What is the validity of surrogate measures of occupational pesticide exposure used in epidemiological studies?

Ioannis Basinas, Martie van Tongeren, Ken Dixon, and John Cherrie
Aims

• To identify and review the relevant published literature with the intent to summarise the current available knowledge and provide information on the performance of the surrogate exposure measures used in occupational epidemiology of pesticides.
Exposure assessment in pesticide epidemiology

• Common exposure assessment (EA) methods in pesticide epidemiology:
  • Self-reported exposures
  • Job-titles
  • Expert assessments
  • Job-Exposure Matrices (JEMs)
  • Crop-Exposure Matrices (CEMs)
  • Mathematical equations/algorithms
Pesticide exposure in the workplace

• Pesticides are associated to several chronic and acute health conditions
  • Neurological conditions and diseases
    • Parkinson disease, fatigue, memory loss
  • Cancers
    • Lung, prostate, lymphoma and others
  • Respiratory disease
  • Poisoning
• Most epidemiological associations for chronic diseases are for non-specific pesticide exposure (exceptions apply)
Is there an issue?

- Seasonal patterns, different application methods & conditions
- Use of many different active ingredients and mixtures
- Large personal and temporal exposure variability
- Lack of historical exposure measurements and records
- Assessment of pesticide exposure in epidemiological studies relies heavily on surrogate methods

### Dutch fruit growers (3–4)

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>K</th>
<th>N</th>
<th>BW R(_{0.95})</th>
<th>WW R(_{0.95})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalable captan</td>
<td>108</td>
<td>154</td>
<td>3.1</td>
<td>541</td>
</tr>
<tr>
<td>Dermal captan, wrist</td>
<td>133</td>
<td>188</td>
<td>17.3</td>
<td>143</td>
</tr>
<tr>
<td>Dermal captan, hands</td>
<td>128</td>
<td>182</td>
<td>45.1</td>
<td>65.3</td>
</tr>
</tbody>
</table>

*De cock et al., Am Indus Hyg Assoc J, 1998; 59: 158-168*

### Worker-only model

<table>
<thead>
<tr>
<th>Total (between and within)</th>
<th>Variance ratio(_{a}), between-worker</th>
<th>Variance ratio(_{a}), within-worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>(TS^2, (BS^2, ws^2, y))</td>
<td>(bR_{0.95}) c</td>
<td>(wR_{0.95}) d</td>
</tr>
<tr>
<td>Air</td>
<td>2.52 (1.87, 0.65)</td>
<td>212</td>
</tr>
<tr>
<td></td>
<td>2.52 (1.87, 0.65)</td>
<td>212</td>
</tr>
<tr>
<td>Hand</td>
<td>4.87 (3.81, 1.06)</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>4.87 (3.81, 1.06)</td>
<td>2100</td>
</tr>
</tbody>
</table>

Is there an issue?

- 8880 pregnant women (6802 involved)
- Effect of work conditions on health
- Outcomes: prolonged time to pregnancy, preterm birth, decreased birth weight
- EA: self-reported exposure and JEM based on OH assessments (prevalence <1.2%)
- Low agreement between self-reports and JEM (k=0.22)
- Pesticide exposure classified by JEM showed an association with decreased birth weight OR=2.40 (1.14 to 5.0). No association for self-reports
Is there an issue?

- 709 fathers and 1040 mothers
- Outcomes: neuroblastoma
- EA: self-reported, occupation/industry group, comprehensive OH review
- Agreement between methods (k) ranging 0.6-0.8
- Associations depended on exposure method applied
- For mothers OR was 0.7 when using OH review and 3.2 when using occupation/industry group
Literature review methods

- **Online searches:**
  - ProQuest Dialog
  - Combination of search terms
  - No periodic restrictions
  - Only English language
  - Only occupational studies

- **Contact key researchers:**
  - Direct contact asking for research activities
  - Screening of personal publication lists in PubMed
Review results: subjective exposure surrogates

• 9 studies

• Results:
  • Close relatives = good information sources for simple parameters (e.g. ever/never use)
  • Farmers have good recall for broad pesticides categories, but not for specifics and tend to overestimate exposure
  • The EA methods may influence study conclusions
  • Job title alone poor exposure indicator

• Usual reference = expert ratings
Review results: sub. surrogates vs models

- 6 studies
  - 2 benchmarked adaptations of same add-hoc EA methods (algorithms/JEM)
  - 1 looked on effect of recall when using JEMs
  - 3 compared JEMs/CEMs with experts and self-reports

- Results:
  - Applied exposure assessment may influence study conclusions
  - Reasonable agreement between experts and CEMs
  - CEMs appear to overestimate exposure (100% probability is assumed for ingredient)
Review results: sub. surrogates vs measurements

- 12 studies – vs (mainly) biomonitoring data
  - “AHS” algorithm = 4 evaluations
  - JEMs/regulatory models = 4 evaluations
  - Experts, self-reports, job tasks = 5 evaluations

Results
- Job/industry very poor predictors
- Exposure variability explained
  - Expert ratings: <22%
  - JEM scores: <22%
  - “AHS” algorithm scores: 24%
  - Job titles/ tasks: <16%
- Correlations with measurements
  - Expert ratings: 0.02-0.9 (for dermal exposure)
  - “AHS” algorithm: 0.28-0.50
Questions to answer

• Which are the most reliable EA methods to use?
• What is the effect of recall in EA?
• Historical trends - do they matter?
• How do we deal with variability in exposure?

• Further studies comparing different methods across different situation and involving exposure measurements are needed...
IMPRESS: Improving exposure assessment methodologies for epidemiological studies on pesticides

- A study aiming to increase understanding of the performance of exposure assessment (EA) methods used in previous epi. studies with the intention to recommend improvements in practice for the future.

- **Duration:** 3 years started 1st Sept. 2017

- **Funded by:**

- **Website:** [www.impress-project.org](http://www.impress-project.org)