한국대기환경학회 2004 춘계학술대회 논문집
Proceeding of the 37th Meeting of KOSAE(2004)
Korean Society for Atmospheric Environment

2A1) 농축된 대기 중 미세입자에의 노출이 성인 쥐의 폐에 미치는 영향

Effects of Exposures of Concentrated Fine Particles in the Lungs of Adult Rats

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1. INTRODUCTION

Recent epidemiological studies have suggested a strong correlation between particle-induced health effects and particles in the fine-mode fractions of PM10. Part of the difficulty in identifying adverse health effects of PM is that creating particles similar to "real-world" PM to study the effects on animals or humans in a controlled environment is extremely difficult.

The concentrator used in this study is designed to concentrate both ultrafine and fine PM. This system uses hydration to enlarge particles to super-micrometer droplets with super-saturation and condensation. The particles are then separated by size using a virtual impactor and returned to their original (ambient) size by passing through a diffusion dryer that removes particle-bound water

In the Central Valley of California, contributors to ambient particulate matter include agricultural and ranching activities, fires, wind-blown dust, vehicle exhaust, power plant emissions, and home heating. The intent of this study was to determine if concentrated PM2.5 are cytotoxic and/or proinflammatory in the lungs of healthy adult rats. Following 3 days of exposure (4 hours per day) we measured BAL cell viability, total cells, as well as numbers and relative proportions of macrophages, neutrophils and lymphocytes from rats exposed to CAPs..

2. MATERIALS AND METHODS

Nine- or ten-week-old male Sprague-Dawley rats, free of respiratory disease were quarantined for 1 week prior to exposure to CAPs. The rats were housed in plastic cages with TEK-Chip pelleted paper bedding and were maintained on a 12 hour light/12 hour dark cycle. All animals had access to water *ad libitum* before and after, but not during, exposures due to the design of the exposure chamber.

Concentrated fine and ultrafine ambient particles were generated by means of portable Versatile Aerosol Concentration Enrichment Systems (VACES), that are capable of enriching the concentration of particles in the entire range of 0.01- 10 μm by a factor up to 40, depending on the output flow rate. Smaller PM fractions are drawn through a saturation-condensation system that grows particles to 2-3 μm droplets, which are subsequently concentrated by virtual impaction. Two diffusion dryers are used downstream of the virtual impactors/concentrators to remove excess water vapor and return the concentrated particles to their original size, prior to supplying them for *in vivo* exposures. Parallel filters were analyzed to determine the concentrations of particle-bound trace elements, inorganic ions, elemental and organic carbons.

Immediately following exposure on the third day, rats were anesthetized with pentobarbital and exsanguinated via the abdominal aorta. The tracheas were cannulated and the lungs were lavaged with phosphate-buffered saline. BAL fluid was centrifuged and the cell pellet was resuspended in

PBS. One aliquot of the resuspended cells was used to determine total cell count and viability. Cell viability was measured as an indicator of irreversible loss of plasma membrane integrity. A second aliquot of the resuspended cells was centrifuged to prepare cell differential slides. The slides were dried at room temperature and stained for cell differentials. Macrophages, neutrophils, and lymphocytes were counted using light microscopy.

3. RESULTS

The mean mass concentration of particle ranged from 190 to 847 $\mu g/m^3$, enriched primary with ammonium nitrate, organic and elemental carbons, and metals. Viability of BAL cells from rats exposed to concentrated PM was significantly decreased during 4 of 6 weeks, compared to rates exposed to filtered air ($p<0.05$) as shown in figure 1. Total BAL cells were increased during 1 week of the 6-week study, while macrophages increased during 1 week and neutrophils during 2 week. The decreased cell viability in PM-exposed rats is indicative of cell membrane damage, possibly through oxidative stress catalyzed by transition metals or polar organic compounds. Increased neutrophils in PM-exposed rats indicate a mild inflammatory response. These observations suggest that exposure to enhanced concentrations of ambient ultrafine and fine particles in Fresno, CA is associated with significant effects in the lungs of healthy adult rats.

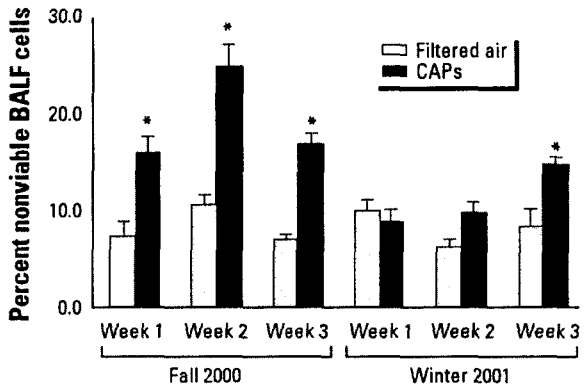

Fig. 1. Percentage of non-viable cells in BAL fir six weeks of studies in fresno (*$p<0.05$).

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