Occupational health issues associated with fracking

John Cherrie
Summary…

- Workplace regulations
- Hazardous substances
- Main potential risk from crystalline silica
  - Silicosis, COPD, renal failure and lung cancer
- Putting these risks in context
- What can be done about this problem?
- Appropriate health surveillance
- Managing other risks to health
COSHH Regulations

- Finding out what the health hazards are
- Undertaking a risk assessment
- Providing control measures to reduce harm to health
- Making sure they are used
- Keeping control measures in working order
- Providing information, instruction and training for employees and others
- Undertaking monitoring and health surveillance
Occupational Hazards

- Diesel engine exhaust
- Volatile organic compounds
- Hydrogen sulfide (H$_2$S)
- Acid gases (HCl)
- Metals (Pb)
- Aldehydes
- Water and other additives
- Respirable crystalline silica
Exposure to crystalline silica

- NIOSH measured exposure levels at 11 fracking sites in 5 states
- NIOSH Recommended Exposure Limit REL = 0.05 mg/m$^3$ as an 8-hour average
- British Workplace Exposure Limit WEL = 0.1 mg/m$^3$

Main hazards from crystalline silica

- Silicosis
- Tuberculosis
- Chronic obstructive pulmonary disease
- Lung cancer
- Chronic renal disease
- Scleroderma
- Rheumatoid arthritis
Risks from USA silica sand workers

- Steenland and Sanderson (2001)
- 4,626 industrial sand workers
- Average employment was 9 years and estimated average exposure was 0.05 mg/m³

<table>
<thead>
<tr>
<th>Cause of death (SRR)</th>
<th>&lt;0.1 mg/m³.yr</th>
<th>0.1-0.5 mg/m³.yr</th>
<th>0.5-1.28 mg/m³.yr</th>
<th>&gt;1.28 mg/m³.yr</th>
<th>p for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer (15 yr lag)</td>
<td>1.0</td>
<td>0.78</td>
<td>1.51</td>
<td>1.57</td>
<td>0.07</td>
</tr>
<tr>
<td>Silicosis</td>
<td>1.0</td>
<td>1.22</td>
<td>2.91</td>
<td>7.39</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>Other resp. disease, inc silicosis</td>
<td>1.0</td>
<td>1.63</td>
<td>1.45</td>
<td>2.4</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Risks from UK silica sand workers

- Brown and Rushton (2005)
  - 2,703 employees / former employees at seven quarries
  - Overall geometric mean silica concentration was 0.09 mg/m³

<table>
<thead>
<tr>
<th>Cause of death (RR)</th>
<th>&lt;0.13 mg/m³.yr</th>
<th>0.13-0.4 mg/m³.yr</th>
<th>0.4-1.0 mg/m³.yr</th>
<th>&gt;1.0 mg/m³.yr</th>
<th>p for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer (no lag)</td>
<td>1.0</td>
<td>1.14</td>
<td>1.12</td>
<td>0.92</td>
<td>0.80</td>
</tr>
<tr>
<td>Non-malignant resp. disease</td>
<td>1.0</td>
<td>1.33</td>
<td>0.98</td>
<td>1.12</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Silica surface properties...

- IARC noted... “carcinogenicity in humans was not detected in all industrial circumstances studied, carcinogenicity may be dependent on inherent characteristics of the crystalline silica...”
- Cancer and silicosis risk most probably arise from inflammation
- Key physicochemical parameters are surface reactivity and particle size (surface area)

Surface treated quartz

Health surveillance

• Where there is a reasonable likelihood of silicosis developing, health surveillance will be necessary.
• Baseline assessment of health status
• Clinical examination
• Work history information
• Chest x-rays
• Symptoms questionnaire / lung function
• Screening for chronic kidney disease?
Exposure controls

- Prevention through Design
- Remote operations
- Substitution (ceramic vs. sand)
- Mini-baghouse, screw augur assemblies
- Passive enclosures, e.g. stilling curtains
- Minimize distance that sand falls
- End caps on fill nozzles
- Effective respiratory protection program
Questions?

My slides are available at www.Slideshare.net/JohnCherrie

NIOSH proposed mini-baghouse unit