Current Usage and Health Significance of the Modern Use of Chrysotile Products: Review of Recently Published Evidence

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ASBESTOS

SERPENTINE

Chrysotile

Tremolite

AMPHIBOLE

Amosite

Crocidolite

Actinolite

Anthophyllite
Our use of asbestos types has increased the airborne level in the urban environment to a fibre concentration that may be 1 fibre/L—mostly chrysotile.

This is a ten-fold increase on the natural background.
Previous uses of Asbestos in Buildings

- Fireproofing steel frame buildings
  - white
  - ‘limpet’ - blue
- Cement sheeting
  flat - white and brown
  corrugated - white
- Pipes and related fittings
- Insulation material - all types
- Acoustic tiles - mainly brown
Previous uses of Asbestos in Buildings

- No amphibolic products are now used.
- Medium or low density products such as acoustic tiles or loose insulation are no longer made or used.
Use in friction products
Previous uses of Asbestos

- Nearly all of the opposition to asbestos and the fear of exposure results from previous use often using amphibole products.

- Improper attempts at abatement and safe disposal of amphibole materials arouses considerable public concern.
Most Asbestos Containing Material (ACM) produced and used today is found as high-density products made from asbestos (chrysotile) cement.

In these products the chrysotile is bound in a tight matrix and will not easily shed fibres under normal day to day use.

Examples of non-friable products are: roof shingles, asbestos cement pipes and sheet, caulking compounds, floor tiles and joint cements.
Asbestos cement roof
Work on Asbestos Cement Products

- Personal exposure during work on AC roofing and with sheeting –
  - range not detected to <0.01 – 1.1 f/ml

- representative pipe installation –
  - range 0.02 – 0.06 f/ml
Work on Asbestos Cement Pipes

- High density products require considerable energy input to liberate any fibres at all from their matrix.
- ‘Representative’ pipe installation –
  - range 0.02 – 0.06 f/ml
- cutting pipes with high speed disc cutter –
  - dry 60 f/ml
UK Regulations

- To protect workers from dust there have to be regulations.
- Current UK regulations are an upper limit of:
  - 0.2 f/ml for amphiboles
  - 0.3 f/ml for chrysotile

Proposed change to 0.1 f/ml for all types.
Ambient Airborne Fibres

asbestos - all types

- Remote rural areas < 0.0001 f/mL
- Large city
  - residential areas 0.0002 – 0.011
  - busy cross-roads 0.0009
  - expressway 0.0033
- Indoors (no asbestos) < 0.0001

Bignon, 1989
Does it matter?

- Will exposure to this level of fibres have an adverse effect on health?
- Should we be concerned?
No
- Permitted occupational levels are very much higher even if extrapolated to continuous exposure.
Several studies have been done on women in mining areas who were not occupationally exposed.

Study by Churg noted ambient levels 200 to 500 times greater than other N. American cities.

No excess lung cancer in the cohort.
The threshold of exposure is the level of cumulative exposure below which disease caused by asbestos will not be detectable.

Risk then increases as the exposure increases.
The existence of a disease threshold was accepted by the Ontario Royal Commission (1984) and noted by Doll and Peto (1985).
In any risk analysis assumptions have to be made:

- assume the risk of asbestos disease is simply dose-dependent,
- therefore risk is related to total (or cumulative) exposure.
- Total exposure is the number of fibres inhaled calculated as the number of years worked, multiplied by the fibre level in the air at work. The result is expressed as fibres per millilitre (f/ml) years.
The simple dose-dependent model becomes more complicated when types of asbestos are considered.

- Amphiboles are more durable *in vivo* than chrysotile
- Unfortunately, regulatory agencies take little account of asbestos types
Risk Assessment

The main problem with assessing the risk of exposure to low levels of chrysotile is that it is done by extrapolation from the effects of high level exposure through several orders of magnitude to the low exposure. In the absence of other models a linear model is used which is a considerable and unwarranted assumption.
Health Effects from Asbestos Exposure

- Heavy exposure to any asbestos type can cause health effects
- People in the building trades and maintenance are at particular risk
- Safety Regulations should be scrupulously obeyed
The only target organ is the lung
Asbestos related diseases

- Pleural plaques
- Asbestosis
- Lung cancer
- Mesothelioma
Asbestos related diseases

- Pleural plaques - amphiboles
- Asbestosis - all types of asbestos
- Lung cancer - mostly amphiboles
- Mesothelioma - amphiboles
Asbestos related diseases

- These diseases are all the result of high exposures.
- Exposure levels today should now be so low that these diseases can be regarded as historical.
- They are mostly diseases of amphibole exposure although animal experimentation has shown that all, except PP, can be caused by chrysotile.
Health Effects from Chrysotile

- Long fibre (>10 µm) - can cause fibrosis and maybe lung cancer after severe exposure. There is little good evidence that it can cause mesothelioma.
- Short fibre - does not cause fibrosis, except maybe after very severe exposure, or lung cancer and is readily cleared from the lungs.
- Very short fibre (<5µm) has nominally zero risk.
Pleural plaques

- Only if these occur bilaterally can they be due to asbestos exposure.
- There are other causes
- Most clinicians and scientists doubt that they are caused by chrysotile
- They are not a progressive condition and cause no clinical symptoms
- **Lawyers love them**
Asbestosis

- A pneumoconiosis caused by high level exposure to asbestos
- Damaged lung tissue becomes scarred
- Now predominately a disease of older men
  - in the UK (2002-3) average age at diagnosis was 72 (98% men)
- The disease can be progressive and can kill
  - UK deaths in 2003 were 113
How many asbestos-related lung cancer deaths are there each year?

Lung cancer deaths caused by asbestos are clinically indistinguishable from those caused by other agents such as tobacco smoke. This means the number of cases cannot be determined by direct counting and must be estimated.
Lung Cancer

- Possibly/probably linked to asbestosis
- The US NCI believes that 1 in 7 people with asbestosis will develop lung cancer
- On this basis UK levels are less than 100 per annum
- There is no good evidence that working with high density chrysotile products produces the disease
Lung Cancer

- UK Govt. estimates still ignore fibre type and any clinical evidence
- Recent paper by Darnton says 0.7 to 1.0 of the number of mesothelioma deaths
- That is 1312 to 1874 deaths for 2003.
- The effect of the RIA by govt. actuaries on Asbestos at Work regulations gives a figure a tenth of this.
In 2002 there were 22,504 men diagnosed with lung cancer
- Some 90% due to smoking so 2,250 from other causes
- Radon causes approx. 600 deaths in men
- Air pollution from 200 to 2,000 deaths
- Asbestos causes up to 1874 deaths (Darnton, 2006)
- Diet and other sources?
- Arithmetic of the absurd!
# Chrysotile only – Male Mortality

<table>
<thead>
<tr>
<th></th>
<th>total deaths (no.)</th>
<th>% rel. risk (SMR)</th>
<th>lung cancer no.</th>
<th>% rel. risk (SMR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardner</td>
<td>384</td>
<td>94</td>
<td>35</td>
<td>92</td>
</tr>
<tr>
<td>Thomas</td>
<td>351</td>
<td>102</td>
<td>30</td>
<td>91</td>
</tr>
<tr>
<td>Ohlson</td>
<td>220</td>
<td>103</td>
<td>11</td>
<td>122</td>
</tr>
<tr>
<td>Weiss</td>
<td>66</td>
<td>61</td>
<td>4</td>
<td>94</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1021</td>
<td>95</td>
<td>80</td>
<td>95</td>
</tr>
</tbody>
</table>
Only the small Swedish study showed a slight excess but remember most of the lung cancers are caused by smoking and recent studies in America have shown that asbestos workers smoke more than the average. A recent survey by Lange suggests the level is around 80%
Quebec miners & millers

- Cohort was nearly 10,000 men (born 1891-1920) and by 1992 8,000 had died.
- No dose response below 1,000 f/ml years (equivalent to working for 40 years at a level of 25 f/ml).
- The slightly raised relative risk attributed to smoking.
<table>
<thead>
<tr>
<th>exposure (f/ml y)</th>
<th>lung cancer no.</th>
<th>SMR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>36</td>
<td>114</td>
</tr>
<tr>
<td>10 - &lt;33</td>
<td>40</td>
<td>138</td>
</tr>
<tr>
<td>33 - &lt;100</td>
<td>33</td>
<td>105</td>
</tr>
<tr>
<td>100 - &lt;200</td>
<td>39</td>
<td>160</td>
</tr>
<tr>
<td>200 - &lt;330</td>
<td>30</td>
<td>132</td>
</tr>
<tr>
<td>330 - &lt;660</td>
<td>32</td>
<td>113</td>
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<td>660 - &lt;1000</td>
<td>20</td>
<td>115</td>
</tr>
<tr>
<td>1000+</td>
<td>80</td>
<td>185</td>
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</table>
# Mesothelioma – ‘chrysotile only’ cohorts

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>0</td>
<td>None in 2288 deaths</td>
</tr>
<tr>
<td>Miners &amp; millers</td>
<td>3</td>
<td>all exposed &gt;300 f/ml y</td>
</tr>
<tr>
<td>Balangero</td>
<td>3</td>
<td>all exposed &gt;300 f/ml y</td>
</tr>
<tr>
<td>Quebec</td>
<td>31</td>
<td>all exposed &gt; 2 years</td>
</tr>
</tbody>
</table>
Mesothelioma – chrysotile only cohorts

- Balangero miners were exposed to Balangeroite and may have been exposed to crocidolite.
- Some of the Quebec cases were exposed to crocidolite and most of the rest were exposed to high tremolite contamination.
- **Tremolitic areas are now no longer mined**
- Studies in South African chrysotile mines – which have little tremolite – have shown no cases of mesothelioma (Rees).
Chrysotile does not cause mesothelioma

“The review of 71 asbestos cohorts exposed to free asbestos fibers does not support the hypothesis that chrysotile, uncontaminated by amphibolic substances, causes mesothelioma.”

(Yarborough Crit Rev Toxicol 2006;36:165-187.)
Chrysotile does not cause mesothelioma

“There has probably never been an attributable, clinically and pathologically proven case of mesothelioma in any manufacturing industry, e.g. cement, friction products, or textiles, amongst the many tens of thousands of workers where chrysotile alone has been used.”

(Ilgren & Chatfield, Indoor Built Environ 1998;7:18-31.)
Chrysotile risks today

- For Lung Cancer and Asbestosis chrysotile presents little or no risk before exposures exceed 20 f/ml throughout working life

- For Mesothelioma – no detectable risk