbestos-containing products have yielded many benefits to society. Fireproofing materials made from asbestos are legendary. The superior electrical and heat-insulating properties of asbestos are well known and have resulted in great industrial demand for products containing asbestos. Until the early 1970s, when asbestos use began to decline, asbestos was incorporated into thousands of products from hair dryers to spackling compound. The construction and automotive industries in particular made extensive use of materials containing asbestos, such as thermal and acoustical insulation, ceiling tiles, roofing, cement water pipes, vinyl floor tiles, brake linings and clutch facings.

Asbestos once touched the life of practically everyone. However, while the public reaped the many benefits from products made of this “magic mineral”, some asbestos workers became ill and died of the asbestos-related diseases — asbestosis, lung cancer and mesothelioma.

ASBESTOS-THE MINERALS

Asbestos is not a single mineral but rather a group of minerals which have common properties, six of which have been used commercially. Asbestos minerals occur in fibrous form, have varying degrees of heat resistance, tensile strength, electrical conductivity and an approximate fiber length-to-width ratio of 3 to 1 (length-to-width ratios can vary). However, the minerals are not identical in chemical composition, crystal structure or geologic distribution. Over time, various types of asbestos have been utilized in different industries, depending on the unique properties of the particular type of asbestos.

Knowing that there are differences among the several varieties of asbestos is critical to the investigation of its health effects. Not all minerals called "asbestos" are the same in their ability to cause disease.

The most common form of asbestos is chrysotile. Known as "white" asbestos, chrysotile is fibrous and serpentine in structure. Over ninety per cent of the asbestos products now in place in the United States and most of the asbestos products in the world are made from chrysotile. Studies indicate that chrysotile asbestos has had the least detrimental health effect on workers who were occupationally exposed.

The other five minerals that occur in fibrous form and which are mined as "asbestos" are: crocidolite (blue asbestos), amosite (brown asbestos), tremolite, actinolite and anthophyllite. These five types of asbestos are collectively called amphiboles. Crocidolite has had the most detrimental health effect on workers occupationally exposed.

➧ **The importance of fiber size and shape**

There is a key distinction between the amphiboles as a group and chrysotile. The shape and size of the mineral fibers are not the same. Amphiboles are rod-like and straight, whereas chrysotile is curly and usually occurs in bundles. Fiber size and shape help geologists to differentiate one form of asbestos from another and influence why a particular form of asbestos is used commercially. The differences in properties between the amphiboles and chrysotile are also of significant medical importance.

Asbestos poses a health risk because the fibers can be released into the air we breathe. When asbestos-containing materials deteriorate or are damaged, the released fibers can remain in the air for a period of time and may be inhaled. Some portion of asbestos fibers can be "cleared" and expelled from the body while other fibers may remain in the respiratory system and cause disease. Most biomedical researchers agree that fiber type, shape and size are related to a particular mineral's potential carcinogenicity and to the mechanisms of asbestos-related diseases. Amphibole fibers, particularly amosite and crocidolite, pose the greatest health risk. Exposure to chrysotile fibers, whether occupational or environmental, poses a significantly diminished health risk.

HISTORY OFASBESTOS

The history of asbestos parallels events taking place with advancing medical knowledge and with technological breakthroughs. A review of these events may explain some of the barriers to an earlier recognition of the health risks of asbestos and why the "state-of-the-art" relating to asbestos health risk has advanced quite slowly.

Industry

The use of asbestos dates back to the Stone Age when cavemen apparently used asbestos to strengthen their earthenware pots. The Greeks gave asbestos its name, noting also that asbestos materials did not burn. Asbesta, is the Greek term meaning "unquenchable". This non-flammable quality led ancient Greeks to manufacture asbestos lamp wicks. The Romans mined asbestos and left us with both non-flammable cremation cloths and records of an illness among slaves who may have worked with asbestos. However, much of these ancient records were lost over time. During the Middle Ages, manuscripts in Europe mentioned diseases common to miners, but there was no mention of asbestos. A small asbestos textile industry developed in Russia during the time of Peter the Great (1675-1725) but most asbestos use remained rather trivial until the time of the Industrial Revolution of the nineteenth century.

The Industrial Revolution was powered by engines which required the production of great quantities of steam. With a growing need for higher power and efficiency, new steam technology required insulation material that would reduce heat loss, resist combustion and remain intact while in contact with high temperatures. The ideal substance to meet these challenges was asbestos.

The asbestos industry, therefore, evolved alongside post-Civil War economy as the United States was becoming an industrialized nation. Both heavy manufacturing and the construction industry were being transformed. High rise buildings required insulation. Asbestos quickly became an essential construction material.

By the late nineteenth century, the activity in asbestos mines increased in Italy and Russia. New asbestos deposits were uncovered in South Africa and in the Canadian province of Quebec. By 1980, asbestos had become an integral part of skyscrapers, battle ships and rockets sent to the moon. Such widespread use, however, was increasingly found to have deleterious consequences on human health.

Advances in medical knowledge

By 1900, the mining of assorted minerals, including coal and quartz, were found to be related to pulmonary illnesses among workers. In 1906 the first modern record of an asbestos-related disease was recorded in England. Not until the mid 1960s, however, was there solid evidence of the carcinogenic health risks posed by occupational exposure to asbestos. A chronology of some of the advances in medical knowledge of asbestos-related disease since 1906 follows:

1906	Montague-Murray of Charing Cross Hospital in London reports the autopsy of an asbestos worker with fibrosis of the lung.
1927	Cook suggests asbestos as the causative agent in pulmonary fibrosis. The term “asbestosis” is used by Cook for the first time.
1930	Merewether and Price detect asbestosis in 26 percent of surveyed asbestos textile workers.
1935	Lynch and Smith describe the first recorded case of lung cancer associated with asbestos.
1935	Lanza confirms the findings of Merewether; New York includes asbestosis in workmen’s compensation legislation.
1938	Dreesen *et al* (Public Health Service) suggest a “threshold limit value” (TLV) for workers exposed to asbestos.
1955	Doll publishes epidemiologic data to suggest an association between asbestos exposure and lung cancer.
1960	Wagner highlights an association between asbestos exposure and mesothelioma.
1964	Selikoff describes an epidemiologic association between end-product users of asbestos (insulators) and a high rate of lung cancer.
1964	Health warning labels required by law on products made with asbestos.

Asbestos exposure is primarily associated with three major diseases — asbestosis, lung cancer and mesothelioma. A fourth and more benign effect of asbestos is the production of “pleural plaques” on the lining of the chest cavity among some individuals who have experienced low level asbestos exposure. The possible development of fluid in the chest cavity (pleural effusion) has also been noted among asbestos-exposed individuals.

➧ **Asbestosis**: Asbestosis is a chronic disease caused by the inhalation of excessive amounts of asbestos fibers. Cigarette smoking contributes to the pulmonary fibrosis which characterizes asbestosis. Asbestosis involves scarring of lung tissue and a narrowing of the pulmonary airways. It is not malignant but may nonetheless be fatal. The severity of the disease is related to the duration and intensity of exposure to asbestos fibers.

If there has been sufficient exposure, asbestosis may progress after a person is no longer exposed to asbestos fibers. In advanced stages, asbestosis causes shortness of breath and may secondarily affect the function of the heart. Victims of this disease become easily exhausted and may ultimately succumb to respiratory or heart failure.

- **Lung Cancer**: Asbestos fibers appear to promote other carcinogens in causing lung cancer. Cigarette smoking is, however, the primary carcinogenic risk factor in causing asbestos-related lung cancers. Asbestosis is an antecedent condition in those developing lung cancer. Cigarette smoking and asbestos act synergistically to cause lung cancer. That is, the combined effect of smoking and asbestos is more than would be expected from their individual effects. Asbestos workers who do not smoke have a slightly higher risk of dying from lung cancer than do people who neither smoke nor are exposed to asbestos. In contrast, asbestos workers with asbestosis who do smoke heavily are over 50 times more likely to develop lung cancer than non-exposed workers who do not smoke.

- **Mesothelioma**: Mesothelium is a membrane that covers and protects internal organs of the body. The mesothelium surrounding the lungs is called the pleural mesothelium. Malignant tumors, or cancers, that develop in the mesothelium are called mesotheliomas. Symptoms include breathlessness and pain. Mesothelioma is usually fatal within a few months to two years after the first symptoms appear.

Mesotheliomas are relatively rare cancers. The major risk factor for mesothelioma is occupational exposure to amphibole asbestos, especially crocidolite. Estimates based on some population studies show that as many as 70 to 80 percent of patients with mesothelioma have had documented occupational or environmental exposure to amphibole asbestos fibers.

Nonoccupational exposure to asbestos can increase the risk of developing mesothelioma. Household contacts of employees who work with amphibole asbestos have higher than average rates of mesothelioma probably as a result of exposure to the asbestos dust brought into the home on the shoes and clothing of workers.

Unlike the lung cancer correlation, as described above, cigarette smoking does not contribute to the development of mesothelioma.

Dose Response

As with most toxicologic health effects, the body’s response to breathing asbestos fibers is dose related.

Thus, asbestos-related disease is more prevalent when asbestos dust levels are high and when exposure continues over prolonged periods. Recognition of this dose-response concept has been the basis of prevention programs which have aimed to reduce environmental dust levels and encouraged the use of protective clothing and respiratory equipment for exposed workers. There also exists a variable individual susceptibility to the harmful effects of breathing asbestos dust. Given the same dose level and duration of exposure, not all persons will develop an asbestos-related disease. The reasons for such variability in human response remain unclear, although cigarette smokers are distinctly more susceptible to the development of lung cancer.

Latency period

An important aspect of all asbestos-related diseases, as well as of pleural plaques, is the phenomenon of latency. Latency refers to the time lag between an individual's first exposure to respirable asbestos fibers and the onset of disease symptoms. Twenty years is now considered a near minimum for the latency period between first asbestos exposure and the ultimate development of asbestosis. The latency period is usually longer than 20 years for lung cancer and mesothelioma.

WHO IS EXPOSED?

The spectrum of occupationally exposed individuals affected by asbestos-related diseases has changed with time. In the 1930s, 1940s and 1950s, individuals diagnosed as having asbestosis were largely those workers who had mined and milled asbestos or those who had been engaged in the manufacture of asbestos textile. Such individuals had completed a latency period covering a prior era when the health regulations in occupational environments were minimal. Protective clothing or equipment had not been used, and dust abatement was lax.

During the 1940s, a large new population of workers exposed to asbestos included shipyard workers handling insulation materials and those who worked in shipyard bystander occupations (pipefitters, welders, electricians, painters, etc.) who were engaged in the construction, repair and maintenance of World War II cargo and naval vessels. The post-war construction boom of the late 1940s and the 1950s allowed further occupational exposure to asbestos-containing materials such as asbestos cement, floor tiles, pipe covering and spray products. Disease in this post-war population of workers first appeared in the 1960s, 1970s and 1980s, after the appropriate latency intervals had elapsed.

Today, asbestos is no longer used in most new insulating, heating or friction products. Occupational exposure is now confined largely to fire fighters, building maintenance personnel and demolition or abatement workers. The non-occupational exposure to asbestos dust by family members of asbestos workers has largely disappeared with appreciation of the overall risk and the introduction of appropriate workplace precautions and controls.

A controversy persists as to whether there remains any significant risk to persons who are not maintenance workers but instead are only part-time occupants of schools and other public buildings. The mere presence of intact asbestos insulation or other asbestos products which are not releasing respirable fibers into the ambient air constitutes minimal, if any, risk and much of the fear regarding “asbestos in place” is unwarranted. Indoor air sampling for asbestos continues to yield trivial fiber counts which are well below levels permitted by government regulatory agencies. Such levels are unlikely to produce any illness, a prediction consistent with scientific evidence that asbestos-related diseases are on the decline.

It is important to understand that the health risk from exposures to non-occupational environments with asbestos in place is largely theoretical. Even when hypothetical “worst-case” estimates of disease due to such non-occupational exposures are considered, the risk, compared with other more common health hazards, reveals asbestos to have a negligible influence on mortality experience.

ASBESTOS, THE LAW, AND THE EPA

Considerable confusion persists as to how best to manage the asbestos-containing materials which remain in place in non-occupational settings such as schools and other public buildings. EPA regulations do not mandate the removal of asbestos if it is in good repair since non-friable asbestos (incapable of being crumbled or reduced to powder by hand pressure) or enclosed asbestos is not considered a health risk. EPA regulations do require that schools identify asbestos-containing materials and that a program of operations and maintenance be established for the continued monitoring of any deterioration that might release fibers into the respirable air of building occupants. When a material containing asbestos is found to be in bad condition, ripped, torn or otherwise deteriorating, one of the following EPA approved methods of abatement should be employed.

• **Enclosure (covering)**: placing something over or around the asbestos-containing material; eg., installing a dropped ceiling below an asbestos tile ceiling.

• **Encapsulation (sealing)**: treating the material with a sealant that binds the asbestos fibers together or coats them; eg., use of a liquid paint or urethane solution or an impermeable plastic membrane.

• **Removal:** this should only be done if the asbestos-containing material is in a severely deteriorated condition and the other methods cannot be effective.

ABATEMENT: WHAT TO DO ABOUT ASBESTOS IN YOUR HOME

Asbestos cannot be accurately identified by simple visual inspection. Positive identification of asbestos requires a certified laboratory technician to remove a sample for testing. If the sample material tests positive for asbestos, the source should be marked for future inspection or for abatement by one of the methods described in the previous section. Abatement measures should be considered only after the suspected material has been proven to contain asbestos and when risk, either by inspection or by actual air sampling measurements, has been determined to be health-threatening.

Some common household products and locations that may contain asbestos:

- Steam pipes, boilers and furnace ducts: may have been insulated with an asbestos blanket or asbestos paper tape.
- Cement sheet, millboard and paper: used to insulate furnaces and wood burning stoves.
- Floor tiles.
- Door gaskets: on furnaces, wood stoves and coal stoves.
- Sound-proofing or decorative material sprayed on walls and ceilings.
- Patching and joint compound for walls and ceilings and textured paints.
- Asbestos cement roofing, shingles and siding: may release fibers if sawed or drilled.
- Artificial ashes or embers: sold for gas-fired fireplaces.
- Old household items: fireproof gloves, stove pads and ironing board covers.
- Automobile brake pads and linings, clutch facing and gaskets.

Newer products are less likely to contain asbestos.

All types of abatement (enclosure, encapsulation and removal) should be carried out by professionals who are knowledgeable about the health risks, skilled in the abatement techniques and trained to protect the environment during the abatement procedures.

If removal is necessary, only trained and licensed workers from a reputable company should be hired. There are approved and government certified training centers listed with regional EPA offices. The removal contractor should demonstrate that the company and its employees have been appropriately trained in safe removal methods. Also, the laboratory testing for asbestos should provide a written report of its findings and should have no business connection with the abatement contractor.

Asbestos removal is an expensive and serious undertaking. The mere presence of asbestos containing materials does not present a health risk unless the materials are damaged in such a way that asbestos fibers may be released into the air. *Improper removal methods may create more of an asbestos risk than existed before removal.* A minority fringe of abatement contractors have placed personal financial interests above technical skills. Cases have been reported of asbestos consultants and contractors that encouraged unnecessary removals and performed the removal inadequately. Up to one half of all asbestos removal done in the past may have been done improperly.

Asbestos containing materials that are in good shape and not subject to disturbance should be *left alone*. In cases where asbestos inspection, repair or removal is necessary, only trained, reputable and accredited asbestos removal professionals should be hired. Demand that asbestos professionals show proof of their completion of federal or state approved training. Be sure to get cost estimates from several professionals or firms before selecting one. Always check the credentials and references from previous clients of asbestos-removal professionals and their associated firms. Check with state and local health departments and regional EPA offices for listings of licensed asbestos professionals.

SUMMING UP

¥ Asbestos is not a single mineral but rather a group of at least six minerals which have some common properties. Not all minerals called “asbestos” are the same in their ability to present health risks.

¥ Asbestos poses a health risk because the fibers can be released into the air we breathe. Most researchers agree that fiber type, shape and size are related to a mineral’s potential carcinogenicity and the mechanisms of asbestos-related diseases.

¥ Exposure to asbestos is primarily associated with three major diseases—asbestosis, lung cancer and mesothelioma.

¥ The body's response to breathing asbestos fibers is dose-related. There also exists variable susceptibility to the harmful effects of breathing asbestos dust. A particular dose level and duration of exposure will cause an asbestos-related disease in some people, but will not cause disease in all exposed individuals.

¥ Asbestos removal is an expensive and serious undertaking. Improper removal methods can create more of an asbestos risk than existed before removal.

¥ Non-occupational exposure to asbestos in public buildings does not appear to pose a significant health risk. Massive efforts to remove all asbestos from office buildings, schools and homes, even when in good repair, can only result in adding additional fibers to the ambient air.

References

Antman, K. and Aisner J. Editors. *Asbestos-Related Malignancy*. Grune & Stratton, Inc., 1986.

Becklake, M.R.. State of the Art: Asbestos-related disease of the lung and other organs: Their epidemiology and implications for clinical practice. *American Review of Respiratory Diseases*, vol. 114, pp. 187-227, 1976.

Bignon, J., Peto J. and Saracci, R. eds. Non-occupational Exposure to mineral fibers. International Agency for Research on Cancer (IARC), Scientific Publications No. 90, Lyon, France, 1989.

Bogovski, P. et al., eds., “Biological Effects of Asbestos”, Scientific Publications No. 8, International Agency for Research on Cancer (IARC), Lyon, France, 1973.

Cooke, W.E., Pulmonary asbestosis. *British Medical Journal*. Vol 11, p. 1024, 1927.

Craighead, J.E. and Mossman, B.T. The pathogenesis of asbestos-associated disease. *New England Journal of Medicine*, vol. 306, pp. 1446-55, 1982.

Doll, R. and Peto, J. Asbestosis: Effects on health of exposure to asbestos. Health & Safety Commission. Her Majesty’s Sationery Office. London, England, 1985.

Dreesen, W.C. et al. A study of asbestosis in the asbestos textile industry. *Public Health Bulletin*, vol/ 241, pp. 1-127, 1938.

Elmes, P.C. The epidemiology and clinical features of asbestosis and related diseases. *Postgraduate Medical Journal*, vol. 42, p. 623, 1966.

Harber, P. et al. Pleural plaques and asbestos-associated malignancy. *Journal of Occupational Medicine*, vol. 29, pp.641-644, 1987.

Health Effects Institute—Asbestos Research: Asbestos in Public and Commercial Buildings: A Literature Review and Synthesis of Current Knowledge. 1991.

Lanza, A.J. et al. Effects of the inhalation of asbestos dust on the lungs of asbestos workers. *Public Health Reports*, vol. 50, pp. 1-12, 1935.

McDonald, J.C. Health implications of environmental exposure to asbestos. *Environmental Health Perspectives*, vol. 62, pp. 319-328, 1985.

Merewether, E.R.A. and Price, C.V. Report on the effects of asbestos dust on the lungs and dust suppression in the asbestos industry. Her Majesty’s Stationery Office, London, England, 1930.

Montague-Murray, H.M. Report of the Department Committee in Compensation for Industrial Disease. London, 1907.

Mossman, B.T. and Gee, J.B.L. Asbestos-related diseases. *New England Journal of Medicine*, vol. 320, pp. 1721-1730, 1989.

Mossman, B.T. and Bignon, J., Corn, M., Seton, A., Gee, J.B.L. Asbestos: Scientific Developments and Implications for Public Policy. *Science*, vol. 247, pp.294-301, 1990.

Murphy, R.L.H. Update on asbestos. Pulmonary and Critical Care Update. *American College of Chest Physicians*, vol. 3, lesson 25, 1988.

Ross, M., Kuntze, R.A., Clifton, R.A. *Defintions for Asbestos and Other Health-Related Silicates, American Society for Testing and Materials, Special Technical Publication 834*, Benjamin Levadie, Ed.,Philadelphia, 1984.

Royal Commision on Matters of Health and Safety, *Report on Matters of Health and Safety Arising From the Use of Asbestos in Ontario, Toronto,* Ontario Ministry of Government Service, Canada, 1984.

Selikoff, I.J. and Lee, D.H.K. *Asbestos and Disease*. Academic Press. 1978.

Wagner, J.C. et al. Diffuse pleural mesothelioma and asbestos exposure in the North Western Cape Province. *British Journal of Industrial Medicine*, vol 17, pp. 260-271, 1960.

Weill, H. and Hughes, J.M. Asbestos as a public health risk: disease and policy. *Annual Review of Public Health*, vol. 7, pp. 171-192, 1986.

Weiss, W. History of hazards associated with asbestos. *Pennsylvania Medicine*, pp. 57-60, June 1986.