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The Health Relevance of Ambient Particulate Matter Characteristics: Coherence of Toxicological and Epidemiological Inferences

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The aim of this article is to review progress toward integration of toxicological and epidemiological research results concerning the role of specific physicochemical properties, and associated sources, in the adverse impact of ambient particulate matter (PM) on public health. Contemporary knowledge about atmospheric aerosols indicates their complex and variable nature. This knowledge has influenced toxicological assessments, pointing to several possible properties of concern, including particle size and specific inorganic and organic chemical constituents. However, results from controlled exposure laboratory studies are difficult to relate to actual community health results because of ambiguities in simulated PM mixtures, inconsistent concentration measurements, and the wide range of different biological endpoints. The use of concentrated ambient particulates (CAPs) coupled with factor analysis has provided an improved understanding of biological effects from more realistic laboratory-based exposure studies. Epidemiological studies have provided information concerning sources of potentially toxic particles or components, adding insight into the significance of exposure to secondary particles, such as sulfate, compared with primary emissions, such as elemental and organic carbon from transportation sources. Recent epidemiological approaches incorporate experimental designs that take advantage of broadened speciation monitoring, multiple monitoring stations, source proximity designs, and emission intervention. However, there continue to be major gaps in knowledge about the relative toxicity of particles from various sources, and the relationship between toxicity and particle physicochemical properties. Advancing knowledge could be facilitated with cooperative toxicological and epidemiological study designs, with the support of findings from atmospheric chemistry.

Although ambient air particulate matter (PM) has been clearly associated with adverse human health outcomes (NRC, 2004; U.S. EPA, 2004), the relationship between specific physicochemical properties of PM and these health effects remains largely unresolved. One of the major barriers to continued advancement in this regard has been the lack of a comprehensive integration of current knowledge derived from three different disciplines, namely, atmospheric chemistry, toxicology, and epidemiology. In fact, the current (U.S.) National Ambient Air Quality Standards (NAAQS) for PM are founded on a long

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