

Epidemiology

Before considering the mortality studies of the various occupational groups exposed to asbestos, it is useful to briefly consider the roles the three important types of asbestos (amosite, crocidolite, and chrysotile) have played in the commerce of North America and Europe, the areas where the major epidemiological studies of asbestos workers were made.

In North America, chrysotile entered the market in large quantities early in this century. Crocidolite was apparently first used in the United States in 1912 when 9 tonnes was imported, but it was not until World War I that its use for high temperature insulation became established -- particularly in the ship building industry. By 1930 nearly 32,000 tonnes of crude crocidolite fiber had been imported into the United States (*Mineral Resources of the United States, 1907...1929*, U.S. Dept. Interior, Washington, D.C.). It was not until the mid 1930's that amosite asbestos gained a market in North America when it began to replace crocidolite for high temperature insulation. Crocidolite was milled in Bound Brook, New Jersey, in 1920, and in 1924 the operation moved to larger facilities in Millington, New Jersey. The many advertisements in the trade journal *Asbestos* during the period 1920 to 1945 indicate that crocidolite was used in many products and particularly for insulation of steam boilers, locomotives, and pipes. As an example, a product containing crocidolite asbestos and called "85% Magnesian Sectional Pipe Covering" was advertised monthly in *Asbestos* from 1920 to 1945 (see also McCullagh, 1980). Amosite, crocidolite, and chrysotile were almost universally used aboard ships during World War II, amosite for high temperature boilers and pipes, crocidolite for packings exposed to acids or salt water, and chrysotile for low temperature and electric insulation.

The use of asbestos in Europe paralleled that in North America, with one notable exception -- the extensive use in Europe of crocidolite asbestos as a sprayed-on coating to fireproof ships⁶, railroad cars,

⁶Mesothelioma is prevalent in the shipyard workers of Europe; at Walcheren, Wilhelmshaven, Plymouth, Trieste, Hamburg, Nantes, Rotterdam, and Mainz (McDonald and McDonald, 1977). The extensive use of crocidolite aboard European ships prior to and during World War II is suggested to be an important factor in the etiology of this disease.

buildings, etc. Sprayed-on coatings were also used in the United States after World War II, but the coatings contained, with few exceptions, chrysotile rather than crocidolite. Sprayed-on asbestos coatings were not used on U.S. ships, the principal use being to fireproof steel building girders and as acoustical coatings in schools and offices.

Asbestos trades workers. A very significant increased incidence, relative to the general male population, of lung cancer, asbestosis, and mesothelioma is found in men who were employed in the "asbestos trades" -- the insulation of steam locomotives, boilers, ships, and buildings; and the fabrication and installation of asbestos-containing textiles, roofing materials, cement products, tiles, wallboards, brake linings, clutch facings, filters, packings, gaskets, etc. Those in the "trades" generally used several types of asbestos minerals during their working careers; most commonly these were chrysotile, crocidolite, and amosite, and rarely anthophyllite. Significant exposures of any group of workers, at least for the past fifty years, to tremolite or actinolite asbestos dusts has probably not occurred.

Thirteen major mortality studies of asbestos trades workers are presented in Table 4; five of these are of workers engaged in the asbestos insulation trades, and eight are of workers in the factory and textile trades. Most of the workers are male, a few are female. In all, 38,904 individuals were followed; of these, 5,450 have died, including 998 (18.3 percent) who died of lung cancer and 327 (6.0 percent) who died of mesothelioma. In the thirteen studies the lung cancer mortality varied from 6.1 to 24.5 percent of all deaths; mesothelioma mortality varied from 0 to 9.5 percent of all deaths. The workers involved in studies nos. 1 through 12 worked with more than one form of asbestos; those in study no. 13 worked only with chrysotile asbestos.

Estimates of expected cancer mortality are very difficult to predict, because cancer rates are modified by the individual's "lifestyle," as well as by occupation. The major "lifestyle" contribution to lung cancer is cigarette use. To better assess the significance of these health studies, it is necessary to examine the cancer mortality patterns of cigarette smokers who were not exposed to asbestos dusts. Unless prevalence of smoking within the study group is carefully evaluated, it