Review EMF Epidemiology

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Carcinogenicity in animals: inadequate

Carcinogenicity in humans: limited

Evaluation of carcinogenicity

Mechanisms & Other relevant data: irrelevant

Leukaemia in children (1)

Group 2B: possibly carcinogenic
Leukaemia in children (2)

- Consistency in epidemiological studies
  - lack of known mechanism / little support from experimental research
  - concern about bias and error in observational studies
- Average exposure to ELF magnetic fields >0.3/0.4 μT
- Less data on other cancers except childhood brain tumours
EMF exposures

- 230 kV overhead line
- 380 V distribution line
- Indoor wiring
Epidemiological studies (1)

All studies until 2000

Studies using calculated fields

Studies using measurements

Night-time exposure

a-c: Ahlbom et al., Br J Cancer, 2000
Epidemiological studies (2)

Study population:
1842 cases
3099 controls

Steps of 0.2 µT:
Slope 1.22
95% CI (1.06, 1.40)
Log-linear model
Adequate model fit

Measurement-based studies:
US, Canada, Germany, UK

Epidemiological studies (3)

Studies conducted after the pooled analysis by Ahlbom et al:
- excluding Brazil
- including Brazil
Simulation study:
To explain the observed association, a confounder must be associated with the risk of leukemia at the order of a RR >5 ➔ unlikely

Schüz, Health Phys, 2007
Selection bias? - likely

Schüz, Health Phys, 2007

Simulation study:
Likely to explain some of the observed association, but unclear whether in its entirety
Biological plausibility (1)
Night-time exposure

Schüz et al., Am J Epidemiol, 2007
Biological plausibility (2)
Contact currents

- Contact currents confounding the association between magnetic fields and childhood leukaemia
- Contact currents observed in relation to higher exposures from power lines
- Rather strong association required

Does et al., Radiation Res, 2011
Evidence:
1. Abberations found in neonatal blood spots
2. Conversion rate low

Greaves, Eur J Cancer, 1999
### Biological plausibility (3)

**Promotion of leukaemia**

#### US Study: Overall survival

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Cases</th>
<th>Events</th>
<th>HR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.1 µT</td>
<td>235</td>
<td>16</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>0.1-0.2 µT</td>
<td>89</td>
<td>7</td>
<td>1.2</td>
<td>0.5 – 2.8</td>
</tr>
<tr>
<td>0.2-0.3 µT</td>
<td>19</td>
<td>1</td>
<td>0.9</td>
<td>0.1 – 6.4</td>
</tr>
<tr>
<td>≥ 0.3 µT</td>
<td>18</td>
<td>4</td>
<td>4.5</td>
<td>1.5–13.8</td>
</tr>
</tbody>
</table>

*Foliart et al., Br J Cancer, 2006*

#### Replication using German data: Overall survival

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Cases</th>
<th>Events</th>
<th>PYRS</th>
<th>HR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.1 µT</td>
<td>445</td>
<td>55</td>
<td>4016</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>0.1-0.2 µT</td>
<td>29</td>
<td>7</td>
<td>247</td>
<td>2.8</td>
<td>1.2 – 6.2</td>
</tr>
<tr>
<td>≥ 0.2 µT</td>
<td>12</td>
<td>3</td>
<td>93</td>
<td>3.0</td>
<td>0.9 – 9.8</td>
</tr>
<tr>
<td>Per 0.1 µT</td>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
<td>1.0 – 1.8</td>
</tr>
</tbody>
</table>

*Svendsen et al., Cancer Epidemiol Biomarkers Prev, 2007*
Effect on population level

WHO – EHC (2007)
Parental exposures

Leukaemia

Smulevich et al., 1999 (41)
Feychtling et al., 2000 (6)
McKinney et al., 2003 (36)
Pearce et al., 2007 (37)
Hug et al., 2009

Combined

Odds Ratio

Hug et al., Am J Epidemiol, 2009
Childhood brain tumours

Ahlbom et al., Br J Cancer, 2000

Leukaemia

Kheifets et al, Am J Epidemiol, 2010

Brain Tumours (measurements)
• ELF magnetic fields remain possible carcinogen

• Selection bias in epidemiological studies lead to overestimation; does it explain the entire association?

• Mechanism?

• If association is causal...

  ... 0.4 µT should not be misused as a threshold for an effect

  ... attributable risk fraction presumably small

• Need for clarification
Pooled Analysis:

Survival & parental exposure studies:

Reviews:
Maslanyj M, Lightfoot T, Schüz J, Sienkiewicz Z, McKinlay A. A precautionary public health protection strategy for the possible risk of childhood leukaemia from exposure to power frequency magnetic fields. BMC Public Health 2010; 10:673.