Current picture of health risks and exposure to respirable crystalline silica in Great Britain

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Silica health issues

- Silicosis
- COPD
- Lung Cancer
  - Rheumatoid silicotic nodules
  - Tuberculosis
  - Rheumatoid arthritis, systemic lupus erythematosus (SLE), scleroderma and sarcoidosis
- Gastric Cancer
Respiratory health effects of silica

Bernardino Ramazzini (1713):

- “..maladies that attack stone-cutters, quarrymen and other such workers…
- “..they often breathe in rough, sharp, jagged splinters…
- “..hence they are usually troubled with cough and some of them contract asthmatic affections and become consumptive.”
- “..when the bodies of such workers are dissected, they have been found to be stuffed with small stones.”

Hawk’s Nest tunnel (1936)
Silicosis – the epidemiological evidence

• A number of epidemiological studies from around the world, including GB

• Some heterogeneity between studies but consistent findings are:
  – Risk of silicosis increases non-linearly with both duration and level of exposure
  – Few cases occur within 15 years of first exposure (chronic silicosis)
  – No threshold
  – Short periods of high exposure significantly elevate the risk

• Normally no symptoms or change in lung function in early stages of the disease

• Progressive and irreversible – but progression is slower if no continued exposure

What are the risks of silicosis?

Lifetime risk from 0.05 mg/m³ for 45 years = 5 in 100

Current GB WEL = 0.1mg/m³ 8hrs TWA

Source: US OSHA 2016
What are the risks of silicosis?

Lifetime risk from 0.1 mg/m$^3$ for 45 years = 30 in 100

Current GB WEL = 0.1mg/m$^3$ 8hrs TWA

Source: US OSHA 2016

What are the risks of lung cancer?

>10 studies have found an increased risk of lung cancer with silica exposure

Exposure-response relationship, flattening at high cumulative exposures

Silicosis is not a necessary pre-cursor for the development of lung cancer
What are the risks of lung cancer?

UK lifetime risk males: 8 in 100

Excess risk from 0.1 mg/m³ for 45 years: 5 in 100

Source: Cancer Research UK
What is COPD?

Chronic Obstructive Pulmonary Disease is a term used for a number of conditions including chronic bronchitis and emphysema

- Characterised by chronic obstruction of the airways that interferes with normal breathing
- Progressive and accelerated decline in lung function over time
- Progressive shortness of breath, cough, sputum occurs later
- ONLY way to identify COPD is through lung function testing

COPD, lung function and silica exposure

![Diagram showing FEV1 vs Age with different scenarios of exposure and outcomes.](image-url)
Silica and lung function

- an extra 8ml lost per year (0.1 mg m$^{-3}$)

- an extra 12ml lost per year

These excess declines are averages, susceptible individuals could experience losses two to three times greater

What are the risks of COPD?

Lifetime risk of COPD* (male) = 11 in 100

*GOLD 3 & 4 severities

Source: HSE COPD population model
What are the risks of COPD?

Excess risk from 0.1 mg/m³ for 45 years: 5 in 100

*GOLD 3 & 4 severities

Source: HSE COPD population model

Exposure to silica in Great Britain

Approximately 600,000 workers are estimated to be exposed to silica

Main sectors:
- Construction
- Stone working
- Foundries
- Quarrying
- Ceramics

Some evidence that exposures have fallen:

- Europe, across all sectors, 1976-2009 (Peters et al. 2011) - 6% per annum
- GB Quarries, 1984-2003 (IOM 2006) - Dust -6% per annum, Silica -1% per annum (not statistically significant)
- GB Silica sand industry, 1978-2000 (Brown & Rushton 2005) -3% per annum
Exposure to silica in Great Britain

1/3 of samples > WEL
Trend: stone -6% per annum

Silica related disease burden

Estimates based upon the epidemiology:

- 800 lung cancer cases per year attributable to silica exposure
- 4000 deaths per year from COPD attributable to occupational exposure
- 74,000 cases of COPD preventable over 25 years through improved control of occupational silica exposure
Disease burden: silicosis

Summary

- Extensive and consistent evidence of the respiratory health risks from silica exposure
- Significant risks still occur at and below the Workplace Exposure Limit of 0.1 mg/m³
- Whilst levels of silica exposure have reduced in recent decades, these improvements have not been uniform and scope for further improvement in control remains
Don’t let your eyes deceive you.
The most hazardous dusts are those that you can’t see
Legal requirements

Assess risk (Reg 6)

Prevent/control exposure (Regs 7 & 8)

Maintain controls (Reg 9)

Check efficacy (Regs 10 & 11)

Information instruction and training (Reg 12)
**COSH reg 7**

- Prevent exposure
- Adequately control exposure
- Apply hierarchy of control
- Implement principles of good control practice
- Control to below WEL

**Hierarchy of control**

- Eliminate / Substitute
- Prevent spread of contaminant
- Control at Source
  - Provision
  - Training
  - Use
  - Maintenance
- RPE
  - Selection
  - Face fitting
  - Provision
  - Training
  - Use
  - Storage
  - Maintenance
  - Only protects wearer

Likelihood of something going wrong
Engineering control

Figure 12: Brushing up activity

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Engineering control

HSG 258 – 3rd edition (2017)

LEV design

HSG 258 – Figure 8
Respiratory protective equipment – last form of control

http://www.bsif.co.uk/campaigns-projects/clean-air-take-care/

http://fit2fit.org/

An RPE programme
RPE - not a cheap option...

RPE

‘Last line of defence’

Numerous failure modes

Can introduce other risks:

- Heat stress
- Communication
- Compatibility

Exposure monitoring - COSHH reg 10

Results should stimulate action:

- revise risk assessment
- improve controls
- decide on need for future monitoring
The benefits of control

- Employer (more immediate cost benefits) e.g.
  - Increased life of tools and consumables
  - Jobs/tasks completed quicker
  - Reduced clean up time
  - Happier client

- Worker
  - Healthier and safer work environment
  - Feels valued
  - Healthier life / longer life
Implement hierarchy of control for RCS

Effective control usually relies on a combination of measures
Summary

RPE is an unreliable control option

Consider health risks at design stage where possible
Summary

Seek competent help when selecting or designing engineering controls

Summary

Involve workers (end users) when selecting or designing engineering controls
Summary

All controls require maintenance

Further information

www.hse.gov.uk
Controlling Exposure to Silica
Mike Slater

Do you breathe freely?
Over **500** workers believed to die from exposure to silica dust every year in the UK construction industry

Source: HSE
Pointing

Range
0.01 to 0.8 mg/m$^3$

92% > 0.075 mg/m$^3$
Drilling concrete

Range
0.01 to 1.36 mg/m³

97% > 0.075 mg/m³

Demolition

Range
0.01 to 0.91 mg/m³

71% > 0.075 mg/m³
Results from personal sampling

<0.01 to 0.24 mg/m³
Respirable crystalline silica

WEL = 0.1 mg/m³
Journal of Occupational and Environmental Hygiene

Publication details, including instructions for authors and subscription information:
http://oehlandonline.com/lit/user30

Occupational Exposure to Silica in Construction Workers: A Literature-Based Exposure Database


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Task based exposures (Geometric means)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Respirable quartz (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasive blasting*</td>
<td>22(4)**</td>
</tr>
<tr>
<td>Multiple tasks (incl. masonry cutting)</td>
<td>53(1)</td>
</tr>
<tr>
<td>Multiple tasks (incl. concrete grinding)</td>
<td>18(2)</td>
</tr>
<tr>
<td>Scabbling concrete</td>
<td>11(1)</td>
</tr>
<tr>
<td>Breaking / Jackhammering concrete</td>
<td>187(10)</td>
</tr>
<tr>
<td>Cutting tunnels</td>
<td>41(1)</td>
</tr>
<tr>
<td>Roof tile cutting</td>
<td>10(1)</td>
</tr>
<tr>
<td>Tuck point grinding</td>
<td>97(8)</td>
</tr>
<tr>
<td>Traffic control</td>
<td>6(1)</td>
</tr>
<tr>
<td>Surface grinding</td>
<td>244(6)</td>
</tr>
<tr>
<td>Pick and shovel work</td>
<td>12(3)</td>
</tr>
</tbody>
</table>

What can we do to reduce the risks to health?
Use methods that avoid creating dust

Use water suppression
Source: http://www.hse.gov.uk/copd/casestudies/wetcut.htm
Use on-tool extraction
Use local extraction
Results from personal sampling

<0.01 to 0.24 mg/m³
Respirable crystalline silica

WEL = 0.1 mg/m³
Crossrail control solutions

- Material substitution and process modifications
- Engineering controls
- Exclusion zones
- Respiratory protection
- Regular dust monitoring
Join us and be part of the solution

www.breathefreely.org.uk
Health and Safety
Executive

Health Surveillance - Respirable Crystalline Silica

Dr Steve Forman
HSE Principal Medical Adviser
Consultant Occupational Physician
Session overview

• Silica health effects

• Legal aspects

• Health surveillance programme

Silica health effects

• Silicosis (acute, accelerated, chronic)
• Chronic obstructive pulmonary disease (COPD)
• Lung cancer
• Tuberculosis
• Rheumatoid arthritis
• Systemic lupus erythematosus
• Scleroderma
• Gastric Cancer
Silicosis

- Normally at least 10 years’ exposure to silica
- Normally no symptoms early on
- Normally lung function tests do not change early on
- Typical to see small opacities on a chest x-ray; this makes the diagnosis of silicosis

COPD

- Long term progressive loss on breathing tests
- Normally no symptoms early on
- Lung function tests every year spot those workers running into trouble
- Chest x-ray NOT generally useful
COSHH Regulation 11

(1) Where it is appropriate for the protection of the health of his employees who are, or are liable to be, exposed to a substance hazardous to health, the employer shall ensure that such employees are under suitable health surveillance.

(2) Health surveillance shall be treated as being appropriate where the exposure of the employee to a substance hazardous to health is such that:

(i) an identifiable disease or adverse health effect may be related to the exposure;
(ii) there is a reasonable likelihood that the disease or effect may occur under the particular conditions of his work; and
(iii) there are valid techniques for detecting indications of the disease or effect,
and the technique of investigation is of low risk to the employee.
COSHH Regulation 11 ACOP

- Examples where health surveillance is appropriate:
  - Previous cases work-related ill health in the workforce/workplace
  - Reliance on PPE as an exposure control measure
  - Evidence of ill health within the industry

Health surveillance

- Detect ill-health effects at an early stage
- Enables employees to raise concerns about how work affects their health
- Provides an opportunity to reinforce training and education of employees (e.g. the impact of health effects)
- **Not** an alternative to proper control of exposure
- **Not** the same as health promotion/health screening
Setting up health surveillance

• Consult with employees and their representatives
• Understanding duties, purpose and possible outcomes
• Clear procedure on management of cases

HSE guidance documents

G404 Health surveillance for those exposed to respirable crystalline silica (RCS)

Supplementary guidance for occupational health professionals
Silica health surveillance

- High risk occupations:
  - Construction, foundries, brick and tile work, ceramics, quarries, stonework, silica flour use

- Wherever there is a reasonable likelihood that silicosis may occur

Health surveillance tools

- Respiratory questionnaire

- Lung function test (spirometry)

- Chest X-ray
Chest x-rays

- Silicosis diagnosed by chest x-ray
- Exposure to x-rays justified in this context on health grounds
- Dose of radiation low
  - Chest x-ray (0.014 mSv)
  - Transatlantic flight (0.08 mSv)
  - 100g of brazil nuts (0.10 mSv)
  - UK average radon dose (1.3mSv)

ILO classification
Chest x-ray frequency

• Consider baseline for future comparison

• After 15 years

• 3 yearly thereafter

Respiratory questionnaire and lung function test

• Baseline and annual assessment

• Serial results need to be accessible

• May need Responsible Person, supported by health professional, to report to between annual surveillance
Single lung function test

Lung Function

Average

Lower Limit of Normal

0  Time →

Subsequent lung function?

Lung Function

Average

Lower Limit of Normal

0  Time →
Serial lung function

Lung Function

Average

Lower Limit of Normal

Time

0

Above average lung function

Lung Function

ΔFEV₁

Average

Lower Limit of Normal

39 years old 43 years old

Time

0
What about employees already exposed?

- Baseline spirometry and respiratory questionnaire
- If 15 years or more exposure then perform chest x-ray, three yearly thereafter

Abnormalities found

- Refer to health professional with appropriate expertise
- May require additional investigations
Fitness for Work

- Opinion of occupational health professional and/or respiratory specialist
- Outcomes include:
  - Continuing exposure, increased surveillance
  - Removal from exposure
- Therefore need clear procedure for management of workers with identified disease at outset of health surveillance programme

Health record

- Keep for 40 years
- Should not include confidential clinical data
- Fitness for work / health surveillance frequency
On site Chest X-Ray Health Surveillance
First hand experience

Workplace Healthy Lungs Summit 2017
22nd November 2017
QEII Centre, London
Industrial Diagnostics Company Ltd

25 years experience in bringing OH services to site
5500 sites and 100,000 employees per annum.
2 millions sets of medical records on file
2500 CXR performed in 2017
Ran previous program in 2005 (500 participants)
Store 2000 plain CXR from 1980’s

Why is a global service important?

1. Same approach all sites across a business
2. Develops reader expertise
3. Research data base
4. Allows robust analysis
5. Engaged the NHS centres of expertise in a single agreed approach - cases are “worked up”
6. Storage of CXR is complex and transfer of records difficult
7. Highly specialist, very costly equipment. Must be a high resolution digital CXR to enable accurate read

Healthy Lung

Lung with Silicosis
2015 - Outsource CXR or in house?

Uncertainties:
No control on quality or reliability
No internal contingency
Cost and added on cost. Likely to make price point
£300.00 for screening service

Decision:
In house

2015 – 2016: 18 months preparation

• Assign the RPA’s
• Radiation protection
• HSE notification
• Develop service protocols and pathways
• Produce standardised letters
• Develop a way of disseminating findings to employer under COSHH
• Managing silicosis and other consequential findings
• Emergency case protocol
• Equipment test and selection
Successful supplier - Carestream

Military grade state of the art Digital CXR system

Bomb proof transportation system with built-in QA workstation

Gadolinium scintillator and X-ray detector detector

Leading NHS supplier – equipment familiarity

Carestream system
Delivery options

1. Room on site. Risk assessment required (IDC provide template) 4 x 2 m room – up to 30 CXR per session. 75% to date. Most cost effective option

2. 7.5T dedicated mobile CXR vehicle on site. 25% to date

3. Via NHS. 0% to date

4. Via private practice. 0% to date
Radiographers

- Clinicians who are used to single site hospital environments
- Changing way of working
- Change hours of working
- Changing concept on dose
- Living away from home
- Driving company vehicles and lorries
- Working in cold, hostile environments
- Reduce medicalisation approach to corporate service approach

Olga Palmer  
BSc (Hons) Diagnostic Radiology, HCPC, SCoR

Employed by IDC
Works away from the office 5 days per week
12 years qualified and used to working in demanding environments
Highly motivated
Radiologists

- NHS or private hospital environments
- Change of focus
- Close scrutiny of otherwise normal studies
- Peer mentorship

- Fortunate in close connections with the NHS
- 2 consultant chest radiologists both with experience with OLD.
- Reporting from head office 2 – 3 sessions weekly.

Dr Dan Barnes Consultant Chest Radiologist and Dr Jan Brozik Consultant Chest Radiologist
Managing results

Stage 1

• Normal – standard letter and repeat at 15 years
• Medical abnormal with declaration – copy to GP advising comparison to Mhx. Make contact with patient if deemed necessary.
• Medical abnormal – no history. Referral and follow up.
• Urgent – NHS 2WW referral. Fax to GP, confirm, call employee with appt. Follow-up process.
• Suspected cases – second read then MDT Stage 2

Onward Referral Management
STAGE 2 – Second Opinion

Second opinion report received

Normal result

Non-normal (medical) result

Suspected case of Silicosis / birefringent second opinion

No Action Required
Continue with normal health surveillance and have next X-ray at 15 years’ exposure or 3 years’ time if currently 15+ years exposure

GP Referral for non-work-based findings
Continue with normal health surveillance and have next X-ray at 15 years’ exposure or 3 years’ time if currently 15+ years exposure

STAGE 1
Referral to Occupational Disease Centre
Health surveillance program and chest X-ray program to be reviewed and advised on an individual basis by Occupational Health
Managing results

Stage 2

Sheffield teaching hospitals Professor David Fishwick and Dr Chris Barber provide the MDT service along with expert colleagues

Provides robust second opinion

Confirmed suspected cases – stage 3

STAGE 3 – Occupational Lung Disease Centre

Comprehensive Lung Disease Centre
Direct Access Referral

8 weeks after referral

‘Complex Case Follow Up’ form completed by employer

Occupational Lung Disease Centre report(s) received

Normal result

Non-normal (medical result)

Confirmed case of silicosis

GP Referral for non-work based findings

Conduct with normal health surveillance and have next 6 years of 15 years’ exposure or 3 years’ exposure if current 15 years’ exposure

No Action Required

Occupational Physician advice regarding fitness for further exposure

Occupational Physician advice regarding fitness for further exposure

Health surveillance program and chest X-ray program to be reviewed and updated on an individual basis by Occupational Health
Managing results

Stage 3

GORDS direct access referral for CT scanning (cases are “worked up”)

Appointment with Consultant Chest Physician followed by Consultant Occupational Physician

Confirmed cases. Annual CXR send to GORDS for review after IDC read.

Challenges

Tracking cases

Employees informing managers prior to OH being aware of outcome (manager training)

Obtaining information from NHS

GORDS wait times increasing
Where has the service been?

200 sites including:
• Inverness
• Cornwall
• Kent
• Northern Ireland

Brick, aggregate, asphalt, white wear, ceramics, stone masons, construction

Global findings so far

<table>
<thead>
<tr>
<th>Total number of service participants (Internal and External Clients)</th>
<th>Total Number: Normal</th>
<th>Total Number: Referred to GP (non urgent)</th>
<th>Total Number: Referred to GP (urgent)</th>
<th>Total Number: Repeat in 1 year</th>
<th>Total Number: Referred for further investigation for Silicosis or other OLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Members</td>
<td>1734</td>
<td>1394</td>
<td>213</td>
<td>46</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>80.4%</td>
<td>12.3%</td>
<td>2.7%</td>
<td>1.0%</td>
<td>3.9%</td>
</tr>
</tbody>
</table>
Research

2500 rows deep

95 rows wide

237,000 separate pieces of data

Largest database of its kind in the UK, Europe, the world???

Thank you!

Contact:

Industrial Diagnostics Company Ltd.

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08450 775512