PROJECT UPDATE

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New York Energy $mart℠

EMEP Environmental Monitoring, Evaluation, & Protection

New York State Energy Research and Development Authority

Environmental Monitoring, Evaluation, and Protection Program

NYSERDA

ULTRAFINE PARTICLES AND CARDIAC RESPONSES: EVALUATION IN A CARDIAC REHABILITATION CENTER

Principal Researcher

MARK J. UTELL

WILLIAM BECKETT

University of Rochester Medical Center

Project Location

Contact Information

For more information on this project see:

http://www.nyserda.org/programs/environment/emep

or contact Ellen Burkhard at: egb@nyserda.org

Keywords

- Biomarkers
- Cardiovascular health effects
- Fine particles (FPs)
- National Ambient Air Quality Standards (NAAQS)
- Ultrafine particles (UFPs)

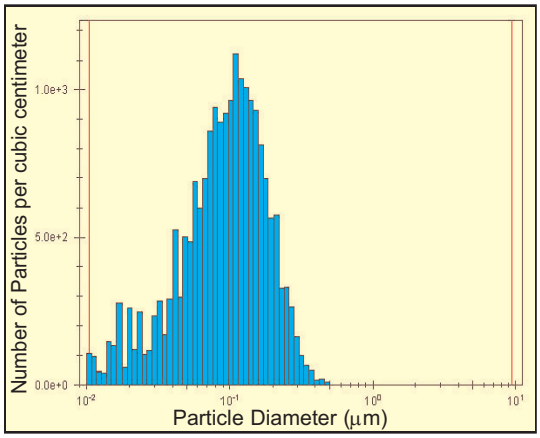
PROJECT FOCUS

As the U.S. Environmental Protection Agency (EPA) and New York State are proceeding with the implementation of mass-based National Ambient Air Quality Standards (NAAQS) for particular matter (PM), clarification of the effects of exposure to ultrafine particles (UFPs) is a high-priority research need. Focusing on a group of sensitive, high-risk patients, this study will assess how exposure to ambient levels of UFPs affects the indicators of cardiovascular function, both at rest and during exercise.

CONTEXT

Epidemiological studies have demonstrated that ambient PM pollution increases cardiac morbidity and mortality. However, the role that different PM components (e.g., organics, metals, and UFPs) play in cardiovascular health effects is still unclear. Several hypotheses have been proposed, and various components and characteristics of PM have been targeted for exploration. Recent research has pointed to UFPs as potentially playing an important role in these deleterious effects.

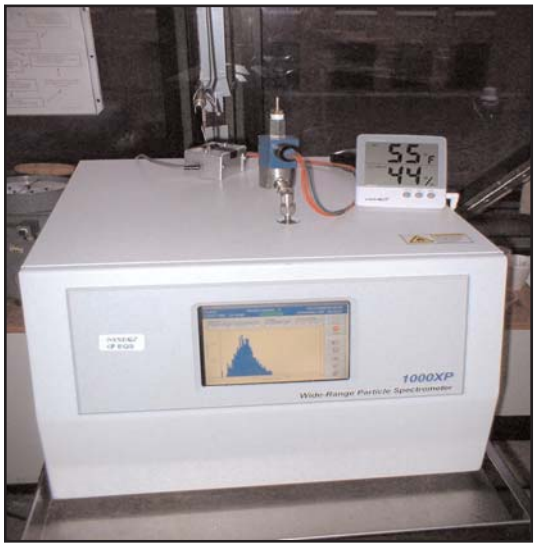
UFPs are extremely small particles, less than 0.1 micron in diameter, that are primarily generated from combustion processes, including stationary fossil-fueled electric-power generation, industrial processes, boilers, and car and truck engines. For the same PM mass, these particles have much higher number concentrations and surface area than larger particles, as well as very high deposition rates in the human respiratory tract. Clinical studies have shown changes in cardiac parameters for healthy subjects when UFPs were inhaled in high numbers in a laboratory setting. The current research builds on two previous studies of UFPs, which



Credit: Mark Utell

Typical particle size distribution

- Characterized the UFP temporal variation year-round at Rochester NY, finding a morning peak for UFPs, believed to be associated with rush-hour traffic, and an afternoon peak believed to be associated with a nearby coal-fired power plant.
- Studied the effects of controlled exposures to UFP at concentrations ranging from 10-50 µg/m^3, finding alterations in cardiovascular function in healthy, exercising volunteers in the laboratory.



Credit: Mark Utell

Air monitoring equipment

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Credit: Mark Utell

Indoor sampling site

Project Status

- Initiated October 2005
- Project ongoing

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PUB

George E. Pataki, Governor

Since 1975, the New York State Energy Research and Development Authority (NYSERDA) has developed and implemented innovative products and processes to enhance the State's energy efficiency, economic growth, and environmental protection. One of NYSERDA's key efforts, the Environmental Monitoring, Evaluation Protection (EMEP) Program, supports energy-related environmental research. The EMEP Program is funded by a System Benefits Charge (SBC) collected by the State's investor-owned utilities. NYSERDA administers the SBC program under an agreement with the Public Service Commission.

METHODOLOGY

This study will examine how exposure to UFPs affects cardiovascular responses in patients in Rochester, NY, who are undergoing medically monitored exercise rehabilitation after acute coronary events, such as myocardial infarctions (heart attacks) or unstable angina leading to coronary stenting (the insertion of a tubular support in cardiovascular surgery). The subjects of the study will be 80 patients with coronary artery disease at the University of Rochester Medical Center's Cardiac Rehabilitation program. Numerous cardiac health parameters will be monitored while the subjects are at rest and when they are exercising, during twice-weekly sessions that include treadmill, bicycle, and rowing exercise for 30 minutes for a period of 10 weeks.

The project team will simultaneously collect air-quality data on particle numbers and sizes; $PM_{2.5}$, SO_2, and O_3 concentrations; and temperature and humidity. Ambient UFP data obtained at the Cardiac Rehabilitation Center will include total UFP number concentrations, size-fractionated number concentrations, and calculated mass concentrations. These data will be supplemented by UFP data collected at a New York State (NYS) Department of Environmental Conservation site in downtown Rochester. Several U.S. EPA criteria pollutant concentrations and meteorological variables (wind speed and direction, temperature) will also be measured there. Finally, using the air quality data collected in conjunction with health data from the rehabilitation study, the project team will assess whether ambient UFP exposures in NYS are associated with alterations in changes in cardiovascular health endpoints.

PROJECT FINDINGS

Not yet available.

The project team hypothesizes that in vulnerable subjects elevated levels of ambient UFPs and fine particles (FPs) are associated with

- Slower and compromised rehabilitation;
- Changes in autonomic nervous system function;
- Changes in myocardial substrate and myocardial vulnerability; and
- Changes in indicators of enhanced cardiovascular risk.

PROJECT IMPLICATIONS

This is the first study focusing on highly susceptible cardiac patients in which UFP level variations will be well characterized, allowing cardiac measurements to be related to real-world UFP exposure. Responding to the pressing research need to clarify the extent to which UFPs may be responsible for adverse health effects of $PM_{2.5}$, the study's findings will be an important contribution to our knowledge of the risks of UFPs versus those of larger particles and the potential health effects of specific types of emission sources.

Credit: Mark Utell

Outdoor sampling site.

Better knowledge of the adverse health effects of UFPs may raise the question of whether mass-based NAAQS are adequately protective of human health. While these current standards address mass concentrations of $PM_{2.5}$ in ambient air, a small mass concentration of particulate matter can mean very high number concentrations of UFPs. The results of further assessments of the cardiovascular and pulmonary effects of UFPs may necessitate reconsideration of the regulatory regime for $PM_{2.5}$.