

COMMITTEE ON THE MEDICAL EFFECTS OF AIR POLLUTANTS

The HPA/COMEAP "Handbook on Air Pollution and Health".

1. Please find attached a prospectus for the HPA/COMEAP proposed new "Handbook on Air Pollution and Health", a revised and restructured book designed to replace the now outdated COMEAP "Handbook on Air Pollution and Health" (1997).
2. The handbook is to be a joint HPA and COMEAP publication and the HPA's definitive resource on the health effects of air pollutants. It is aimed at a wide audience, both internally within the HPA (e.g. environmental health officers, health protection units), and externally (medical professionals, researchers, undergraduate students, interested public).
3. The Secretariat is seeking input from members at this initial stage of the handbook's development and also hopes that members might participate in the writing and editing of certain sections of the handbook as the process progresses. Dr. Tim King has also kindly agreed to review and edit chapters in his capacity as "lay-member".
4. The committee is asked to provide comments on the structure and content of the handbook, as laid out in the attached prospectus, and to make suggestions as to what could/should be added or removed. Suggestions are also welcomed on sections highlighted in yellow. More generally, the secretariat would appreciate members thoughts on the following questions:
 - a. Are there pollutants that members think should be added or omitted?
 - b. Have the most relevant air pollution and health issues been covered? If not, what other issues do members feel should be discussed?
 - c. Is the proposed content sufficient to improve understanding of the basics of air pollution and health among interested lay-public and environmental/health professionals? i.e. is it pitched correctly for the intended audience?
 - d. Does the structure of the handbook guide readers through the fundamentals of air pollution and health in a logical way?
5. Members are also asked to let the secretariat know if they have any photographs, illustrations or images suitable for use in the handbook e.g. photographs of urban pollution for the history chapter.

**Secretariat
October 2008**

Prospectus for the HPA's "Handbook on Air Pollution and Health".

Preface/foreword

- A brief introduction to the HPA's new "Handbook on Air Pollution and Health", what it aims to achieve, its intended audience etc. The handbook is to be the HPA's definitive resource on the health effects of exposure to air pollutants.

Introduction

- This introduction is a brief summary of the main chapters of the handbook
- Air pollution from the poor urban air quality of the industrial revolution to the current situation of air quality standards/limits/monitoring etc.
- The most important types of pollutants (gaseous, particulate) in outdoor and indoor air, with regards to health.
- Brief mention of the primary anthropogenic sources of air pollutants (transport, industry, power generation, mining activities) and how they have changed over the last 100 years e.g. Improvements in urban air quality due to switching from domestic coal/solid fuel burning to gas/electricity, movement of fossil-fuel burning power stations from rural to urban areas.
- Measurement of air pollutants in UK cities and rural areas.
- What action is being taken to reduce air pollution? Introduce EU and UK level legislation, air quality standards/limits.
- The biological systems of the body most affected by air pollution – respiratory tract, lungs, heart/cardiovascular system etc.
- Diseases/health problems caused or worsened by air pollution - bronchitis, COPD, asthma, heart disease etc.
- Other health endpoints affected by air pollution e.g. mortality, birth outcomes.
- How we know that air pollution is responsible for illness and premature deaths in the UK i.e. brief explanation of epidemiological approaches, occupational studies etc. Mention of recent findings re: particles and CV disease.
- Some of the unknowns regarding air pollution, some of the questions that need answering and the areas for future research e.g. nanomaterials.

Chapter 1 – A brief history of air pollution

- The historical sources of air pollution and when air pollution began to be a problem in London and other large cities.
- A description of what it might have been like to live in London in the 19th century, when the industrial revolution was in full swing with coal burning factories and domestic burning of coal and solid fuel.
- Description of the kinds and levels of air pollutants found in London and other European cities during the industrial revolution e.g. smoke, sulphur dioxide, to highlight the comparatively “clean” air we experience today.
- List of major air pollution episodes of the last 100 years and the excess deaths associated with them. e.g. London, Dec 1952, Meuse Valley 1930, London Dec 1991.
- The changes that have led to the air quality we enjoy today and how the main contributors to air pollution have changed.
 - The switch from domestic coal/solid fuel burning to gas/electricity and the movement of fossil-fuel burning power stations from rural to urban areas (and the use of tall chimneys) improving poor urban air quality.
 - Clean Air Act 1956.
 - The rise of motor vehicle use in cities contributing to poor air quality
 - Contribution of improved automotive technologies (catalytic converters, fuel efficient cars, hybrids), congestion zones, low emission zones.
 - Make reference to Chapter 5 (regulation) and Appendix 6 giving timeline of EU directives to show how European legislation has evolved.

Chapter 2 – Air pollutants

- Introductory section explaining the focus on the pollutants listed (“The following are the main air pollutants of importance to human health...etc”).
- The main sources of air pollutants – Transport, industry, power generation, mining activities, domestic heating (e.g. brown coal in Ireland?), transboundary pollutants etc...
- Individual pollutants – For each, a brief description, sources and levels (past and present, trends, indoor/outdoor)...
 - Gaseous
 - SO₂
 - NO_x
 - CO
 - Ozone
 - Particles
 - PM_{2.5}
 - PM₁₀
 - Ultrafine particles / Nanoparticles
 - Composition of particles
 - “The SO₄²⁻ issue”.
 - Others
 - Lead
 - Other metals (Cd, Ni, Hg, V, Zn, Cr, Fe, Cu, Ca?) **others?**
 - Environmental tobacco smoke
 - PAHs (BaP, naphthalene)
 - VOCs (benzene, 1,3 -butadiene, formaldehyde).
 - POPs (dioxins, furans, PCBs).
 - **Novel organics in indoor air/dust?** (phthalates, BFRs, musks).
 - **Biological Pollutants?**
 - Moulds and fungi (damp indoor environments)
 - Allergens (dust mites, pollen)

Guidance on how best to divide up pollutants would be welcomed. E.g. Include other metals in particles/composition of particles?

Chapter 3 – Distribution/dispersion of air pollutants

- What happens to air pollutants once they are emitted from source?
- Factors (meteorological, physical, chemical) affecting the distribution and movement of air pollutants
 - Wind dispersion
 - Photochemical reactions/photolysis
 - Ozone formation/scavenging, rural ozone peaks
 - Accumulation, temperature inversion, smog formation in cities
 - Removal of pollutants by precipitation
- Case study e.g. Buncefield fire – Dispersion of smoke plume, how the smoke could have distributed if weather conditions had been different.
- Typical levels of pollutants as a function of distance from source e.g. distance from roads when pollutants reach background levels, distance from industrial installations that emissions can be detected above background levels.
- Trans-boundary pollutants e.g. SO_2 , NO_x → acid rain, ozone, Saharan dust?
- Air pollution episodes – Winter and Summer episodes, conditions required, typical levels, examples.

Chapter 4 – Measurement and monitoring of air pollutants

- Pollutants that are currently monitored in the UK (SO₂, NO_x, ozone, CO, particulates, benzene, metals, etc..) and where they are measured (major cities, roadsides, ozone in rural areas).
- The importance of measuring particulates, the current emphasis on PM₁₀ and increased monitoring of smaller particles - PM_{2.5} and ultrafines.
- Description of different kinds of air pollution monitors (gas analysers, TEOM and gravimetric monitors).
- How air pollutant concentrations are expressed following their measurement - units (ppb, µg/m⁻³) and averages (8hr, 24hr).
- Monitoring systems on industrial installations for compliance purposes(?).
- Explanation of the UK air monitoring network. Automatic and non-automatic networks. http://www.airquality.co.uk/archive/networks_home.php
- A map of monitoring sites around London? e.g. <http://www.londonair.org.uk/london/asp/publicdetails.asp?region=0>
- Mention of monitoring networks in the US and other countries which provide data for epidemiological studies.
- Guidelines/standards/limit values - an explanation of these, rather than the actual standards, which will be in the appendices e.g. EU limit values, WHO air quality guidelines.
- Introduction to the health based banding system (see chapter 7 for more details) <http://www.airquality.co.uk/archive/standards.php#std>
- For comparison and to illustrate the range of urban pollutant levels, a table of average pollution levels in the 10 largest cities around the world (incl. London), or 10 British cities or 10 European cities or 10 US cities or the world's 10 most polluted cities.
- Case studies - e.g. Mexico City, Beijing, giving average levels, contributory factors, unique meteorological or geographical factors. E.g. altitude in Mexico city, humidity in Beijing, Athens valley(?).
- Measurement/monitoring of moulds, fungi, allergens?

Chapter 5 – Regulation of air pollution

- UK Air Quality Strategy – published by UK Government (Defra) – Sets out air quality standards and objectives to be achieved for the following pollutants to protect health and the environment - SO₂, NO_x, PM₁₀, PM_{2.5}, ozone, CO, benzene, 1,3-butadiene, PAHs, Pb.
<http://www.defra.gov.uk/environment/airquality/strategy/index.htm>
- UK also obliged to comply with EU directive - The European Air Quality Framework Directive (EU Limit Values) – and Daughter directives.

Table of “National air quality objectives and European Directive limit and target values for the protection of human health”.

<http://www.defra.gov.uk/environment/airquality/strategy/pdf/air-qualitystrategy-vol1.pdf> pp20-21.

- Local government - Air quality management areas (AQMAs), Local transport plans (LTPs), Local authority pollution, prevention and control (LAPPC) regime, Clean Air Act (for domestic premises).
- Legislation and initiatives regarding motor vehicle emissions (European emission standards legislation), Future of Transport White Paper, congestion charge, LEZ
- Emissions from industry (Pollution Prevention Control Act, IPPC) and the role of the Environment Agency.
- EU Emissions Trading Scheme (ETS)
- World Health Organisation (WHO) air quality guidelines (published in 2000 and 2005)
- AQEG - Air Quality Standards and Objectives
<http://www.airquality.co.uk/archive/standards.php#std>
- EPAQS – A mention of EPAQS work and how it has contributed to the regulatory framework – e.g. 15-min SO₂ objective - and a short paragraph on the EPAQS/COMEAP merger (importance of limit values etc.).
- Air quality regulations unique to the UK e.g. EPAQS 15-min SO₂ objective.
- Regulations for mould, fungi, allergens?

Chapter 6 – The respiratory* and cardiovascular systems

- *In this case respiration refers to breathing and gaseous exchange.
- This chapter will be an introduction to the physiology of the respiratory* and cardiovascular systems as they relate to the health effects of air pollutants.

Physiology of the respiratory* system

- Upper respiratory tract → alveoli
- Gaseous exchange
- The respiratory epithelium
- Lung defence/immune system – mucus, cilia → alveolar macrophages
- Inflammation – neutrophils

Physiology of the cardiovascular system

- Heart and blood vessels, coronary/pulmonary arteries, myocardium
- Pulmonary/systemic circulations.

Diseases/disorders of the respiratory* and cardiovascular systems

- A brief introduction to the diseases of these systems which are relevant to air pollution.
 - Asthma
 - Bronchitis
 - Chronic obstructive pulmonary disease (COPD)
 - Decreased lung function
 - Lung cancer
 - Coronary Heart disease (atheromatous plaques etc)

Chapter 7 – Health effects of air pollutants

- The health effects of air pollution and how they are studied.

How do we know air pollution affects health?

- Explanation of the different kinds of studies, techniques and approaches used and how they have revealed how air pollutants can affect health.
 - Occupational, chamber, mechanistic studies
 - Epidemiological approaches - Time series, cohort studies, landmark epidemiological studies
 - Statistical techniques e.g. meta-analyses
 - Confounding factors (smoking, diet, socio-economic status etc)
 - Association vs causality.

Vulnerable groups and air pollution

- Air pollution poses greatest threat to vulnerable individuals
- The elderly/infants and young children, those with existing heart conditions/cv disease, pulmonary disease (bronchitis, COPD), asthmatics, pregnant women

Health effects of air pollutants (similar to current handbook)

- SO₂ - Bronchoconstriction, lung function in children, bronchitis, increase in mortality. Current work/COMEAP reports
- NO_x - Bronchoconstriction, increased sensitivity to allergens, mortality
- CO - Headache, dizziness, death.
- Ozone - Irritant, inflammation of airways, increase in asthmatics admitted to hospital, increase sensitivity to allergens
- Metals (Cd, Pb) – Neurobehavioural effects, IQ (Pb), kidney damage
- Environmental tobacco smoke – Lung cancer, CV disease, increased risk of asthma, bronchitis, pneumonia in infants/children
- PAHs (BaP, naphthalene) – Carcinogenicity
- VOCs (benzene, 1,3 -butadiene, formaldehyde).
- Moulds, fungi, allergens? – triggering asthma, “farmer’s lung”?

Particles

- Why particles are important
- Diagram showing deposition of particles of differing sizes in the lung (15µm trapped in nose → <4µm deep into lung → <20nm (ultrafines) reach alveoli)
- Studies which revealed the contribution of particles to the health effects of air pollution.
- Mass vs number. The importance of surface area.
- Increase in ill health indices associated with 10µg m⁻³ increase in PM₁₀
- Cardiovascular effects of inhaled particles (reference COMEAP CV report)
- Proposed mechanisms of action of particles (including role of other pollutants associated with or bound to particles e.g. metals, PAHs).

Health based air pollution banding system

- Brief explanation (1-10 index, four bands, based on measurements of SO₂, NO₂, PM₁₀, ozone, carbon monoxide etc)
- Particularly important for susceptible individuals who suffer from heart disease or lung diseases, including asthma.
- Bandings table - <http://www.airquality.co.uk/archive/standards.php#std>

Economic costs of air pollution

- Hospital admissions, working days lost, ongoing healthcare costs
- Cost benefit analyses with study examples
- Quantification of health effects (QUARK?)
- The air pollution work of the Inter-departmental Group on Costs and Benefits (IGCB). <http://www.defra.gov.uk/environment/airquality/panels/igcb/index.htm>

Philosophical musings on issues of air pollution and health*

- Variability of exposure and sensitivity in a population and their influence on results from epidemiological studies.
- Mortality at low exposures.
- “No threshold” for pollutants such as PM or ozone?

* Section included at the insistence of RLM.

Chapter 8 – Specific air pollution and health issues

- Can be short summary paragraphs, or longer sections (several pages) depending on the issue.
- Air pollution and cardiovascular disease – particles, atheromatous plaques, myocardial infarction (CV report).
- Quantification of the effects on health of exposure to air pollution in the UK (QUARK I and II)
- Asthma – Air pollution and exacerbation. Causation (Asthma report)
- Ozone – Summer ozone episodes and health thresholds (Heather's ozone report?)
- Incinerators, cement kilns - do they affect health/cause cancer?*
- Carbon monoxide – The silent killer.
- Roadside exposures and health – Health effects near busy roads?
- Air pollution and Children's Health (WHO/COMEAP children's health statement)(?).
- Nanomaterials – Similarity to ultrafines (cardiovascular effects), nanotubes and asbestos-like effects.
- Common misconceptions regarding particulate matter*
- Mixtures - Multi-pollutant confounding and effect modification of the observed health effects of pollutants identified in epidemiological studies e.g. suggested that the adverse health effects of NO₂ are confounded by particles.
- Air pollution and physical performance(?) – Beijing Olympics 2008, asthmatics and summer ozone.
- Flooding events and indoor air pollution from mould and fungi.

*RLM papers written for HPA Chemicals and Poisons report will be useful here.

Chapter 9 – The future of air pollution research

- There are still many unknowns regarding air pollution and health. Research is still needed in many areas.
- Short introduction mentioning past research programmes. How COMEAP research recommendations translate to DH research programmes. Links to previous programmes (IEH report etc).
- Emerging concerns, predictions and future focus.
- Areas where the literature is expanding, e.g. birth outcomes.
- Research priorities e.g. Inhaled nanomaterials (NNRC).
- Air pollution and climate change e.g. increased summer ozone concentrations (assuming there is a threshold for ozone), flooding and mould growth.
- 20 critical research questions (?).

Chapter 10 – Glossary

- Glossary of air pollution terminology.

Chapter 11 – Appendices

1. UK Air Quality Strategy – Standards and objectives
2. The European Air Quality Framework Directive (EU Limit Values)
This table - “National air quality objectives and European Directive limit and target values for the protection of human health”.
<http://www.defra.gov.uk/environment/airquality/strategy/pdf/air-qualitystrategy-vol1.pdf>
3. World Health Organisation (WHO) air quality guidelines
4. AQEG - Air Quality Standards and Objectives
5. <http://www.airquality.co.uk/archive/standards.php#std>
6. EU directives (giving a timeline of air pollution legislation in the EU)
7. COMEAP report summaries?
8. Useful webpages

References – A “Further reading” type bibliography at the end of each chapter, with 10-12 of the most important papers, reviews, books, COMEAP reports etc.

Secretariat
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