ECONOMIC VALUATION OF TRANSPORT-RELATED HEALTH EFFECTS:

Review of methods and development of guidance, with a special focus on children

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With acknowledgments to: H.J. Boesch, H. Sommers, E. van Kempen, B. Staatsen
Outline

• Aims and work steps of the project
• The general framework
• Results and guidance for:
  – Air pollution
  – Noise
  – Road traffic crashes
  – Transport-related lack of cycling and walking
• Conclusions
• A glimpse on the benefit side…
Partnerships

• Main partners:
  – Ecoplan (Switzerland) – economic aspects
  – RIVM (Netherlands) and contributors – epidemiological aspects

• Supported by:
  – USEPA, ADEME (France), Austria, RIVM, PRONET, UIC

• Seeking synergy with key related initiatives:
  – OECD/EC VERHI project
  – THE PEP/HEPA Europe project on cost/benefit analysis of cycling and walking
  – PRONET
  – INTARESE
  – ENHIS/WHO guidelines for HIA air pollution, noise
Aims of the project

To follow-up areas for further work identified by the THE PEP project *Transport-related health effects with a particular focus on children (2004)*:

- Selection of health effects in adults and children
- Estimated relationships between exposure and health effect (dose-response relationships)
- Estimated fraction of exposure coming from transport
- Practical guidance for measurement and monetary valuation of health effects with views of achieving a more harmonized approach
- Particular focus on children (but not only)
Transport-related health and environmental effects – conceptual framework

- Physical inactivity
- Air pollution
- Injuries
- Climate change
- Psychosocial effects
- Noise
- Nature and landscape effects
Key features of the guidance

- Scope of the guidance: for non-experts, practitioners
- Pragmatic approach
  - Point out which factors are contributing the majority of the costs and which can be neglected in situations of limited resources
- Based on existing approaches, combining health and economic evidence
- Focus on the health part of cost evaluation
- Guidance can be used in a modular or combined approach
## Work steps

<table>
<thead>
<tr>
<th>Collection and review of existing methodologies and major studies and initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identification of:</strong></td>
</tr>
<tr>
<td>• relevant health effects for which sufficient epidemiological evidence is available to be included in the economic valuation</td>
</tr>
<tr>
<td>• key criteria to be applied in making an economic valuation of these effects</td>
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<tr>
<td><strong>Development of a proposed methodological approach</strong></td>
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<td><strong>International workshop to discuss and achieve consensus on the proposed methodology (November 2008, Düsseldorf)</strong></td>
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<tr>
<td><strong>Integration of feedback, report for final review,</strong> <strong>Finalization of report</strong></td>
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<tr>
<td><strong>Dissemination of the methodology through report, papers, and electronic means</strong></td>
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<td>(e.g. THE PEP Clearing House and Toolbox, WHO, PRONET web site)</td>
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</tbody>
</table>
The general framework

Transport system

- Trip characteristics (e.g. distance, purpose, luggage)
- Individual characteristics (gender, income, age, fitness etc.)
- Mode characteristics (e.g. comfort, price/km etc.)

Mode choice

Effects and exposures

- Active mobility (cycling & walking)
- Traffic injuries
- Air pollution
- Noise
- Physical activity
- Congestion
- Use of space
- Etc.

Health effects

- Risk of some diseases
- Obesity
- Other effects
- Morbidity, mortality

Items included in report
**Summary of selected health end points to be considered for economic valuations of transport-related interventions and policies in adults**

<table>
<thead>
<tr>
<th>Transport-related exposure</th>
<th>Selected health end-point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic noise</td>
<td>Severe annoyance</td>
</tr>
<tr>
<td></td>
<td>Severe sleep disturbance</td>
</tr>
<tr>
<td></td>
<td><em>Myocardial infarction</em></td>
</tr>
<tr>
<td>Traffic-related air pollution</td>
<td>Mortality: all-cause, cardiovascular and respiratory</td>
</tr>
<tr>
<td></td>
<td>Morbidity:</td>
</tr>
<tr>
<td></td>
<td>hospital admissions (cardiovascular and respiratory)*, lower</td>
</tr>
<tr>
<td></td>
<td>respiratory symptoms*, chronic bronchitis*, bronchodilator use*,</td>
</tr>
<tr>
<td></td>
<td>restricted activity days*, working loss days*</td>
</tr>
<tr>
<td>Traffic safety</td>
<td>Mortality</td>
</tr>
<tr>
<td></td>
<td>Injury</td>
</tr>
<tr>
<td>Transport-related physical activity</td>
<td>Mortality:</td>
</tr>
<tr>
<td></td>
<td>all-cause</td>
</tr>
<tr>
<td></td>
<td>CHD, stroke, type II diabetes, colon/breast cancer*</td>
</tr>
<tr>
<td></td>
<td>Morbidity:</td>
</tr>
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<td>CHD, stroke, type II diabetes, colon/breast cancer*</td>
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* for indicative estimates only
Summary of selected health end points to be considered for economic valuations of transport-related interventions and policies in children

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<tr>
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<td>Mortality: all-cause</td>
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<td></td>
<td>Morbidity:</td>
</tr>
<tr>
<td></td>
<td>Cough*</td>
</tr>
<tr>
<td></td>
<td>Medication use*</td>
</tr>
<tr>
<td>Traffic safety</td>
<td>Mortality</td>
</tr>
<tr>
<td></td>
<td>Injury</td>
</tr>
<tr>
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<td>n.a.</td>
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* for indicative estimates only
Costing approach: COI & WTP

Total health costs

Direct and indirect costs

- Administration costs
- Costs of medical care
- Economic production losses

(lost consumption)

Intangible costs (for victims)

Market prices / COI

No market prices

Part of total health costs which is double counted (by COI and WTP)

COI method with only net economic production losses (lost (future) consumption will be subtracted)

-> double counting of small part of the costs of medical care and of the administration costs
Guidance – basic structure

**INPUT DATA:** HEALTH

- **STEP 1:** Traffic characteristics by transport mode and type of vehicle
- **STEP 2:** Population density, exposure levels
- **STEP 3:** Exposure-response functions identified through meta-analysis or epidemiological studies. Data on prevalence, incidence, background rates and demographics. Disease burden taking severity and duration of effects into consideration
- **STEP 4:** Estimated health effects (identification of exposure response functions and calculation of number of cases)

**INPUT DATA:** TRAFFIC, ENVIRONMENT, COSTS

- Traffic characteristics (e.g. traffic volumes, speed, density, quality of infrastructure) by vehicle type and traffic mode
- Emissions of each vehicle type and traffic mode. Dispersion models and meteorological data
- Economic cost figures: e.g. health costs per case, cost of life years

**Total costs**

summing up health effects multiplied by cost figures
Guidance: road traffic crashes

**INPUT DATA: HEALTH**
- Population density
- Number of deaths
- Number of non-fatal injuries (possibly by severity of outcomes)

**INPUT DATA: TRAFFIC, ENVIRONMENT, COSTS**
- Traffic characteristics (e.g. traffic volumes, speed, density, quality of infrastructure) by vehicle type and traffic mode
- Number of total traffic crashes (possibly, number of traffic crashes per vehicle/km by category of vehicle)
- Economic cost figures: e.g. health costs per case, cost of life years

**STEP 1**
- Traffic characteristics
  - by transport mode and type of vehicle

**STEP 2**
- Assessment of exposure
  - Number of traffic crashes
    - (either from official statistics or based on traffic quantity)

**STEP 3**
- Estimated health effects
  - (calculation of number of cases)

**STEP 4**
- Economic valuation of health effects
  - all effects valued in economic terms

- Total costs
  - summing up health effects multiplied by cost figures
Guidance: air pollution

<table>
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<th>INPUT DATA: HEALTH</th>
<th>INPUT DATA: TRAFFIC, ENVIRONMENT, COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEP 1</strong></td>
<td><strong>Traffic characteristics</strong></td>
</tr>
<tr>
<td>by transport mode and type of vehicle</td>
<td>traffic characteristics (e.g. traffic volumes, speed, density, quality of infrastructure) by each vehicle type of each traffic mode</td>
</tr>
<tr>
<td><strong>STEP 2</strong></td>
<td><strong>Assessment of exposure</strong></td>
</tr>
<tr>
<td>emissions -&gt; dispersions -&gt; concentrations</td>
<td>emissions of each vehicle type of each traffic mode</td>
</tr>
<tr>
<td><strong>STEP 3</strong></td>
<td><strong>Estimated health effects</strong></td>
</tr>
<tr>
<td>(identification of exposure response functions and calculation of number of cases related to air pollution )</td>
<td>dispersion models and meteorological data air pollution indicators</td>
</tr>
<tr>
<td><strong>STEP 4</strong></td>
<td><strong>Economic valuation of health effects</strong></td>
</tr>
<tr>
<td>all effects valued in economic terms</td>
<td>economic cost figures: e.g. health costs per case, cost of life years</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td>summing up health effects multiplied by cost figures</td>
</tr>
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</table>
Guidance: t-r lack of physical activity

Methodological challenges:
- Which fraction of physical inactivity is attributable to “traffic”?
- Which approaches can be proposed to calculate this attributable fraction?
- Which assumptions can be made regarding morbidity costs related to cycling and walking?

3 possible approaches to apportionment:
1. Effectiveness of interventions for cycling/walking
2. Comparisons between levels of cycling/walking achieved in cities (cities with highest levels representing the highest potential)
3. Modelling approaches
Morbidity-related costs: an alternative approach

multiply costs from all-cause mortality with agreed multiplication factor: possible ratio: 1:1?

years of life lost (YLL) / disability adjusted life years due to morbidity/mortality

(Public Health Group, Victoria, 2005), selected causes with association to physical activity, Tables 10 and 11)

<table>
<thead>
<tr>
<th>Causes</th>
<th>Morbidity</th>
<th>Mortality</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YLD</td>
<td>YLL</td>
<td></td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>60,790</td>
<td>52,986</td>
<td>1.2</td>
</tr>
<tr>
<td>Stroke</td>
<td>13,141</td>
<td>20,618</td>
<td>0.6</td>
</tr>
<tr>
<td>Road traffic accidents</td>
<td>11,505</td>
<td>9,306</td>
<td>1.2</td>
</tr>
<tr>
<td>Diabetes</td>
<td>29,183</td>
<td>8,565</td>
<td>3.4</td>
</tr>
<tr>
<td>Mental (Alzheimer's/other dementia, depression)</td>
<td>53,436</td>
<td>6,048</td>
<td>8.8</td>
</tr>
<tr>
<td>Hypertensive heart disease</td>
<td>na</td>
<td>1,436</td>
<td>-</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>16,182</td>
<td>9,797</td>
<td>1.7</td>
</tr>
<tr>
<td>Totals</td>
<td>184,237</td>
<td>108,756</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Interactions between exposures

Physical activity and air pollution

- No systematic review available
- Evidence from singles studies:
  O'Donoghue et al. 2007; Rank et al., 2001; Chertok et al., 2004, van Wijnen et al., 1995; Kingham et al., 1998; Adams et al., 2001; Kingham et al., 1998
- Particulates, hydrocarbons: exposures/uptakes seem to be comparable
- NO2: indication of higher uptake for cyclists
- Significant influence from wind speed and between route-variation
- Short peak exposures vs. long-term exposure?
- Caveat: short-term exposures to high ozone levels
Bringing it all together

**Total health costs due to transportation**

- Total health costs due to traffic crashes
- Total health costs due to air pollution
- Total health costs due to noise

**Total health costs due to physical inactivity**

- Total health costs due to "other" health effects

A: possible double counting (cardiovascular effects)
Conclusions

• Sufficient evidence available for a range of health endpoints related to road traffic crashes, air pollution, noise and insufficient physical activity
• Still lack of specific estimates for children for many health endpoints -> further research needed
• Other, non-monetizable effects should be acknowledged
• Uncertainties and assumptions should be clearly stated / sensitivity analysis
• Harmonized method for economic valuation developed (modular or in combination) based on best available evidence that provides dimension of costs related to transport-related health effects
Thank you very much!

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Pollution reductions options network

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Union International des Chemins de Fer (UIC), France
WHO/UNECE guidance and tool for economic assessment of health benefits from cycling and walking

Download the guidance document, HEAT for cycling and user guide from www.euro.who.int/transport/policy/20070503_1