

Health Effects of Particulate Matter

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PARTICULATE MATTER (PM)

- ◆ PM is a mixture, including particles of differing origin (combustion, crustal, biological) and varying size.
- ◆ Particles of respirable size:
 - PM₁₀ includes so-called coarse fraction;
 - PM_{2.5} is the fine fraction;
 - PM_{<0.01mm} is the ultrafine fraction.

PM: Acute Health Effects

- ◆ increased respiratory symptoms
- ◆ decrements in lung function (peak flow)
- ◆ increased bronchodilator use
- ◆ increased hospitalizations for respiratory disease (pneumonia, asthma, bronchitis)
- ◆ increased cardiopulmonary mortality

PM: Chronic Respiratory Effects

- ◆ Decreased rate of growth in lung function in association with PM exposure observed longitudinally in Southern California Children's Health Study (also in Austria).
- ◆ Increased risk of lung cancer related to PM exposure.

PM and Asthma

DIESEL EXHAUST PARTICULATE

- ◆ **Induces airway inflammation in normal subjects.**
- ◆ **Enhances local allergic responses after nasal instillation in humans.**
- ◆ **Induces airway responsiveness in mice; enhances lower airway responses to allergen in mice.**

PM-associated Mortality

Epidemiological Data

- ◆ Multiple time-series studies have shown cardiopulmonary mortality to be associated with levels of particulate matter (PM).
- ◆ Several longitudinal studies have also linked chronic PM exposure and mortality.

POTENTIAL MECHANISMS FOR PM-CAUSED MORTALITY

- ◆ Increased susceptibility to infection leading to pneumonia
- ◆ Enhanced severity of preexisting pulmonary conditions
- ◆ Acute cardiovascular events (perhaps secondary to pulmonary and systemic inflammation *or* autonomic nervous system stimulation)

"COHERENCE" OF PM RESPIRATORY MORBIDITY/MORTALITY EPI DATA

- ◆ **Small decrements in lung function are not likely to cause even patients with preexisting lung disease to die.**
- ◆ **PM-associated lung function changes are small in asthma and COPD patients.**
- ◆ **The level of PM inhaled with a single cigarette > than the ambient levels associated with increased mortality.**

COHERENCE WITH RESPIRATORY TOXICOLOGIC DATA?

- ◆ **Animal studies -- exposure to concentrations of single pollutants much higher than ambient levels is required to cause acute respiratory toxicity.**
- ◆ **Human studies -- exposure to diesel exhaust and concentrated ambient particulate (CAP) have induced mild airway inflammation.**

COHERENCE OF CARDIAC MORBIDITY/MORTALITY EPI DATA

- ◆ Several studies have shown an association between hospital admissions for cardiovascular disease and PM levels.
- ◆ Increased heart rate, decreased heart rate variability, increased arrhythmias, increased C-reactive protein, and increased plasma viscosity have been associated with PM exposure in humans.

COHERENCE WITH CARDIOVASCULAR TOX DATA?

◆ Animal studies

- inhalation of CAP has been shown to decrease heart rate variability in dogs.
- inhalation of CAP, oil fly ash, and transition metals has caused increased toxicity in animal models of cardiovascular disease.

PM-associated Mortality

- ◆ The epidemiologic database is consistent re: PM-cardiopulmonary mortality association.
- ◆ There is coherence of epidemiologic data re: acute morbidity effects.
- ◆ Although PM-induced morbidity is coherent with the mortality effect, the magnitude is insufficient to explain increased mortality.

PM-MORTALITY ASSOCIATION: BIOLOGIC PLAUSIBILITY

- ◆ The mechanism(s) that mediate the acute mortality effect of PM remain unclear (oxidative stress is currently the most popular).
- ◆ The specific components of PM of urban that are most responsible for the mortality effect is also unclear.
- ◆ More experimental research is needed to understand the acute toxicity of PM.