Exposure to Carcinogens in the Oil and Gas Industry

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Major Carcinogen of Concern:

Benzene
What is Benzene?
C₆H₆
Sweet Smelling Common Chemical
Benzene is one of the top 20 chemicals used in the US, exposing some 2-3 million workers. Widely used around the world.
Most benzene is used to make other materials, primarily ethylbenzene, cumene, and cyclohexane.

Ethylbenzene used to make styrene, then used to make polymers and plastics.

Also used in the process to make nylon.
Benzene is found in gasoline-increases octane and reduces “knocking”. Generally 1-5%
Benzene can effect the liver, kidney, lung, heart, brain, and blood. It causes chromosomal damage.
IARC has classified benzene as a Class I, known human, carcinogen.
The health hazards of benzene have been known for decades.
First reports of blood damage go back to the late 1800’s/ leukemia reported early in 20th century.
In 1948 the American Petroleum Institute stated that “it is generally considered that the only absolutely safe concentration for benzene is zero”.
Zero level for benzene is a concept that applies to all carcinogens.
Products with benzene include gasoline, mineral spirits, paints, glue, and cigarettes.
Immediate Symptoms:

- Drowsiness, dizziness, irregular heartbeat, headaches, tremor, confusion, unconsciousness, and at high enough levels even death.
Major effect is on the blood
1934-Alice Hamilton

- 1897-report in Russia of hemorrhages from rubber cement
- 1910-report in the US of same problem
- 1918-13 weeks of rubber cement, bleeding gums and hemorrhage
Benzene and Leukemia

- First cases reported in the 1920’s
Basically there are two types of white blood cells, red cells, and platelets.
Types of Leukemia

- AML
- ALL
- CLL
Other Hematologic Problems

- Myelofibrosis
- Multiple Myeloma
- Lymphomas
Reduction in WBC at 0.1ppm
“Usual” Scientific Controversy
Chromosomal Changes
Workers with exposure required medical surveillance
Cigarette smokers get more Leukemia
Petrol station workers
Sources of benzene exposure include petrol, diesel, aviation fuels, downstream chemicals
New hazards for the Oil and Gas Industry

- “fracking”
- tar sands
There is one other major carcinogenic exposure--

Asbestos
• Spectrum of Asbestos-Related Disease
  • Asbestos warts
  • Benign asbestotic pleural effusion
  • Asbestosis
    • Parenchymal
    • Pleural
  • Neoplastic
    • Lung
    • Mesothelioma
    • Pleura
    • Peritoneum
    • Esophagus
    • Stomach
    • colon/rectum
    • Larynx
    • Oro-pharynx
    • Renal
# Multiple Factor Effect

<table>
<thead>
<tr>
<th>Group</th>
<th>Death Rate</th>
<th>Mortality Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Asbestos, Non-Smoker</td>
<td>11.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Asbestos Worker, Non-Smoker</td>
<td>58.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Non-Asbestos, Smoker</td>
<td>122.6</td>
<td>10.9</td>
</tr>
<tr>
<td>Asbestos Worker, Smoker</td>
<td>601.6</td>
<td>53.2</td>
</tr>
</tbody>
</table>

Synergism also applies to combination of benzene and alcohol with regard to bone marrow effects
All forms of asbestos can cause disease
Malignant neoplasms in rats following inhalation of asbestos

<table>
<thead>
<tr>
<th>Type of asbestos</th>
<th>Carcinoma</th>
<th>Mesothelioma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amosite (146*)</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Anthophyllite (145)</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Crocidolite (141)</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Canadian Chrysotile (137)</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Rhodesian Chrysotile (144)</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>controls (126)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*rats surviving at least 300 days.

Malignant Neoplasms in rats following inhalation of asbestos

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Rats</th>
<th>Carcinoma</th>
<th>Mesothelioma</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>219</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3 mos.</td>
<td>180</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>6 mos.</td>
<td>90</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>12 mos.</td>
<td>129</td>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>24 mos.</td>
<td>95</td>
<td>37</td>
<td>2</td>
</tr>
<tr>
<td>Controls</td>
<td>126</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

RATIO OF OBSERVED TO EXPECTED CUMULATIVE PROBABILITY OF DEATHS
AT 30 ELAPSED YEARS SINCE ONSET OF WORK

LENGTH OF TIME WORKED

<1 MONTH
1 MONTH
2 MONTHS
3-5 MONTHS
6-11 MONTHS
1 YEAR
2+ YEARS

C. LUNG CANCER

RATIO OF OBSERVED TO EXPECTED

Figure 10
Significant Risk Occupations

Asbestos mining and milling
Asbestos product manufacture
Manufacture of products containing asbestos
Insulation installers
Construction industry
Shipbuilding
Ship repair
Ship personnel-engineering
Maintenance - public buildings
Maintenance - refineries, chemical plants
Power production - utilities
Railroads
The Oil and Gas Industry should take precautions to protect workers, those exposed downstream, and the environment.