General principles for assessment and quantification of the health impacts of air pollution

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Air Pollution damages human health

Through the 1900s: Air pollution episodes, e.g. cause increased death and ill-health on the same day or on the days immediately following

Late 1980s onwards: Daily pollution at ‘normal’ levels causes increased death and ill-health on the same day or on the days immediately following

There is no known ‘safe level’ (threshold), for the population as a whole

Increased risks of death believed to be among people with pre-existing serious cardio-respiratory disease

Mid 1990s onwards: Long-term exposure causes much bigger problems

The dominant effect is increased risk of mortality in adults from long-term exposure to air pollution represented as annual average PM2.5

Again, there is no known ‘safe level’

The risks seem to apply to the population as a whole, not just those with short remaining life expectancy
So... What are the implications for public health?

Some key initiatives in quantification

- Bart Ostro and colleagues
- ExternE – early 1990s – cost-benefit analysis for CAFÉ
- AHPEIS – from APHEA – then APHEKOM – Sylvia
- Nino Kuenzli and colleagues – 3-country study etc.
- WHO – eventually WHO Global Burden of Disease – including Ross

- + many many others...
So... What are the implications for public health?

Two principal kinds of quantification questions. Many similarities in the answers but some differences also.

a. The burden of disease: “How big is the problem?” What is the effect on public health (mortality and morbidity) of air pollution at current levels? How much damage is air pollution causing to human health? How does it compare with other social and environmental risk factors?

b. The health impact assessment (HIA) of policies and measures that affect air pollution: “Will these policies make a difference – to air pollution? And so to human health via air pollution?”

This talk: HIA of a change in pollution but what’s very interesting is HIA of a policy or measure that changes pollution, e.g. HIA of active transport

For Burden and HIA – What is best evidence-based estimate?
Quantification... is about building a simple model

In principle:
- Many pollutants (PM10, PM2.5, ozone, NO2...)
- Many health outcomes (mortality, hospital admissions, respiratory symptoms...)
- Many pollutant-outcome pairs

FOR THIS PARTICULAR QUESTION
- What combination of pollutant-outcome pairs (‘pathways’) can and will we use, to answer that particular question?
- How will we quantify each pathway – for this target population and time period and question?

Implication – there is not one universally best “off-the shelf” quantification model – THINK about each
A simple model for air pollution burden and HIA

- **Pollution**: sources; emissions pathways
- **Population at risk**: overall; subgroups
- **Background data**: Morbidity/mortality rates
- **Incremental pollution + background**
- **C-R functions**: Risks as % change Per unit pollutant
- **Valuations or DALYs**
- **Health Impacts**
- **Aggregated Effects**
  - Burden or Impact of policy
Process...

- CLARIFY THE QUESTION ... and how the results will be used – where do they fit into the decision-making process?
- THINK what kind of quantification model will best answer it
  - What pathways in combination
  - How to quantify each one in this particular context
- DO IT, i.e. make a 1st quantification – if necessary making assumptions
- CHECK what are the gaps / assumptions
- ASK the DIM question: Does It Matter?
- Where it does matter – try to improve the model – WORK ITERATIVELY – many times
- Assess and be open about strengths and weaknesses / uncertainties
Clarify the question – and how results will be used
e.g. health impacts of local traffic measures or power station or...

• Health impacts in what population?
  – Scale will affect almost all aspects of the quantification model –
    including what pollutants to use

• Health impacts over what time period?
  – Over one year? Why? (A lasting pollution change has a lasting effect)
  – Allow for time-lag between change in pollution and change in risk?

• Are results needed by sub-population/

• Will they be aggregated via DALYs and/or monetary values?

• Timescale; resources; stakeholder involvement etc; etc; etc...
Causality and ‘double-counting’

• As far as practicable base core quantification on pathways where causality is widely accepted – there are lots of these, for PM and ozone especially

• We don’t need a lot of direct evidence to agree causality: Does air pollution affect days off work?

• I’m in favour of quantifying based on ‘indicator pollutants’ also, especially for burden questions – it’s more difficult with change.

• Use these as sensitivity analyses – else there is double-counting

• Try it and see if different approaches give similar answers
  – If yes, great
  – If no, why not?
Strength of evidence

Remember – the aim is to make a best estimate

• Usual scientific criterion is ‘proof beyond reasonable doubt’, using e.g. standard 5% statistical significance levels

• For HIA this is a biased process – it ignores too many things where there is reasonable but not compelling evidence of an effect

• A better criterion for HIA is include on ‘balance of probabilities’ or ‘more likely than not’. [“Can we make a better estimate than zero?”].

• We make quantitative judgements (and assessments of their uncertainty) before the evidence is compelling or there is consensus about it.

• This approach generally is resisted (reluctance to go beyond well established evidence; fear of attack for ‘over-estimating’) but I think it’s worth maintaining
Extrapolation

• Some people say: “You mustn’t go beyond the evidence”. “Don’t extrapolate”. Sounds plausible. BUT
  – Experience shows there is some coherence to how the world works
  – Evidence is unavoidably about the past. Prediction is unavoidably about the future.
  – Extrapolation is part of what we do... while being open to newness and the possibility of mistake. The choices are about what aspects and how much.

• “Don’t extrapolate stupidly”: THINK about the specific issue – Is zero = no effect (in that age-group) really our best estimate?

• Typical issues include (i) beyond pollution range of what was studied; (ii) beyond age range; (iii) transfer of relationships from one location to another, e.g. from USA to Europe

• Accept some added uncertainties – describe and discuss
Quantification is a ‘science thing’
But it’s a ‘people thing’ also

It needs experts…
But it needs others too
The HIA process – adapted from Briggs 2008

**Issue framing**
- Problem formulation
- Consulting with stakeholders
- Scenario development
- Scoping
- Indicator selection

**Stakeholder consultation**
- Essential – needs to involve stakeholders
- Usually expert-driven
- Needs to involve stakeholders

**Design**
- Screening
- Piloting
- Protocol development

**Execution**
- Sources
- Releases
- Transport and transformation
- Exposures
- Health effects
- Impacts

**Appraisal**
- Reporting
- Evaluation
- Ranking/prioritisation

**Sources**
- Releases
- Transformations

**Exposures**
- Health effects
- Impacts
Don’t be surprised...

- if your methods and results get attacked
- If your methods and results get distorted
- If your methods and results get ignored

... because quantification is part of bigger processes involving a lot of money

- Do the science the same as before ... just, don’t be surprised; and factor in some time for dealing with the trouble.
My Fundamental Principle of Quantification ...

THINK! (again and again; with others)
THANK YOU...

• To colleagues too numerous to name
• To WHO / EC for inviting me
• To you for being here...