Roof Core as a Modifier of Dermal Exposures in Hot Asphalt Roofers

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Why study roofers?

Many occupational risks (falls, accidents, back pain...)

Cancer in roofers?

http://www.roofer95.com/safety.htm

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**Occupational exposures to polycyclic aromatic hydrocarbons, and respiratory and urinary tract cancers: a quantitative review to 2005**

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**Background:** Exposure to polycyclic aromatic hydrocarbons (PAHs) has been reported in several industries, including those of the aluminum production, coal gasification, coke production, iron and steel foundries, coal tar and related products, carbon black and carbon electrodes production.

**Patients and methods:** This paper reviews the results from cohort studies conducted on workers exposed to PAHs in these industries, with a focus on cancers of the respiratory and urinary tract.

**Results:** An excess risk from lung/respiratory cancers was found in most industries, the pooled relative risk (RR) being 2.58 (95% CI 2.28–2.92) for coal gasification, 1.58 (95% CI 1.47–1.69) for coke production, 1.40 (95% CI 1.31–1.49) for iron and steel foundries, 1.51 (95% CI 1.28–1.78) for roofers and 1.30 (95% CI 1.06–1.59) for carbon black production. The evidence for cancers of the bladder and of the urinary system is less consistent, with a
Roofing asphalt a ‘probable human carcinogen’ (2A, IARC)

Cancer Mortality Among European Asphalt Workers: An International Epidemiological Study. I. Results of the Analysis Based on Job Titles

Cancer of lung, bladder, skin, digestive tract???

Confounders? No exposure measurements?
Polycyclic aromatic hydrocarbons (PAHs):
Asphalt, diesel exhaust, coal tar

Other sources?

reported large differences in the smoking rates among over 200 occupational groups using nationally representative data from the National Health Interview Survey (NHIS). Pooled cigarette smoking rates in the period 1987 to 1994 varied from 4% in clergy and physicians to 58% in roofers, with consistently higher smoking rates among blue-collar workers. Furthermore, significant reductions...
Old roof? Hot asphalt? Or both?

- Dermal exposure higher if workers tear old roof
- If old roof contains coal tar, higher levels of carcinogenic PAHs (BaP) on skin
- Dermal exposure can be reduced by gloves (possibly more if roofers have skin burn)
But, why would roofers have skin burn?

~ 550°F (288°C)
But, why would roofers have skin burn?

~ 550°F (288°C)
Which one is more important: Inhalation or dermal contact?
Personal breathing zone air

Particle-bound PAHs:
pumps (SKC XR-5000) with PM$_{2.5}$ inlets & 37 mm Teflon filters.

Gas-phase PAHs:
adsorbent tubes (XAD-2, 75/150 mg), 2.7 L/min flow rate.

Dermal wipes

Hand wash with sunflower oil. Dichloromethane extracts.
Study design

Monday & Thursday

**Morning:**
- Questionnaire
- Hand wipe
- Blood/urine
- Refreshments
- Air monitors given
- Gift cards given

**Afternoon:**
- Return monitors
- Questionnaire
- Hand wipe
- Blood/urine
- Refreshments
- Gift cards given
Air PAHs

Particle bound PAHs:
Naphthalene in most.
Also some:
Pyrene, Chrysene, Benzo(a)anthracene, Benzo(e)pyrene, Benzo(a)pyrene

Gas phase PAHs:
Naphthalene & Phenanthrene most abundant
Dermal wipe extracts

Total PAHs on Hand Wipes, Day 1

- Naphthalene
- Phenanthrene
- Anthracene
- Fluorene
- Dibenzothiophene
- Carbazole
- Fluoranthe
- Benzo(a)pyrene
- Pyrene
- Chrysene
- Benzo(a)anthracene
- Triphenylene
- 5-Methylnaphthalene
- Dibenz(a,h)anthracene
- Benzo(e)pyrene
- Benzo(a)fluoranthene
- Benzol[j]fluoranthene
- Benzol[k]fluoranthene
- Indeno[1,2,3-cd]pyrene

Sample Color Scale

0 1 2 3 4 5 6 7 8 9

Pre-shift wipes
Post-shift wipes
<table>
<thead>
<tr>
<th>No of Benzene Rings</th>
<th>Sample Concentration (µg per wipe)</th>
<th>186 Pre-shift</th>
<th>166 Pre-shift</th>
<th>186 Post-shift</th>
<th>166 Post-shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Naphthalene</td>
<td>0.16</td>
<td>0.20</td>
<td>0.18</td>
<td>0.18</td>
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<tr>
<td>2+</td>
<td>Carbazole</td>
<td>0.14</td>
<td>0.17</td>
<td>0.17</td>
<td>0.15</td>
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<tr>
<td>2+</td>
<td>Dibenzothiophene</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.02</td>
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<tr>
<td>3</td>
<td>Anthracene</td>
<td>0.09</td>
<td>0.09</td>
<td>0.10</td>
<td>0.10</td>
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<tr>
<td>3</td>
<td>Phenanthrene</td>
<td>0.24</td>
<td>0.23</td>
<td>0.33</td>
<td>0.34</td>
</tr>
<tr>
<td>3+</td>
<td>Benzo[b]naptho[2,3-d]thiophene</td>
<td>0.24</td>
<td>0.22</td>
<td>0.50</td>
<td>0.55</td>
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<tr>
<td>4</td>
<td>Benz[a]anthracene</td>
<td>0.15</td>
<td>0.14</td>
<td>0.23</td>
<td>0.36</td>
</tr>
<tr>
<td>4</td>
<td>Chrysene</td>
<td>0.25</td>
<td>0.24</td>
<td>0.39</td>
<td>0.86</td>
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<tr>
<td>4</td>
<td>Pyrene</td>
<td></td>
<td>0.32</td>
<td>0.39</td>
<td></td>
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<tr>
<td>4+</td>
<td>Benzo[b]fluoranthene</td>
<td>0.15</td>
<td>0.14</td>
<td>0.23</td>
<td>0.36</td>
</tr>
<tr>
<td>4+</td>
<td>Benzo[j]fluoranthene</td>
<td>0.19</td>
<td>0.19</td>
<td>0.09</td>
<td>0.04</td>
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<tr>
<td>4+</td>
<td>Benzo[k]fluoranthene</td>
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<td>0.19</td>
<td>0.19</td>
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</tr>
<tr>
<td>5</td>
<td>Benzo[a]pyrene</td>
<td>0.18</td>
<td>0.17</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>5</td>
<td>Benzo[e]pyrene</td>
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<td>0.03</td>
<td>0.06</td>
<td></td>
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<tr>
<td>6</td>
<td>Benzo[ghi]perylene</td>
<td>0.22</td>
<td>0.21</td>
<td>0.22</td>
<td>0.22</td>
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<tr>
<td>5+</td>
<td>Dibenz[a,h]anthracene</td>
<td></td>
<td>0.22</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5-Methylchrysene</td>
<td></td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Σ 40 PACs (total µg)</td>
<td></td>
<td>1.57</td>
<td>1.67</td>
<td>3.59</td>
<td>4.51</td>
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<tr>
<td>Σ 4-6 ring PACs (total µg)</td>
<td></td>
<td>0.81</td>
<td>0.76</td>
<td>2.27</td>
<td>3.17</td>
</tr>
</tbody>
</table>
Roof core samples

- Extracts analyzed for coal tar via fluorescence scan
No evidence of coal tar observed

Roof core sample

Coal tar spiked control
Results resemble those observed in skin wipes.
Conclusions

• PAHs (esp. 4-6 ring) more abundant in wipes after the work

• No evidence of coal tar in roof core
  – But PAH levels higher than published asphalt samples

• Pattern of PAHs similar in roof core and dermal wipes after work
We thank all of the roofers who participated

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