Ultrafine Particles and Cardiac Responses: Evaluation in a Cardiac Rehabilitation Center

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ABSTRACT:
This study examines the effects of ultrafine particles (UFP) on cardiovascular responses in patients undergoing medically monitored exercise rehabilitation in Rochester, NY following hospitalization for acute coronary events, such as myocardial infarctions (heart attacks) or unstable angina. 75 patients will be participating and are closely monitored during their rehabilitation 12-week protocol; to date, 29 patients have been enrolled and 19 have completed the entire protocol. The patients undergo physiologic monitoring (Holter monitor) as well as blood sampling; complete medical histories and diaries are also recorded. The program involves supervised, grade twice or thrice weekly exercise sessions for a total of 12 weeks. Ultrafine particle number and size (Wide range Particle Spectrometer, MSP Corp.) are being measured continuously outdoors (3.8 ± 0.8 (SD) x10^3 p/cm^3) at the rehab site. Particle number, size (TSI SMPS model 3071), and mass (TEOM) are also measured continuously at a central measuring site in eastern Rochester. Other EPA criteria pollutants are measured at the eastern Rochester DEC site. In addition, one-third of the patients (n = 25) will have personal particle count monitoring in their cars to and from the rehab facility (n ~ 8 completed, particle count concentration ~ 17.3 ± 7.7 (SD) x10^3 p/cm^3, and in their homes (n ~ 12 completed, particle count concentration ~ 9.4 ± 7.8 (SD) x10^3 p/cm^3) for 48 hours using a portable nucleic counter (TSI model 3781).

DATA ACQUISITION:
Measured continuous size-fractionated particle matter samples from indoor and outdoor air of a functional cardiac rehabilitation facility located in Rochester, NY (Fig. 1). The Spectrometer was run in SMS mode allowing for measurement of particles in the size range 10 – 500 nm every four minutes. Also, outdoor number concentrations and size distributions of fine and ultrafine particles in the same size range (10 – 500 nm) are being measured every five minutes at the New York State Department of Environmental Conservation (NYS DEC) monitoring site in Rochester, NY (Fig. 2). NYS DEC site measurements are being made using an SMPS consisting of a DMA and CPC (TSI Models 3071 and 3010, respectively). The simultaneously measured outdoor concentrations at this site (Fig. 4) were compared with measurements made at the DEC site (Fig. 3). A subset of subjects are measuring particle number concentration at home and in their automobile using a water-based CPC (TSI model 3871).

Protocol Information
•Subjects live within 5 mile radius of one of the two particle monitoring sites.
•Outcome variables adjusted for:
  •Days since cardiac event
  •Current use or changes of medication
  •Weather variables
  •Estimated completion in 2008

Rehab Demographics
•29 Subjects signed consent.
•1 dropped out, 3 finished part of entire protocol.
•19 completed 10 week protocol (all Caucasian).
•6 currently still enrolled in protocol.

Cardiac Variables
•Heart Rate variability (Arrhythmias) •QT interval duration (Ischemia)
•T-wave amplitude and variability

RESULTS AND DISCUSSION:
We have gathered ultrafine particle data continuously at both the cardiac rehab site since 2004 and the DEC site since 2002 thus providing ample data to support further analysis of particle size distribution data to estimate source apportionment in relation to outcomes in these subjects. We have previously shown nucleation event based increased particle levels with a relationship to SO2 or, as a result of emissions from local sources. Consistent measurements from 2002 to 2007 have been made at the DEC site (7.1/±3.8 2007, 8.2/±5.3 2002). There is a good correlation (r²=0.35) between the DEC and Cardiac Rehab ultrafine particle monitoring and between Indoor and Outdoor measurements at the Rehab site (r²=0.48). Home and car monitoring have shown personal exposure to vary greatly indoors with point sources (stoves, heating) causing large temporary excursions. Cardiac endpoints will be compared to this extensive data set in future analyses.

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