Critical Review of Studies of Health Effects of Traffic- Related Air Pollution

Ira B. Tager, M.D., M.P.H.
Division of Epidemiology
School of Public Health
University of California, Berkeley

For the
Research Committee-HEI
And
The Writing Panel

Writing Panel

- Kenneth Demerjian--SUNY, Albany / Emissions-Exposure / RshC
- Mark Frampton—U of Rochester / Toxicology
- Michael Jerrett--UC, Berkeley, Chair / Emissions-Exposure
- Frank Kelly—King's College / Emissions-Exposure
- Lester Kobzik—Harvard SPH / Toxicology
- Nino Künzli—IMdM, Barcellona / Epidemiology
- Brian Leaderer—Yale SPH / Emissions-Exposure / RevC
- Thomas Lumley—U of Wash SPH / Statistics
- Fredrick Lurmann—Sonoma Tech. Inc Emissions-Exposure
- Sylvia Richardson—Imperial College Statistics / RshC
- John Samet—Johns Hopkins Epidemiology
- Ira Tager--UC, Berkeley, Chair / Epidemiology / RshC
- Michael Walsh—Consultant Emissions

Organization of Monograph

- Extended executive summary
  - Target technical and policy readership
- Introduction
  - Focus on 1986 (start of diesel emission control to 2020 (capture Euro 2015 standards)
- Emissions Characterization
- Exposure Assessment Methods
- Epidemiological studies
- Statistical issues raised by epidemiology studies
- Toxicology
- Conclusions/Research Recommendations

Organization of Monograph

- Chapters
  - Emphasis on synthesis and summary rather than exhaustive recitation of data
  - Each chapter to end with a specific summary to be brought forward for the executive summary
- Approximately 200 pages
  - Exclusive of references and supplementary tables and figures

Time Line

March-Sept. 2008	Complete chapters
End of Sept. 2008	Final Drafts to Panel
October 2008	Panel meeting
Nov.-Dec. 2008	Outside review
Jan.-Feb. 2009	Address reviewer comments
May 2009	Final document
June 2009	To HEI editor

PURPOSE OF THE MONONGRAPH

- **ADDRESS THE QUESTION:**
  - **Does “near source” air pollution from traffic cause health effects that are separate from those due to background regional pollution from transport and secondary processes**

Discussion About Appropriate Field of Influence Within Which to Study *Traffic-Related Health Effects*

- We define the field as "near source" for traffic as a distance of 500 m from a traffic source
  - Decision influenced by number of published works (e.g., Zhou & Levy 2007)
  - No perfect choice—tentative decision made after much discussion
- Important trade-off:
  - Will not be able to examine impacts of O_3 for which traffic pollutants are major precursors
    - best measured on a larger scale away from "near" roadway

Topics Being Addressed in Emissions Chapter

- Emission changes based on regulation and market trends
- Models used to determine contribution of motor vehicle-related emissions to total emissions
- On-road and near-road measurements
- Atmospheric physical and chemical transformation

Selected Specific Issues to be Addressed in Emissions Chapter

- Quality of emissions data
  - Particularly related to near-sources characterization
- Given rapid temporal changes in emissions profiles, relevance of emissions profiles from past for current health studies
- How to deal with geographical differences between North America, Europe, Japan, etc.
- Evaluation of quality of emissions models

Selected Specific Issues Discussed Relative to Emissions

- Research Needs Suggested To Date
  - More intensive monitoring at roadside
    - Capture components that do not travel more than a few hundred meters from source
  - Determine minimum information needed to characterize near-source emissions for short and long-term health studies

Topics Being Addressed in Exposure Chapter

- Measurement of motor vehicle-related pollutants and surrogates at various spatial scales
- Strengths and limitations of models developed to estimate exposure to traffic-related pollutants—for example
  - Source apportionment
  - Land use regression
  - Spatial models

Selected Specific Issues Discussed Relative to Exposure

- No ideal measure among:
  - Distance
  - Vehicle density
  - Models (e.g., dispersion, source apportionment)
- How to account for in-vehicle exposures
- Need for better characterization of populations within field of influence of “near source” exposure

Selected Specific Issues Discussed Relative to Exposure

- Are there “high quality” surrogates for exposure assessment?
- Consideration of lack of personal exposure data as problem of uncertainty—need to model uncertainty
- What are the proper exposure metrics for specific epidemiologic designs
  - Time series (case-crossover)
    - Limitations of source apportionment for these designs—may not have sufficient daily characterization
  - cohort

Topics Being Addressed in Toxicology Chapter

- *In vitro* and *in vivo* studies relevant to specific health outcomes
  - Specific components, particle size, surrogates
- Dosimetry
- Human exposure studies
  - Controlled
  - Natural (e.g., policemen's study)
  - Real world RCT (London walking study)
- Mechanisms that link toxicology to human health effects

Selected Specific Issues Discussed Relative to Toxicology

- What components should be emphasized
  - Benzene, formaldehyde, aldehydes (ethanol-based fuels)
  - Mixtures (“synergy”)
    - Current and projected for future
    - Comparisons across different geographic areas
  - Particle size versus components
- How to validate surrogates important for dispersion models
- What is the toxicological analogue for “dose”-response in epidemiological studies

Topics Being Addressed in Epidemiology-Health Effects Chapter

- Criteria for causal inference
  - Evaluation of data characteristics
    - Exposure metrics; population heterogeneity
    - How traffic summarized
- Epidemiological data on health effects related exposure to traffic-generated ambient pollution for the general population and in occupational settings:
  - Disease-specific morbidity and mortality
    - Cardiovascular diseases
    - Respiratory diseases
    - Birth outcomes
    - Cancer

Selected Specific Issues Discussed Epidemiology-Health Effects Chapter

- How to make general criteria for causal inference specific to health effects related to traffic-generated pollutants
  - Is there an exposure metric that is a standard against which to judge?
- How to summarize effect (association) estimates in the face of differences in:
  - Choice of metrics (even within same study)
  - Population structure
  - Temporal differences in time of study

Statistical Issues Raised by Epidemiologic Studies to Be Addressed

- Issues related to pooling of data
  - Pooling reduces uncertainty but not the bias that may be in observational studies
    - Problem of distinguishing between heterogeneity versus interaction
- Statistical issues specific to use and application of methods of factor analysis for source apportionment
- Propagation of measurement errors in studies of chronic effects
- General issues related to applications of Bayesian methods

THE END
THANK YOU

Part of Presentation from Last Annual Meeting Discusses Chapter Content

Executive Summary

- Goals
  - Summary material in language appropriate to both
    - Technical readers
    - Policy audience
  - Summaries to contain more specific material than typical executive summary
    - Structure of “mini-chapters”

Emissions Characterization

- ***Premise: Emissions data needed to describe exposure***
  - **Trends in transportation emissions in the context of national inventories**
    - **Effects of control technologies, vehicle operation, new fuels**
  - **Emissions modeling**
  - **How emissions change as a result of traffic patterns**
  - **Physical and chemical transformations near roads**
- ***Relative importance of traffic emissions to air pollution in total and at specific locations***
  - **Contribution to PM, gases, VOC, NO_x**
    - **Composition of emissions not documented in emission models**
  - **Source apportionment**

Exposure Assessment Methodology

- Description, application and critique of methods used in epidemiologic studies
  - Distance metrics
  - Source apportionment
  - Surrogate pollutants (NO_2, EC, BC CO) and how derived (fixed monitors, at residences)
  - Spatial modeling (geostatistical, dispersion, land use)
    - How validated
- Measurement of exposure in-vehicle
- Application and utility of remote sensing for exposure assessment

Epidemiological Studies of Health Effects

- Limit to studies whose express purpose was to study health effects related to mobile sources
- Metrics to characterize traffic exposure
  - Distance from road way
  - Maximum distance to nearest road
  - Traffic density
  - Dispersion and other (e.g., land use) modeling
  - Freeways/highway
  - Surrogate pollutant markers (NO_2, CO, EC/BS, benzene, etc.)
- Must include some distance to roadway, traffic density or dispersion modeling
  - ?Surrogate pollutant alone not sufficient

Epidemiological Studies of Health Effects

- ***Overall goal***: To what extent does exposure to mobile source emissions cause or exacerbate disease and mortality:
  - Cardiac (coronary heart disease, dysrhythmias)
  - Other vascular disease (stroke, other CVD)
  - Respiratory (asthma, COPD, lung function, CA)
    - Allergy in context of asthma
  - Respiratory and childhood cancers (leukemias, CNS)
  - Perinatal and neonatal Outcomes
    - Birth outcomes
    - Mortality

Toxicology Related to Mobile Source Emissions

- Focus on studies related to human health endpoints for which epidemiological evidence is supportive
- Types of studies (Respiratory, cardiovascular)
  - Traffic mixture
    - Controlled human exposure studies
    - Studies of animals exposed to traffic emissions
    - *In vitro* studies
  - Individual Components (human, animal, *in vitro)*
    - Mobile source air toxics
    - Coarse PM
    - Traffic surrogates
    - diesel

Toxicology Related to Mobile Source Emissions

- Types of studies
  - Respiratory Specific
    - Lung growth
    - Immune
    - Neurological
    - Hormonal
    - Carcinogenic
  - Other
    - Relevant from non-traffic studies