Preface

Special Issue of Inhalation Toxicology for Air Pollution and Health: Bridging the Gap from Sources-to-Health Outcomes

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This preface provides a brief summary of the contents of this special issue of *Inhalation Toxicology*, preceded by a brief overview of the conference where these selected papers were presented.

The Conference

EPA has established National Ambient Air Quality Standards (NAAQS) for six principal air pollutants or "criteria pollutants" that include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter in two size ranges [less than 2.5 μm (PM2.5) and less than 10 μm (PM10)], ozone, and sulfur dioxide (http://www.epa.gov/air/criteria.html). While associations have been identified between these pollutants and adverse health effects, considerable uncertainty remains with regards to the methods and approaches to understanding relationships between air pollution and health effects, such as, which components (gas and or aerosol) and/or sources are most toxic, the mechanisms of actions of the pollutants and causal relationships, effect of confounding factors, and who are susceptible populations, especially for particulate matter since it is composed of many individual species (EPA 2006a (ozone), EPA 2006b (Pb), EPA 2008a (NOx), 2008b (SOx), EPA 2009 (PM), EPA 2010 (CO)). Air pollution and health research continues to reduce these uncertainties across the source-to-health effects paradigm as indicated by the National Research Council (NRC 1998, 1999, 2001, 2004) and EPA (EPA 2006a, 2006b, 2008a, 2008b, 2009, 2010).

Linking air pollution and adverse health effects is complicated and requires expertise across a range of scientific disciplines from atmospheric sciences to exposure to health effects scientists as well as inclusion of air quality managers and policy makers who develop and implement policy to reduce risk from air pollution. Interaction among these groups at different points in time helps to identify gaps in knowledge and suggest future research directions. "***Air Pollution and Health:***

Bridging the Gap from Sources to Health Outcomes" an international specialty conference by the American Association for Aerosol Research (AAAR) (http://aaar.2010specialty.org/) provided one such opportunity for these interactions. The Conference was organized and chaired by Drs. Paul Solomon (U.S. EPA) and Maria Costaintini (HEI) and was designed to help disseminate and integrate results from scientific studies that cut across the range of air pollution and health related disciplines of the source-to-health effects continuum. Conference objectives are listed in Table 1. The Conference was multi-pollutant, focusing across the five key science areas of the NRC paradigm: sources, atmospheric sciences, exposure, dose, and health effects. Eight key policy-relevant science questions that integrated across various parts of the science areas formed the basis of the meeting. A ninth question addressing policy implications of the results also was included. The science questions are listed in Table 2.

This was AAAR's third international specialty conference and extends the findings presented at AAAR's first specialty conference "Particulate Matter: Atmospheric Sciences, Exposure, and the Fourth Colloquium on PM and Human Health," Pittsburgh, PA, 2003 (Davidson et al. 2005). Results from the 2010 AAAR Air Pollution and Health conference are being published in five special journal issues (*Inhalation Toxicology*, this issue; Aerosol Science and Technology; Atmospheric Environment; Environmental Health Perspectives; and Air Quality, Atmosphere and Health). These five special issues should be published by spring 2011. A sixth issue with papers addressing each of the science questions is in process in Air Quality, Atmosphere and Health, which should be published later in 2011.

This Issue

This special issue of *Inhalation Toxicology* includes selected papers from the Air Pollution and Health conference that align with the goals and objectives of *Inhalation Toxicology*.

The lead paper in this special issue provides a brief informative overview of new developments in aerosol dosimetry (Phalen et al.). New information relating to influence on body size, gender, race, age, lung diseases, and other factors affecting particle dosimetry are coming to light, but more research is needed to fully understand the interactions and implications. New advancements in dosimetric modeling of inhaled particles are noted. Ultrafine (UF) and nano-particles, including engineered nanoparticles are opening up new challenges in the field of dosimetry, especially in regards to recent studies indicating the translocation of UF particles beyond the lung to many other organs, including the brain, the latter now also directly impacted by UF via the olfactory nerves.

The second paper describes a retrospective health effects study examining the relationship between hospital admissions and cardiovascular (CV) and respiratory diseases as well as daily CV and respiratory mortality and total mortality. Associations were examined with UF to accumulation mode particles by count separated into three bin sizes and PM2.5. Strongest associations were observed with accumulation mode particles and no associations were observed for daily mortality.

Jumping ahead, in the last paper, Chang et al. calculate a hazard index (HI) based on occupational exposures (air concentrations) within the integrated iron and steel industry. This exposure assessment was conducted to evaluate the potential VOC uptake by inhalation within four process areas of the industry, focusing on the chronic exposures related to non-cancer health risks. They calculated the HI for sixteen selected volatile organic carbon (VOC) compounds. HI ranged from 17-108, where HI < 1 for a specific compound is considered safe.

The remaining 8 papers describe either *in-vitro* (Maciejczyk et al.; Akhtar et al.; Jalava et al.) and/or *in-vivo* studies that all measured various biomarkers to indicate potential health effects from the selected pollutant(s) or source(s). Biomarkers include known biological indicators of inflammation, such as oxidative stress measured by reactive oxygen species (ROS) or NF-κB, as well as physiological effects, such as changes in heart rate or heart rate variability. Other biomarkers include changes in gene expression, cytotoxicity, and endothelial progenitor cells (EPC).

In-vitro studies include exposures of diesel and biodiesel (Jalava et al.); a series of Standard Reference Materials (SRM), including non-ferrous dust, urban PM, diesel PM, and ambient PM2.5 (Akhtar et al.); and concentrated ambient particles (CAPs) in New York City (Maciejczyk et al.). The *in-vivo* studies reported within include tracheal instillation and/or inhalation of either mice or rats. Murine exposures include source material (Tzamkiozis et al.) or specific air pollutant components (gasoline, diesel, or biodiesel; flame generated soot; ozone or ozone-carbon black sequentially; Ni nannoparticles; and engineered nanoparticles) (Tzamkiozis et al.; Van Winkle et al.; Hamade et al.; Liberda et al.; Demokritou et al., respectively). Two *in-vivo* studies examined the effect of age, one on rats, the other mice (Van Winkel et al.; Hamada et al., respectively).

Overall, significant and strong associations were found with Ni or Ni nanoparticles, whereas significant but weaker associations were observed with Zn, Fe, Cu, Cr, and other redox active components. However, its important to note that while these trace components (e.g. redox active transition metals) continue to be significantly associated with biomarkers of adverse health effects, they comprise only a very small fraction of the PM mass (e.g. 10s to a few 100 ng/m^3 versus 1 to a 100 μg/m^3 for PM2.5 mass (Maciejczyk et al.). Biodiesel exposures appeared to be less toxic than standard diesel (Jalava et al.). Response to air pollution varied by age and strain of the murine tested and may be genetically influenced as well. Exposures to engineered nanoparticles of Ni, Fe_2O_3, SiO_2, or Ag-SiO_2 composite indicated potential adverse effects based on the biomarkers measured, e.g. cytotoxicity or EPC.

It also is important to note, that while informative, these studies do not tell the entire story, which is often complicated by contradictory results among different independent studies, perhaps a function of studies focusing on different source materials/sources/species, different biomarkers, and different health outcomes. One conference objective was to bring together a wide range of studies across the source-to-health effects continuum, for comparison, discussion, and dissemination to the extent possible, in concrete packets such as this special issue as well as the others associated with the 2010 AAAR Air Pollution and Health international specialty conference. We believe the conference and subsequent publications achieved this objective.

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Declaration of Interest

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Table 2. Conference Objectives.

1. Bring together researchers from across the source-to-health outcomes paradigm (NRC 1998) to engage in discussion and rigorous debate regarding the latest information on linking adverse health effects of air pollution to emissions sources and atmospheric pollutants.

2. Communicate effectively the latest information to scientists, air quality mangers in the public and private sectors, and policy makers in support of developing efficient and cost effective approaches to decreasing acute and chronic adverse health effects from air pollution on community and regional scales. The conference theme is multi-pollutant focusing on the sources, fate, and health effects of ambient air pollutants. The meeting is designed to appeal to a large interdisciplinary international audience.

3. Highlight findings from major measurement, data analysis, and modeling studies and programs conducted since the last AAAR PM and health conference in 2003. Papers and presentations that show linkages from sources to air quality and/or air quality to health outcomes are strongly encouraged.

4. Add significantly to the peer-reviewed literature by publishing research results presented at the conference in a variety of special issues of selected journals and or synthesis papers.

Table 2. Science Questions

1. **Pollutants and Sources Associated With Health Effects.** How does our understanding of the health effects of air pollutants (singly or in mixtures) help identify pollutants that can be linked to sources the control of which would provide maximal health benefits? (Overarching Theme)

2. **Reliability of Methods, Models, and Approaches.** How reliable are methods (measurements and models) and approaches (epidemiological and toxicological) for studying and quantifying the links between air pollutants (species and or sources) and adverse health effects?

3. **Pollutant Characterization and Population Exposure.** How do relevant pollutant properties vary in space and time from sources and in ambient air; what are the implications of these variations for population exposure?

4. **Relation between Exposure and Dose.** What advances have been made in understanding the relationships between exposure, both spatially and temporally, and estimates of dose that tie to health outcomes?

5. **Mechanisms of Action and Biomarkers of Exposure and Effects.** Are patterns emerging that relate component(s) of air pollution and/or source types to mechanisms? What is the status of identifying and measuring biomarkers of exposure and/or adverse health effects from air pollution?

6. **Susceptible Populations.** Who are the susceptible populations, what drives different susceptibilities to the same or different air pollutants, and are there susceptibility traits associated with specific health outcomes that are common among the subpopulations?

7. **Confounding or Other Factors.** What roles do confounding or other factors have in increasing, decreasing, or obscuring attribution of the true health effects from ambient air pollutants?

8. **Accountability.** Do actions taken to improve air quality result in reduced ambient concentrations of relevant pollutants, exposure, and health effects, and have we encountered unintended consequences?

9. **Regulatory and Policy Implications.** What are the policy implications of our improved understanding of the source to health effect paradigm?