

## FOREWORD

# Aerosol dynamics and health: strategies to reduce exposure and harm

Gerald Rupp

Vice President for Research, Institute for Science and Health, 300 Hunter Avenue, Suite 110, St. Louis, MO 63124, USA

### Conference abstract

The term 'air pollution' is used to describe the presence of chemicals or materials in the atmosphere that produce poor air quality. Air pollutants may be classified into four principal categories which include anthropogenic (man-made; e.g. combustion products), biogenic (biological; e.g. pollen, allergens), technogenic (technology; e.g. metal aerosols or smelter) and geogenic (geological; e.g. erosion of earth, i.e. minerals, volcanic ash). From these categories are derived the seven main pollutants of human health concern, i.e. carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide, hydrocarbons, lead, and particulate matter (PM). The common provenance of all these emissions is from the combustion of fossil fuels (e.g. coal, petrol and diesel), biomass (e.g. cooking) and tobacco smoke. PM is now considered to be the most precarious of pollutants, with the combustion-derived nano-particles being linked to a myriad of premature and excess deaths world-wide; especially for persons with pre-existing cardiovascular disorders. This meeting intended to bring together scientists from a host of disciplines (toxicologists, biologists, chemists, physicists and material scientists) that work at the bio-particulate interface. It aimed to present and discuss, via topical 'break-out' sessions, the current thoughts on the 'burden to human health' following exposure to and harm from combustion-derived particles. Furthermore, strategies for 'harm reduction' were another feature of this cross-disciplinary meeting. The final objectives were to identify biomarkers of exposure and harm to these inhalation hazards. All topics covered sought to find biomarker indices for human health effects.

### Conference summary

In June 2008, the Institute for Science and Health (IFSH), USA, convened a conference in Cardiff, Wales, UK. The conference was organized by Dr. Gerald Rupp (Vice President for Research, IFSH) and Dr. Kelly Bérubé (School of Biosciences, Cardiff University). The topic, *Aerosol Dynamics and Health*, was run in conjunction with 'The Aerosol Society UK', a major European society recognized for its collective expertise in aerosol science - an acknowledged area of strength in Europe. The conference brought together an international audience of speakers and delegates where the participants were treated to an exciting programme of research with stimulating presentations from leading presenters from the USA, Canada, Europe and the UK.

Professor Frank Kelly (Kings College London, UK) opened the meeting by presenting a keynote reception presentation on *London air quality - a real world experiment in progress*. He noted that despite the air quality

gains achieved in previous decades, like many other large cities around the world, London continued to experience high levels of air pollution, owing to a combination of mobile sources and regional background. In view of widespread public concern about the health effects of air pollution, the Mayor of London launched the Air Quality Strategy (2002), setting out policies and proposals to move towards the point where pollution no longer poses a significant risk to human health. The primary focus of the strategy was the reduction of pollution from road traffic - the main source of the pollutants of concern from within the city.

The first meeting session, *Differential Health Effects of Environmental Aerosols*, chaired by Dr. Timothy Jones (Earth Sciences, Cardiff University, Wales, UK) was divided into three key topic areas that included *characterization, measurement and anthropogenic sources* of particulate matter. The speakers (from Ireland, Spain, Germany, Brussels, Scotland and Wales) covered topics ranging from shipping and port emissions to finding

chemical biomarkers that define air pollution from ship exhaust relative to city roadsides (*characterisation*), EU emissions standards as biomarkers of improved human health (*measurement*) and physicochemical fingerprinting of airborne particles derived from municipal landfills (*man-made sources*).

The session on *Aerosol Dynamics: Measurement, Dosimetry, Toxicology* (meeting session two), chaired by Dr. John McAughey (British American Tobacco, England, UK) included a focus on particle deposition in the human respiratory system by using *in silico* modelling and biomarkers of exposure to inhaled debris, as a means to achieve desired aerosol doses. The toxicology of combustion-derived air pollution mixtures was also covered, and studies on diesel exhaust, hardwood and gasoline derived particulate matter were presented. These investigations noted that two factors added to the complexity of interpreting biological reactions, in terms of the physicochemistry of inhaled mixtures, which were non-monotonic dose responses and appropriate metrics of dose.

The speakers in session three, *Public Health Issues Involving Environmental and Tobacco Aerosols*, chaired by Dr. Roger Jenkins and Professor Judy Zelikoff, presented case studies on the epidemiology of traffic and tobacco smoke emissions on coronary heart disease (CHD). Long-term residential traffic exposure was associated with sub-clinical atherosclerosis, prevalence of the disease and incidence of myocardial infarction, the most deleterious of the manifestation of CHD. Smokeless tobacco was a novelty topic and speakers presented work on harm reduction, alternative nicotine delivery systems and vaccination against nicotine as potential treatment alternatives for tobacco smoking. It was noted that from a public health perspective, the focus should be on reduction of total tobacco-related diseases, not the total number of tobacco users.

The final meeting session was a spot-light on *Biomarkers of Exposure and Harm and Novel Strategies*, chaired by Professor Judy Zelikoff (New York University, USA). The principal biomarker categories involved pulmonary toxicology, oxidative stress and early life insults. The uses of *in silico* toxicology brought into play the 'omic level data freely available for researchers to employ novel modelling strategies for identification of mechanistic biomarkers of exposure and harm to aerosols. Inter-omic

analysis was also highlighted as a means for biomarker discovery following inhalation of toxicants. A novel, *in vitro*, human, lung model for examining the effects of inhaled toxicants was showcased. The use of such mucociliary phenotypes to yield human end-point data, that could not be ascertained using more classical *in vitro* approaches, was put forward as a prerequisite for further developments of *in vitro* studies to model *in vivo* inhalation of complex atmospheres.

In terms of novel strategies, bespoke assay development to measure oxidative stress was discussed. The general scientific consensus was that oxidative stress was the prominent biomarker of exposure and harm to combustion-derived aerosols. The use of inhibitor studies with antioxidants revealed compelling evidence that oxidative stress played a critical role in the aetiology of smoking-related disorders. The meeting closed with the report of an *in vivo* model used to predict later onset disease outcomes following early life insult to tobacco aerosols. It was envisioned that the test system would aid in the development of novel therapeutic approaches and biomarkers that could change the natural course of disease early in life.

The meeting was enriched by excellent discussion during 'break-out' sessions incorporated into the conference to conduct dynamic group discussions capable of generating new ideas and thoughts for pertinent issue sets. Break-out session one involved issue sets on *aerosol particle* discrimination by size and source - what implications did differences in size and sources have for biological dose and toxicology? The issue set for Break-out session two included what work needs to be done to validate aerosol reduction strategies and promote better health? The third and final break-out session incorporated issues on whether biomarkers of harm and exposure could be used to predict aerosol-related harm and how to validate biomarkers for this purpose? The group synopses for all break-out groups were presented during report-out sessions and recorded as a resource for future meeting topics.

The meeting was brought to a close by Dr Kelly Bérubé (Cardiff University, Wales, UK), meeting co-host, who thanked all the participants for their attendance and contributions, as well as the organizers, for their hard work in putting together the very successful, inaugural IFSH meeting on aerosol dynamics.