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The Importance of Width in Asbestos Fiber Carcinogenicity and its Implications for Public Policy

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Evidence from human epidemiology, experimental animal implantation and inoculation studies, and lung burden studies shows that fibers with widths greater than 1 μm are not implicated in the occurrence of lung cancer or mesothelioma. Furthermore, it is generally believed that certain fibers thinner than a few tenths of a micrometer must be abundant in a fiber population in order for them to be a causative agent for mesothelioma. These conclusions are fully consistent with the mineralogical characteristics of asbestos fibers, which, as fibrils, have widths of less than 1 μm and, as bundles, easily dissagregate into fibrils. Furthermore, the biological behavior of various habits of tremolite shows a clear dose-response relationship and provides evidence for a threshold between fiber width and tumor experience in animals. Public policy in regulating mineral fibers should incorporate this knowledge by altering the existing federal asbestos fiber definitions to reflect it.

Width and length of fibers are both important parameters in determining the carcinogenic potential of asbestos and other specific fibrous materials. Most investigators who have examined this subject agree that there exists a minimum length and maximum width below which and above which fibers are not related to tumor induction. Although fiber dimension is linked to the pathogenic effects of asbestos and certain other fibrous materials, it is also recognized that fiber characteristics other than dimension (i.e., durability, harshness, surface chemistry, surface area or activity, etc.) likely play an important role in the pathogenetic process. Whatever fiber characteristics contribute to the pathogenicity of asbestos, however, it is important to ensure that size parameters used for regulatory purposes reflect those most closely associated with asbestos and known carcinogenic effects.

Although it is common to see the dimensions of asbestos fibers discussed in terms of a ratio of length to width, or aspect ratio, the use of such a dimensionless parameter results in the loss of information about the size of fibers and, therefore, is of little use in the discussion of fiber carcinogenicity or exposure. While asbestos fiber length is recognized in federal regulatory policy, width is ignored entirely. It is the purpose of this paper to examine the relationship between asbestos fiber width and fiber carcinogenicity, to suggest how this parameter might be used to identify other potentially harmful mineral fibers and to enhance the specificity of existing asbestos regulations.

The National Institute for Occupational Safety and Health (NIOSH) has established the definitions and analytical methods for asbestos used to one degree or another by all asbestos regulatory bodies in the United States. Under the NIOSH scheme, asbestos is simply defined as any fiber of chrysotile, crocidolite, amosite, anthophyllite, tremolite, or actinolite. A "fiber" is defined as a particle with a length to width ratio (aspect ratio) of at least 3:1 and a length of 5 μm or more as determined by the phase-contrast optical microscope (PCM) at a magnification of 450X–500X.[1–2] In this paper a "NIOSH fiber" refers to any particle with these dimensional parameters as determined by any accepted analytical technique.

PREVIOUS WORK

Mesothelioma and Fiber Width

Several investigators have examined the question of what particle sizes are most likely associated with the induction of mesothelioma. Merle Stanton first proposed that a distinct relationship exists between the shape or dimensions of durable fibers and mesothelial tumors in rats.[3] Stanton and co-workers concluded from these experiments that populations with abundant fibers longer than 8 μm and narrower

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