17. MAN-MADE VITREOUS FIBERS

Stuart M. Brooks, M.D., and Wasif M. Alam, M.D., M.S.P.H.

1. What are man-made vitreous fibers (MMVs)? What is their exposure prevalence?

MMVs are a variety of manufactured materials with excellent insulating properties. They are used with increasing frequency as asbestos substitutes and have thousands of applications in industrial and nonindustrial settings. They are used for reinforcement in buildings, ships, and automobiles, as well as home appliances, industrial kilns, and furnaces. Exposure to MMVs occurs during production, fabrication, and application of materials. According to the National Occupational Exposure Survey, approximately 500,000 American workers are potentially exposed to MMVs.

2. Differentiate MMVs from man-made mineral fibers (MMMFs).

MMFs and MMMFs are essentially the same. MMVs are not true minerals; they are amorphous silicates manufactured into a fibrous form. They are grouped, according to origin, into glass fiber (from glass; also called fiberglass), ceramic fiber (from kaolin clay), and mineral wool (from rock or slag).

3. Why are MMVs considered superior to asbestos?

MMVs have generally replaced asbestos as insulating agents in recent years, even though data continue to support the 1988 judgment by the International Association for Research on Cancer (IARC) that mineral fibers are a possible human carcinogen (group 2B). Recent epidemiologic studies provide little evidence of lung carcinogenicity for either glass wool or rock/slag wool. Ceramic fibers, a much less common source of exposure than glass wool and rock/slag wool, are of concern because of positive animal studies, but human data are insufficient. The carcinogenicity of asbestos for the lung and mesothelioma is well established.

4. Name the fibrous minerals most commonly used in industry.

MMVs include glass wool, rock wool, slag wool, glass filaments and microglass fibers, and refractory ceramic fibers (RCFs). RCFs are manufactured for high-temperature applications.

5. What physical characteristics of fibers determine their toxicity and carcinogenicity?

The carcinogenic potential of any fiber is related to its dimension and biopersistence. According to experimental evidence, only fibers longer than 5 microns, thinner than 3 microns, and with a length-to-diameter ratio more than 3 are able to reach the periphery of the lung. In addition to the traditionally considered variables of particle size and shape, mineralogic characteristics such as dissolution behavior, ion exchange, sorptive properties, and the nature of the mineral surface (e.g., surface reactivity) play important roles in determining toxicity and carcinogenicity. The biologic activity of MMVs made of glass, rock, slag, or other minerals does not depend only on their respirability but also on their chemical durability and persistence. In the use of MMVs, the goal is to decrease their harmful effects by increasing their dissolution and removal from the lungs.

6. Discuss the pathophysiology of disease caused by MMVs.

How fibers cause diseases and what specific determinants are critical to fiber-induced toxicity and carcinogenicity are still not completely understood. Further research in fiber toxicology and additional toxicity and exposure data are needed to characterize more accurately the health risks of inhaled fibers. Scanning electron micrographs, however, show that MMVs are readily phagocytized by rat alveolar macrophages (AMs) in culture. The phagocytosis begins within
30 minutes after the onset of the exposure and continues for a 96-hour observation period. Short fibers (< 20 microns in length) are readily phagocytized by AMs, whereas longer fibers are attacked with a large number of AMs. In all studies, ceramic fibers phagocytized by AMs were characterized by moderate fibrotic activity. A statistically significant increase in the incidence of tumor (mesothelioma) was observed in RCFs, which show a carcinogenic potential similar to that of natural asbestos (crocidolite or chrysotile).

7. How is the risk of fiber exposures measured?

Naturally occurring and man-made fibers of respirable sizes have been identified by the U.S. Environmental Protection Agency (EPA) as priority substances for risk reduction and pollution prevention under the Toxic Substances Control Act (TSCA). The health concern for respirable fibers is based on the association of occupational asbestos exposure and environmental exposure with the development of chronic respiratory diseases in humans, including interstitial lung fibrosis, lung cancer, and mesothelioma. Considerable laboratory evidence also indicates that fibers of varying physical and chemical characteristics may elicit fibrogenic and carcinogenic effects in animals under certain exposure conditions. To assess the potential risk associated with production and use of certain man-made materials for which human data are either unavailable or inadequate, it has been necessary to use data from studies conducted in laboratory animals and with cells or tissues. During the past several decades, it has been suggested that data about the mechanisms by which particles cause disease may be used to reduce the uncertainty in estimates of human risks.

8. What are the occupational exposure limits (OELs) for MMVF?

To set OELs for aerosol particles, dusts, or chemicals, one must evaluate whether mechanistic factors permit identification of a no-observed-effect level (NOEL). In the case of carcinogenic effects, an NOEL can be assumed if no genotoxicity is involved, and exposure is considered safe if it does not exceed the NOEL. If tumor induction is associated with genotoxicity, any exposure is considered to be a risk, although an NOEL may be identified in the animal or human exposure studies. The same assumption is made when no information about the carcinogenic mechanism is available. Because carcinogenic effects have been associated with long-thin fiber geometry and high durability in vivo, all fibers meeting such criteria are considered to be unsafe. Investigations of fiber tumorigenicity/genotoxicity should include information about dose-response relationship, pathobiology, particle clearance, and persistence of the material in the target organ. Such information introduces quantitative aspects into the qualitative approach that has so far been used to classify fibrous dusts as carcinogens.

9. How serious are the health effects of MMVF?

Increasing knowledge about the carcinogenic properties of asbestos has given rise to extensive research into possible adverse health effects of alternative materials. MMVF turned out to be of unique interest, because they have already been used for several decades for isolation purposes. Except for RCFs, studies show that inhalation does not provoke tumors in rodents, whereas intratracheal, intraperitoneal, and intraperitoneal stimulation induces a carcinogenic effect for most kinds of MMVF. Compared with asbestos, MMVF clean much faster from lung tissue. No consistent epidemiologic evidence indicates an increased standardized mortality ratio due to malignant tumors of the airways and malignant mesotheliomas in people formerly exposed to MMVF. An itchy skin problem (glass-fiber dermatitis) appears to be far more common than the rather theoretic tumor risk in workers who handle thicker and therefore more irritating fibers without protection. Based on these facts and the actual exposure situation, handling of glass fibers and wool poses no clear-cut cancer risk; however, the potential risk of exposure to RCF has to be evaluated with more caution. In 1988 the IARC classified such mineral fibers as glass wool, rock wool, and slag wool as probably carcinogenic in humans. MMVF breaks transversely, but do not split longitudinally in the manner of asbestos to produce thinner fibers. Thus airborne dust inhaled by workers does not penetrate beyond the longer bronchi.

10. MMVF are classified as "probably their carcinogenicity?"

The mechanism of MMVF carcinogenicity in the production of free oxygen radicals to the initiation of carcinogenesis. When free is exposed to oxidative stress, DNA damage New oxygen radicals may modify DNA and the occurrence of neoplastic cells, MMVF also in the activity of neutrophilic granulocytes and macrophages results in increased production DNA of epithelial cells.

11. Does smoking affect MMVF exposure? 

Experimental studies indicate that the PM and granulocytes and macrophages activated by M in tobacco smoke. The combination of fibers with contribute to the occurrence of neoplastic cells

12. In a workers’ compensation case, when likely due to MMVF?

Before jumping into a diagnosis, one should ask:

- **History**: A thorough history of workers’ leisure activities (e.g., hobbies) should be taken into account. MMVF have thousands of applications.
- **Risk assessment**: Determine whether the what degree and for how long. It is essential to newly exposed to MMVF may develop acute chronic bronchitis, pleural plaques and pleural lung cancer—should be related to long-term characteristics, biodurability and type (e.g., I cancer). Therefore, biomonitoring is needed.

**Biomonitoring**: Biomonitoring may be done analysis, which determines whether MMVF a building product and estimates the amount, ma under microscopy. Air sampling and analysis esti air. Light microscopy with phase-contrast en measures, as used for asbestos, are also available.

**Physical examination**: Glass-fiber derm thick and therefore more irritating fibers. Micro fibers more than 5 μm in diameter. Punctate eryth posse is recent, whereas long-term exposure le discomfort. Glass fiber dermatitis is one dermatitis resulting from mechanical irritation, macules, papules, and folliculitis with exocrin been reported after the first 2 weeks of employ planted splinters of glass fibers. When glass fib isected by indoor air sampling), the direct trauma to the throat. Glass blowers have a significantly high tarrh, chronic sinusitis, and nasal bleeding than other function among glass blowers may show chronic.

Determination of the relationship of MMVF times complex. An interdisciplinary approach m
10. MMVF's are classified as "probably carcinogenic." What is the likely mechanism of their carcinogenicity?

The mechanism of MMVF carcinogenicity remains unclear. It is assumed that their involvement in the production of free oxygen radicals is one of the most important factors contributing to the initiation of carcinogenesis. When free oxygen radicals are produced at a fast rate, the cell is exposed to oxidative stress. DNA damage is an important consequence of oxidative stress. New oxygen radicals may modify DNA and lead to mutation; finally, they may contribute to the occurrence of neoplastic cells. MMVF's also may contribute to the increase of the number and activity of neutrophilic granulocytes and macrophages. The appearance of MMVF fractions in granulocytes results in increased production of free oxygen radicals, which may damage the DNA of epithelial cells.

11. Does smoking affect MMVF exposure?

Experimental studies indicate that the production of free oxygen radicals by neutrophilic granulocytes and macrophages activated by MMVF's increases under the influence of chemicals in tobacco smoke. The combination of fibers with tobacco smoke may amplify DNA damage and contribute to the occurrence of neoplastic cells.

12. In a workers' compensation case, when can you say that ill health effects are most likely due to MMVF's?

Before jumping into a diagnosis, one should ask the following important decision-making questions:

**History.** A thorough history of workers' past and present employment together with their leisure activities (e.g., hobbies) should be taken. A detailed history is often enough to make a diagnosis. MMVF's have thousands of applications in nonindustrial settings.

**Risk assessment.** Determine whether the person is at all exposed to MMVF and, if so, to what degree and for how long. It is essential to understand dose-response relationships. Workers newly exposed to MMVF's may develop acute respiratory and skin irritation. Pneumoconiosis, chronic bronchitis, pleural plaques and pleural thickening, and asbestos-like effects—especially lung cancer—should be related to long-term exposure. It is important to know the fiber's physical characteristics, biodurability and type (e.g., RCF's rather than glass wool may result in lung cancer). Therefore, biomonitoring is needed.

**Biomonitoring.** Biomonitoring may be divided into two general categories. Bulk sample analysis, which determines whether MMVF's are present in bulk material (usually some sort of building product) and estimates the amount, may be done by polarized light microscopy or electron microscopy. Air sampling and analysis estimate the number of fibers present per volume of air. Light microscopy with phase-contrast enhancement is commonly used. Direct reading meters, as used for asbestos, are also available for estimating concentrations of airborne fiber.

**Physical examination.** Glass-fiber dermatitis is commonly associated with exposure to thicker and therefore more stinging fibers. Mechanical irritation of the skin may result from fibers more than 5 μm in diameter. Punctate erythema and itching may be produced when the exposure is recent, whereas long-term exposure leads to hardening of the skin, usually without itching. Discomfort. Glass-fiber dermatitis is one of the most common forms of occupational dermatitis resulting from mechanical irritation. Intense itching accompanied by erythematous macules, papules, and folliculitis with excoriation over arms, neck, face, and upper chest has been reported after the first 2 weeks of employment. Paronychia and warts may result from implanted splinters of glass fibers. When glass fibers contaminate an indoor environment (as detected by indoor air sampling), the direct trauma of inhalation may cause cough, epistaxis, and sore throat. Glass blowers have a significantly higher prevalence of chronic bronchitis, nasal catarrh, chronic sinusitis, and nasal bleeding than control workers. Therefore, measurement of lung function among glass blowers may show chronic respiratory findings.

Determination of the relationship of MMVF's to the health complaints of a worker is sometimes complex. An interdisciplinary approach must focus on the occupation medicine specialist,
industrial hygienist, employee, employer, and workplace. However, decision making is the responsibility of the occupational medicine specialist with the required knowledge and training.

BIBLIOGRAPHY


18. CARBON MONOXIDE

Elizabeth A. Katz, M.P.H., C.I.H.

1. What substance is the leading cause of Carbon monoxide (CO) causes over 800 to acute CO illness exceed 10,000 nationally. byproduct of combustion.
2. What are the symptoms of acute CO? Symptoms of acute CO poisoning include chest pain, visual disturbances, decreased in stupor may progress to unconsciousness. Ons
3. Why does mild-to-moderate CO intoxication? The nonspecific symptoms which may result in widespread undiagnosed morbidity in persons or household members may be misinterpreted as alcohol level, which has been noted in many complicating factor, because signs and symp toms. CO is odorless and colorless and can be biologic samples.
4. What are the immediate sequela of severe acute intoxication leads to loss of the heart and may cause death. A short period of time can be adverse effect.
5. Besides CO, what other products of CO? Depending on the material the other toxic materials may be formed. In addition, to vaporize.

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<tr>
<th>Toxic Product</th>
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<tbody>
<tr>
<td>Cyanide gas</td>
<td>Ureth</td>
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<tr>
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<td>Chlor</td>
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Toxic Product