

# Chapter 4: Health Assessment Aspects of Multipollutant, Results-Based Air Quality Management

- **Status of Chapter**
- **Contents**
- **Conclusions**
- **Review Comments**



**Joe Mauderly**

**Lovelace Respiratory Research Institute  
Albuquerque, NM**

# STATUS OF CHAPTER

## Essentially completed

- Numerous minor revisions per internal and external review comments

No major changes to structure or conclusions

- Circulated to co-authors for final approval
- Chasing down last few literature citations

# AUTHORS

- Expertise includes epidemiology, biostatistics, exposure assessment, and toxicology
- Criteria for selection: Expertise in key fields  
Evidence of multipollutant interests  
Availability

## Chapter Coordinators

**Joe Mauderly, DVM**

**LRRI**

**Ron Wyzga, ScD, MSc,**

**EPRI**

## Section Authors

**Rick Burnett, PhD**

**Health Canada**

**Margarita Castillejos, PhD (et. al.)**

**UNAM, Mexico City**

**Haluk Ozkaynak, PhD**

**EPA**

**Jonathan Samet, MD, MSc**

**USC**

**David Stieb, PhD**

**Health Canada**

**Sverre Vedal, MD, MSc**

**U. Washington**

# UNDERLYING ASSUMPTIONS

- **Air pollution adversely affects health**
- **All exposures are to complex mixtures that vary in time & space**
- **Current knowledge precludes accurately apportioning effects among pollutants**
  - **Even among criteria pollutants, and more so among others**
  - **Especially consideration of non-additive effects of combinations**
- **Few, if any, adverse outcomes are unique to air pollution**
- **The ideal goal of MPAQM is a step-wise progression toward managing all pollutants to achieve the greatest health benefit per unit of AQM and societal resources**
- **The purposes of health research in this context are to:**
  1. **inform development of MPAQM strategies**
  2. **assess their health benefits**
- **This chapter is to be an assessment, not a roadmap**

# UNDERLYING HYPOTHESES

1. Portions of the health burdens currently attributed to individual criteria pollutants are likely to be the combined effects of multiple criteria and/or non-criteria pollutants

2. The full nature and extent of the air pollution-related health burden is not yet known

**Synergies among pollutants**

**Linkages and synergies between pollution and other causes**

**Other health effects not yet identified**

3. Substantial improvement in our understanding of air quality-health relationships is both possible and practical ... with strategic attention to the direction of research resources

# DEVELOPMENT OF THE CHAPTER

1. **Multiple document planning & lead author workshops**
2. **Chapter 4 author workshop in Ottawa in April 2007**
  - Identified issues, discussed views**
  - Discussed approaches to chapter & scope**
  - Developed outline & assigned section responsibilities**
3. **Collected inputs and performed editorial smoothing**
  - All authors responded well**
4. **Circulated iterative drafts**
5. **Submitted review draft (March 2008)**
6. **Responded to review comments**
7. **Circulating final version for chapter author approval**

# **GENERAL STRUCTURE OF THE CHAPTER**

**Introduction**

**Role of health assessment in MPAQM**

**Current understanding of the AQ-health relationship**

**Accountability in a MPAQM context**

**Guiding & assessing the effectiveness of MPAQM strategies**

**Establishing realistic expectations**

**Conclusions**

## **4.1 Health Assessment Issues in MPAQM**

### **4.1.1 Key Issues**

**Defining adverse effects and target populations**

**Apportioning effects among pollutants & combinations**

**Improving estimates of exposure**

**Estimating the proportional contributions of AP to health burdens**

**Evaluating health benefits of MPAQM strategies**

**Setting realistic expectations**

### **4.1.2 Other Issues**

**Non-inhalation impacts of air pollution**

**Similarities and differences among the three countries**

populations, pollution, health impacts, and health research support

## **4.2 Current Understanding of Relationships Between AQ & Health**

### **4.2.1 The Nature of Sources of Information**

**Epidemiology**

**Laboratory studies**

### **4.2.2 Current understanding of the impact of AP on health**

**Confidence that health is impacted by AQ**

**Scope of health outcomes impacted**

**Uncertainties in attributing risks to pollutants & sources**

**Exposure-response relationships**

**Synergisms among pollutants**

**Effects of air pollution vs. other causes**

### **4.2.3 Impact of regulatory cycle-driven research on ability to address MPAQM information needs**

## **4.3 Accountability in a MPAQM Context**

### **4.3.1 Tutorial on Accountability Science**

### **4.3.2 Issues and challenges in assessing benefits**

**Knowledge of exposure**

**Knowledge of health responses**

## **4.4 Guiding & Assessing the Effectiveness of MPAQM Strategies**

### **4.4.1 Key Enabling Factors**

### **4.4.2 Strategies for Reducing Present Limitations**

**Improving estimates of exposure**

**Improving assessment of health impacts**

### **4.4.3 Gains From Improved Interactions Between the Atmospheric & Health Research Communities**

### **4.4.4 Gains From Increased Collaboration Among Canada, Mexico, & the U.S.**

## **4.5 Establishing Realistic Expectations**

### **4.5.1 Current Status and Future Programs**

### **4.5.2 Progress to Be Expected in the Next 10 Years**

**Exposure specification**

**Understanding what causes what**

**Understanding the importance of combinations of pollutants**

**Grouping pollutants by biological reactivity**

**Importance of chronic exposures**

**Knowledge of health outcomes**

**Knowledge of susceptibility**

**Accountability**

### **4.5.3 Caveats Concerning Unrealistic Expectations**

## 4.6 Conclusions

### Overall Conclusion:

**Our current knowledge provides a limited basis for advising and assessing MPAQM**

**AQ management to date, based on estimates of health risks, has undoubtedly done much good**

**Exposure and health research have followed the current regulatory framework, rather leading by looking forward toward an evolution of that framework toward MPAQM**

**MPAQM may be defined in different ways, and there is yet no consensus. Although specific information needs may vary among approaches, the fundamental deficiencies in current knowledge are the same regardless of definition.**

## 4.6 Conclusions

### Conclusion #1:

The two most important (and interrelated) fundamental knowledge gaps are:

1. What causes what?
2. Are combinations of pollutants important?

The information needs can be parsed into greater detail, but these are the most important questions that should underlay MPAQM health research strategies for the next decade

MPAQM places increasing importance on potential non-additive effects of pollutant combinations

## 4.6 Conclusions

### Conclusion #2:

**The full scope of health effects of criteria pollutants is probably not known, and there is much greater uncertainty about the range and magnitude of effects of non-criteria pollutants**

**We have very sparse exposure data for most non-criteria pollutants, by which we might test linkages to health**

## 4.6 Conclusions

### Conclusion #3:

**Better characterization of exposure is the single most pressing need**

**More detailed data linking time-activity patterns with pollutant concentrations in different locations through which people move**

**Better personal exposure information for sub-populations of health interest**

**Improved exposure models that take advantage of better input data**

## 4.6 Conclusions

### Conclusion #4:

**We need better strategies for linking health outcomes to groupings of pollutants**

**Can not study all individual pollutant species**

**Example groupings include physical-chemical class, initial biological reactivity, biological response pathway, health outcome, source**

**Groupings most appropriate for health may differ from those most appropriate for ecosystems, visibility, etc.**

**Groupings that prove useful for health should inform control strategies**

## 4.6 Conclusions

### Conclusion #5:

**Studies of biological response mechanisms will be important for:**

**Attributing causality**

**Developing grouping strategies**

**Developing biomarkers**

**Need greater emphasis on systematic comparisons than in past**

**Understanding dose-response will be important**

**Need attention to validation of animal and cellular responses**

## 4.6 Conclusions

### Conclusion #6:

**Accountability strategies can be improved, especially with better knowledge of exposure, effects, and causality**

**Some, but few, systematic efforts are underway**

**“Natural experiments” are useful, but longer-term, improvements in air quality are more typical**

**Concurrent changes in non-pollution factors create challenges to interpretation**

**Apportioning health burdens between pollutant and non-pollutant causes is important**

## 4.6 Conclusions

### Conclusion #7:

**Partnerships among atmospheric, exposure, and health scientists are important**

**Multipollutant orientation increases need for not only exchanges of information, but also direct collaboration**

**Interactions are needed at the conceptual, experimental design, and technical levels**

## 4.6 Conclusions

### Conclusion #8:

**Research sponsors have responsibility for strategic deployment of research resources within a matrix of information needs and research approaches**

**Broad scope of issues increases potential for a “random walk” of studies producing information that cannot be integrated well**

**Scientific community can advise and propose, but ultimately responds to sponsor direction**

**High-level management does not conflict with creativity or competition**

**Programs should be forward-looking, and not constrained by current regulatory structure**

## 4.6 Conclusions

### Conclusion #9:

**With sufficient attention to strategic direction, substantial progress can occur within a decade**

**Progress will be incremental over a much longer period, but short-term gains are possible within the bounds of current funding levels and research capabilities**

**The idealized goals of MPAQM will likely never be reached, but considerable advancement is possible**

**Shifts in the air quality health research landscape are already underway**

# EXTERNAL REVIEW COMMENTS

**1. Kudos for scope, level of detail, and epidemiological sections**

**2. Move section on biological time scales**

Done

**3. Add better description of need for multipollutant statistical models and methods for addressing multiple pollutants in epidemiological and laboratory studies**

Done

**4. Put section on reasonable expectations at end**

We left it as the last item before summary conclusions

**5. Need more emphasis on HAPs**

We changed wording in a few places, but felt that the point of encompassing all pollutants and major classes was made adequately

**6. Several line-specific comments**

These were all addressed in various ways

# INTERNAL REVIEW COMMENTS

Numerous minor editorial comments (all addressed)

Other comments (paraphrased):

- Chapter too long, repetitive, lacks focus, and not a “roadmap”
- Needs more explicit priorities for different pollutants and types of studies
- Reducing aggregate risk per unit of resources is not necessarily the goal
- Statements describing current limitations may be taken out of context
- Does not discuss relationship of MPAQM to current regulatory framework
- Why discuss issues that were already important for single-pollutant work?
- Need more emphasis on importance of exposure data, rationale not clear
- Needs more emphasis on grouping pollutants by biological mechanism
- Need better discussion of importance of developing statistical models

# INTERNAL REVIEW COMMENTS

- **Need more review of current approaches and studies that are yielding reasonably accurate exposure information**
- **Missing a call for using data already available for 1) different regions with different pollution; and 2) multiple pollutants in one location**
- **Underplays the importance of integrated assessments including everything from exposure to toxicology**
- **Implies wrongly that it may take years to determine which PM types are most important**
- **Point out usefulness of negative data from high-dose animal studies**
- **Add numerous citations for importance of traffic emissions**