Bladder cancer in crack testers applying azo dye-based sprays to metal bodies

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Introduction
Bladder cancer risk in the metal industry has been discussed controversially. Crack test sprays are used for nondestructive materials testing. In the past, these sprays might have contained azo dyes based on carcinogenic aromatic amines.

Methods and investigated subjects
Nine bladder cancer patients with suspected occupational bladder cancer and reported use of crack test sprays were asked for occupational and non-occupational risk factors. Six cases were N-acetyltransferase 2 (NAT2) genotyped. In a literature research, the structural formulas of azo dyes contained in some of the former crack test sprays were found (Fig. 1).

![Chemical structure of Sudan red 7B](image)

Material testing with crack test sprays
The principle of the procedure patented in 1943 is as follows: A red staining penetrant is sprayed on the area of interest. In the case of a material defect, the dye, based on capillary action, will invade the fault and will stay in the crack even after cleaning of the test area. After having dried, a white developer is applied which facilitates the creeping of the red dye from the depth of the crack to surface. This makes the fault clearly visible (Fig. 2).

![Crack test in a quick acting valve](image)

Results
The first exposure to crack test sprays ranged from 1957 to 1986. Age at first exposure was between 14 and 29 years. Age at first diagnosis of bladder cancer varied from 35 to 64 years. Latency periods were between 17 and 37 years. The maximum reported latency period was 45 years (Table 1).

<table>
<thead>
<tr>
<th>Relevant exposure</th>
<th>Start of exposure</th>
<th>Age at start of exposure</th>
<th>Latency period</th>
<th>Age at FD</th>
<th>Smoking habits</th>
<th>NAT2-Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Azo dye</td>
<td>1967</td>
<td>14</td>
<td>30</td>
<td>44</td>
<td>NS</td>
<td>R</td>
</tr>
<tr>
<td>2 Sudan red</td>
<td>1970</td>
<td>33</td>
<td>19</td>
<td>52</td>
<td>NS</td>
<td>S</td>
</tr>
<tr>
<td>3 p-Phenyldiazo-anilin-N-ethyl-2-naphthylamine</td>
<td>1986</td>
<td>18</td>
<td>17</td>
<td>35</td>
<td>NS</td>
<td>S</td>
</tr>
<tr>
<td>4 Crack test spray</td>
<td>1966</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>5 Comparable to Sudan red</td>
<td>1967</td>
<td>19</td>
<td>28</td>
<td>47</td>
<td>NS</td>
<td>R</td>
</tr>
<tr>
<td>7 Sudan red</td>
<td>1957</td>
<td>19</td>
<td>45</td>
<td>64</td>
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<td>S</td>
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<tr>
<td>8 Crack test spray</td>
<td>1969</td>
<td>22</td>
<td>36</td>
<td>58</td>
<td>NS</td>
<td>n.d.</td>
</tr>
<tr>
<td>9 Crack test spray</td>
<td>1980</td>
<td>32</td>
<td>29</td>
<td>61</td>
<td>NS</td>
<td>n.d.</td>
</tr>
</tbody>
</table>

FD: First Diagnosis; NAT 2-Status: R Rapid, S Slow
n.d.: not determined; S Smoker; NS Nonsmoker

Conclusion
Every bladder cancer patient with a history of metal-related jobs should be explicitly asked for crack testing.

Synonyms for Sudan red 7B (CAS Nr. 6368-72-5)
Solvent Red 19
Ceres Red 7B
Fat Red 7B
Lacquer red V3B
Hexatype carmine B
Oil violet
OrganoI bordeaux B
N-Ethyl-1-[[4-(phenylazo)phenyl]azo]-2-naphthalenamine
N-Ethyl-1-[[p-(phenylazo)phenyl]azo]-2-naphthalenamine
(Phenylazo-4-phenyl)-1-ethylamino-2-naphthalene
typogen carmine
C.I. No. 26050

References