July 1, 1968

ASBESTOS - - A FAMILY OF MINERALS

SUMMARY:

This paper sets forth some of the reasons why the term "asbestos" should not be used loosely in discussing medical questions.

There is no single mineral known as asbestos. "Asbestos" is a name given to a family of minerals. It includes two major groups, containing a total of six varieties of asbestos. Each of these six differs from the others, physically, chemically and in biological effect. Any study of the effects of asbestos is complicated by this diversity.

Studies of both people and animals show differing types of reaction to the various types of asbestos. Animal studies of excessive exposure indicate that of the three major commercial types of asbestos, commonly used chrysotile is least likely to produce a reaction.

Because different varieties of asbestos produce different reactions, scientists are working on better methods for identifying the types of asbestos involved in their studies on human health. Other complications arise because trace amounts of mineral impurities are often found in samples of raw asbestos ore and refined fiber.

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VARIOUS TYPES OF ASBESTOS

Any attempt to assess the effect of asbestos on health is complicated by the fact that asbestos is not a single chemical or physical entity. "Asbestos" is a generic name given to a group of hydrated silicate minerals that have one common attribute, namely, the ability to be separated into relatively soft, silky fibers.

The known varieties of these minerals can be divided into two main classes on the basis of their crystal structures: serpentine asbestos and amphibole asbestos. The lone member of the serpentine class is chrysotile asbestos, which is by far the most common of the asbestos minerals. About 95 per cent of the asbestos used in this country is chrysotile, principally from mines in Canada.

There are five recognized varieties of amphibole asbestos: crocidolite, amosite, anthophyllite, tremolite and actinolite. Of the amphiboles, crocidolite and amosite have the greatest commercial significance, although the use of anthophyllite is increasing.

Each of the six types of asbestos differs from the others, chemically and physically. To add to the complexity, the chrysotile from one Canadian mine, for example, will differ in chemical impurities and in physical properties from the chrysotile from

CHARACTERISTICS OF THREE MAJOR TYPES

Each of the three types of asbestos that are most important commercially -- chrysotile, crocidolite and amosite - exhibits distinguishing characteristics.

CHRYSOTILE - By far the leading producers are Canada and the Soviet Union. Smaller deposits are found in South Africa, Rhodesia, China, the United States and Italy. Chrysotile is a white serpentine asbestos and occurs in areas where serpentine rock was cracked by earth movement long ago and subjected to intense pressure and volcanic waters. This transformed some of the granular serpentine into fibrous chrysotile. Chemically, chrysotile is hydrous magnesium silicate with a magnesium hydroxide surface. It has a positive electrical charge. It can be attacked by acids. It is a flexible fiber and does not pulverize readily. Commercial fibers contain small and varying amounts of iron and calcium compounds, depending upon origin.

CROCIDOLITE - The bulk of the world's supply comes from South Africa. There are also small deposits in Australia, but they are no longer being mined commercially. It is an amphibole asbestos occurring in iron-rich sedimentary rock. Chemically, crocidolite is a ferrous sodium silicate with a silica surface. It has a negative electrical charge.

It is acid-resistant. It is characterized by a deep blue color. Crocidolite is less flexible than chrysotile.

AMOSITE - The Transvaal district of South Africa is the only place where amosite is mined commercially. It is a member of the amphibole asbestos family, occurs in the same type of rock as does crocidolite, and has the same negative electrical charge, but is brown in color. Chemically, amosite is a ferrous magnesium silicate with a silica surface. It is also acid-resistant, but less so than crocidolite. It is brittle and pulverizes easily.

The major characteristics of these three types of asbestos are summarized in a table attached to this paper.

Because of the basic chemical and physical differences among chrysotile, crocidolite and amosite, it would be expected that overexposure to the three varieties would show varying biological effects. Scientific observation confirms this expectation. There seems to be broad agreement that chrysotile, the type of asbestos most heavily used in the United States, is least likely to produce asbestosis, a non-malignant lung disease brought on after inhalation of excessive concentrations of asbestos dust over a period of many years.

ANIMAL EXPERIMENTS SHOW DIFFERENT EFFECTS

Dr. J. C.Wagner experimented with all three types of asbestos on various laboratory animals, and found that crocidolite produced the most severe asbestosis and that amosite was more than five times as likely to produce a reaction as chrysotile. He reported, in 1963:

> "With chrysotile dust it was possible to produce severe lesions in the lungs of guinea-pigs, slight fibrosis in monkeys, while no significant effect was observed in two rabbits. Amosite dust causes marked asbestosis in all three kinds of animals. Lesions occur more rapidly in guinea-pigs exposed to this dust than in those exposed to chrysotile. There is an indication that the disease is progressive in monkeys and rabbits. Similar pathology to that which occurred in a monkey exposed to chrysotile for 22 months was observed in a monkey exposed to amosite for four months. The impure crocidolite dust caused severe disease in guinea-pigs, and the rate of respiratory infection among animals exposed to this dust was more marked than with the other types. It is possible that this may be due to the high quartz content of the dust.
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> "Finally, asbestos bodies could be demonstrated in the lungs of animals exposed to all three types of asbestos dust. These were scanty in the animals exposed to chrysotile and usually segmented. Only occasional fibers were observed. In contrast to this, the asbestos bodies in the animals that were dusted with amosite were plentiful, and segmentation was rare: fibres were extremely numerous and far outnumbered the bodies."

Following further investigation, Dr.Wagner offered an explanation for this observation at a medical symposium in 1965:

"A method of producing asbestos dust clouds has been devised and an animal inhalation experiment carried out to test it .... The elimination rate of Rhodesian chrysotile has been found to be three times greater than that of the amosite and crocidolite, which suggests an explanation for the previously observed reduced fibrogenicity of this dust. The reason for the difference in the elimination rate remains to be determined."

COMMERCIAL ASBESTOS CONTAINS OTHER MATERIALS

Asbestos ore and refined asbestos fiber contain mineral impurities, trace elements, and trace quantitites of organics, which vary from type to type and from mine to mine. In transit the ore may pick up additional trace organic impurities.

These trace materials are also the subjects of medical study to see if they may have a role in any of the health effects observed in animals. Trace impurities of nickel, chromium and manganese for example, were found by Dr. L. J. Cralley and associates in samples of chrysotile used in the asbestos textile industry. Other impurities in commercial asbestos fiber include iron, aluminum, calcium, sodium and potassium.

WORLD ASBESTOS BANK

Much scientific research has focused on studying the varying biological effects of different types of asbestos and on developing techniques for identifying asbestos fibers of unknown origin. In 1967 a "World Asbestos Bank" was established in Johannesburg,

South Africa, under the direction of the British Medical Research Council. The purpose of the "bank" is to provide standardized samples of asbestos from regions all over the world to be supplied to medical researchers for chemical, physical and biological investigation and for comparision purposes in clinical studies.

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TABLE

CHARACTERISTICS OF MAJOR COMMERCIAL TYPES OF ASBESTOS

NAME	Chrysotile	Crocidolite	Amosite
CLASS	Serpentine	Amphibole	Amphibole
COLOR	White	Blue	Brown
CHEMICAL COMPOSITION	Hydrous Magnesium Silicate	Ferrous Sodium Silicate	Ferrous Magnesium Silicate
SURFACE COMPSITION	Magnesium Hydroxide	Silica	Silica
ELECTRICAL CHARGE	Positive	Negative	Negative
REACTION TO ACID	Susceptible	Resistant	Resistant
TEXTURE	Flexible	Medium Flexibility	Brittle

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