
Air Toxics and Asthma: Impacts and End Points

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The National Urban Air Toxics Research Center (NUATRC) hosted a medical/scientific workshop focused on possible asthma/air toxics relationships, with the results of the NUATRC's first research contract with the University of Cincinnati as the point of discussion. The workshop was held at the Texas Medical Center on 4 February 1994 and featured presentations by distinguished academic, government, and industry scientists. This one-day session explored the impact of various environmental factors, including air toxics, on asthma incidence and exacerbation; an emphasis was placed on future research directions to be pursued in the asthma/air toxics area. A key research presentation on the association of air toxics and asthma, based on the study sponsored by NUATRC, was given by Dr. George Leikauf of the University of Cincinnati Medical Center. Additional presentations were made by H. A. Boushey, Jr., Cardiovascular Research Institute/University of California at San Francisco, who spoke on of the Basic Mechanisms of Asthma; K. Sexton, U.S. Environmental Protection Agency, who spoke on hazardous air pollutants: science/policy interface; and D. V. Bates, Department of Health Care and Epidemiology at the University of British Columbia, who spoke on asthma epidemiology. H. Koren, U.S. Environmental Protection Agency, and M. Yeung, of the Respiratory Division/University of British Columbia, Vancouver General Hospital, discussed occupational health impacts on asthma. Doyle Pendleton, Texas Natural Resource Conservation Commission, reviewed air quality measurements in Texas. The information presented at the workshop suggested a possible association of asthma exacerbations with ozone and particulate matter (PM₁₀); however, direct relationships between worsening asthma and air toxic ambient levels were not established. Possible respiratory health effects associated with air toxics will require considerably more investigation, especially in the area of human exposure assessment. Two major recommendations for future research resulted from this workshop and an accompanying NUATRC Scientific Advisory Panel meeting: a need for more complete individual personal exposure assessments so that accurate determinations of actual personal exposures to various pollutants can be made; and a need for field experiments utilizing biomarkers of exposure and effect to more accurately assess the extent and variability of the biological effects, if any, of individual air toxics. — *Environ Health Perspect* 103(Suppl 6):209–211 (1995)

Key words: asthma, air pollution, respiratory disease, air toxics

Introduction

The Mickey Leland National Urban Air Toxics Research Center (NUATRC) was established by the Clean Air Act Amendments of 1990 expressly to carry out research in the environmental health science disciplines on possible health risks posed by ambient levels of air toxics in urban atmospheres. The NUATRC, with a board of directors appointed by the President, the Speaker of the House of Representatives, the Senate Majority Leader, and a nationally renowned scientific advisory panel, is a public/private research institution funded by the federal government through the U.S. Environmental Protection Agency (U.S. EPA) and by private corporations and foundations. It is charged with carrying out sound, peer-reviewed research to assess the residual risk to public health from existing levels of the 189 statutorily defined toxic air pollutants.

Asthma is a serious respiratory disease that is increasing in incidence and prevalence both in this country and around the world (1,2). It is affecting nonwhite populations at higher rates than white populations and seems to be more prominent in urban populations (3,4). The reasons for these trends are not known, but it has been suggested that environmental factors, specifically exposure to certain pollutants, are contributors to these increases (5–8). It was the intent of NUATRC to bring together experts in the field of air pollution and asthma to address these issues and provide the scientific community with background information regarding asthma and air pollution. These experts were also to provide directions for future research in this area.

The workshop included several presentations to address:

- the approach to regulatory control of pollutants (such as air toxics);
- the techniques for collecting and analyzing pollutant emissions and exposure data;
- background information regarding the pathophysiology of asthma, especially the inflammatory aspects of the disease;
- the current knowledge of associations between asthma and the National

Ambient Air Quality Standards (NAAQS);

- the epidemiologic information regarding associations between air toxics and asthma;
- the relevance of using occupational asthma as a model for more naturally occurring asthma that might be caused or worsened by environmental exposure; and
- future approaches to examine the known relationships between air toxics and the development or worsening of asthma.

The asthma work was particularly relevant to NUATRC's charge since noncancer environmental disease end points such as asthma have not been receiving the bulk of environmental health research resources. The increasing asthma incidences seemed to be focused in urban and minority communities, which is consistent with growing public interest in environmental equity.

Presentations

K. Sexton of the U.S. EPA discussed the roles that scientists and policy makers have in the decision-making process for setting priorities and developing regulations regarding exposure to and health effects from pollutants such as air toxics. He explained that there are many circumstances

This paper was presented at the Workshop on Air Toxics and Asthma—Impacts and End Points held 4 February 1994 in Houston, Texas. Manuscript received: January 17, 1995; accepted February 3, 1995.

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when decisions have to be made regarding limits of exposure to particular substances, with little scientific information to support those decisions. He emphasized the need for continued data collection regarding air toxics, with information needed on emissions, ambient exposures and both cancer and noncancer health end points such as asthma. He also suggested that research should be narrowly focused and directed toward the type of data needed for statutory requirements.

D. Pendleton of the Texas Natural Resource Conservation Commission described current technology for monitoring ambient pollutant concentrations including air toxics and presented information on recent trends concerning these concentrations in different regions of Texas. He also described interactions between the Texas Natural Resource Conservation Commission and the U.S. EPA as they affect future directions in data collection for source emissions and human exposures to air pollutants such as the air toxics.

H. Boushey of the University of California, San Francisco, discussed what is currently known about the underlying pathophysiology of asthma. He described the hypotheses that environmental exposures (allergens, viruses, pollutants, etc.) may all play roles in the development and worsening of this disease. He provided recent evidence for the role of the immune system and cell-derived mediators in the development of the airway inflammation that is now considered the hallmark of asthma. He emphasized that in order to study the causative factors that can contribute to the development of asthma, we should recognize that we are dealing with multifactorial exposures and that these cofactors (e.g., environmental tobacco smoke) should be included in our assessment.

H. Koren of the Health Effects Research Laboratory of the U.S. EPA described current information on the association between NAAQS, pollutants, and asthma. The body of scientific data suggests that ozone and sulfur dioxide can cause or worsen asthma. However, epidemiologic data to support these conclusions are limited and most of the positive data come from controlled chamber exposure studies. He suggested that controlled human clinical studies should be performed with air toxics to evaluate the physiologic, biochemical, and cellular responses to these agents.

D. Bates of the University of British Columbia in Vancouver described the epidemiologic evidence that currently exists suggesting associations between environmental exposure to pollutants and asthma. As did H. Boushey, he emphasized that we are dealing with multifactorial exposures to a variety of substances, and the interplay between these substances may be as important as the impact of the individual substances themselves. He encouraged the implementation of further epidemiologic studies using objective measures of lung function and biomarkers of exposure and effect to address associations of pollutants and asthma. He especially emphasized the need for personal exposure data to help in these studies.

M. Yeung, also from the University of British Columbia in Vancouver, presented what is currently known about occupational asthma and also described a model based upon occupational asthma that could be used to explain the development of asthma outside the workplace. This approach could be promising in that several interactive factors can be examined to determine the relative contribution of each factor to the development of the disease. These factors include both intrinsic or host elements (allergic nature, smoking history, etc.) and extrinsic factors (pollutant exposures, viral illnesses, antigen exposures, etc.). Cohorts of individuals can be extensively characterized and then followed in different environmental settings to determine development or worsening of airways disease.

G. Leikauf of the University of Cincinnati provided a rationale for a list of 30 air toxics that potentially could contribute to the development or worsening of asthma. His approach involved an initial determination of the presence of the air toxic in the environment and then the development of an hypothesis that classes of chemicals could be either asthmogenic or irritants based upon their chemical properties and known ability to sensitize. Using this list of air toxics, he suggested that development of exposure and epidemiological studies to better understand the relationship between these substances and asthma and the interaction between these substances and other environmental factors in causing and worsening asthma were immediate needs.

In response to G. Leikauf's presentation, B. Goldstein of the University of Medicine and Dentistry of New Jersey pointed out that of the various potential

sources of exposure to air pollutants air toxics in the outdoor environment may have the least impact upon the development of lung disease. He suggested that indoor pollutants, followed by the NAAQS pollutants, may play a greater role in the development of lung disease such as asthma. He also emphasized (as did many of the previous speakers) the importance of examining mixtures of compounds and the interplay between these compounds, including environmental tobacco smoke, aeroallergens, and chemicals.

In summary, the workshop provided valuable and current information regarding the pathophysiology of asthma and the possible role of criteria pollutants and air toxics in causing or worsening asthma. With regard to air toxics, it appears that little is known about their potential contribution to the development or worsening of the disease. It was the recommendation of the workshop that the following research directions be pursued:

- Exposure assessment studies should be conducted to more accurately characterize the actual individual exposures to air toxics, including the development of more precise ambient air and personal monitoring methodology. In addition, the relative contribution of indoor and outdoor sources should be determined.
- Experimental field utilization of biomarkers of exposure and effect should be initiated for use in exposure assessment and epidemiologic studies. These studies would be directed to the relationship between personal exposure to various pollutants and the health effects encountered by the individual. It appears that some relevant biomarkers have been developed but await large-scale field testing for determination of their utility.

REFERENCES

1. Evans R, Mullally DI, Wilson RW, Gergen PJ, Rosenberg HM, Grauman JS, Chevarley FM, Feinleib M. National trends in the morbidity and mortality of asthma in the U.S. Prevalence, hospitalization and death from asthma over two decades: 1965-1984. *Chest* 91:65S-74S (1987).
2. Yunginger JW, Reed CE, O'Connell EJ, Melton J, O'Fallon WM, Silverstein MD. A community-based study of the epidemiology of asthma: incidence rates, 1964-1983. *Am Rev Respir Dis* 146:888-894 (1992).

3. Evans, R. Asthma among minority children: a growing problem. *Chest* 101:368S-371S (1992).
4. Weiss KB, Gergen PJ, Crain EF. Inner-city asthma: the epidemiology of an emerging U.S. public health concern. *Chest* 101:362S-367S (1992).
5. Koenig JQ, Pierson WE. Air pollutants and the respiratory system: toxicity and pharmacologic interventions. *Clin Toxicol* 29:401-411 (1991).
6. Molino NA, Slutsky AS, Zamel N. The effect of air pollution on allergic bronchial responsiveness. *Clin Exp Allergy* 22:667-672 (1992).
7. Ponka A. Asthma and low level air pollution in Helsinki. *Arch Environ Health* 46:262-270 (1991).
8. Schwartz J, Slater D, Larson TV, Pierson WE, Koenig JQ. Particulate air pollution and hospital emergency room visits for asthma in Seattle. *Am Rev Respir Dis* 147:826-831 (1993).