Medical Surveillance for Silica-exposed Employees

Kenneth Corbet MD FRCPC
Consultant, Occupational Medicine
Clinical Associate Professor
University of Calgary

September 29, 2014
No conflicts to declare
Learning Objectives:

• Describe the objectives of a medical surveillance program for silica-related disease
• Interpret regulations – administrative vs. risk-based
• Who is “silica-exposed” and can we estimate risk?
• Describe the essential elements of screening
• Determine when medical referral is indicated.
Definitions & Principles
Medical Surveillance

Medical surveillance is periodic screening for defined clinical criteria in groups of employees who are:

• exposed to a workplace hazard
• at risk of an occupational disease
Objectives of the Surveillance Program:

• Early recognition and diagnosis of *chronic silicosis*
• Limit further exposure, limit disease progression and respiratory impairment, limit cancer risk
• Meet case reporting duties (e.g. OHS, WCB, IIHL)
The natural history of a disease

A: How long after the onset of exposure is the disease detectable by screening?

B: How much ‘lead time’ does screening offer before the person would present clinically?

C: Does early intervention lead to an improved outcome?
Medical Surveillance Criteria

Medical surveillance may be warranted if:

• achieving the OEL relies heavily on *employee behaviors* (e.g. administrative rules, PPE)
• the ‘true’ exposure of the employee poses a health risk
• a medical test or examination can identify cases of possible disease (and meets usual screening criteria)
• early intervention can prevent or limit the progression of an occupational disease.
Employee Perceptions

If I’m eligible for monitoring, I must be at high risk for lung disease.

If I participate in monitoring, I won’t get lung disease.

You’re mean you’re not screening for lung cancer?

= Effective, ongoing, consistent communication: accurately describe the health risks and benefits of participation.
Silica & Silica-related Disease
Silica-related Diseases

The target disease for medical surveillance is
• *Chronic (simple) silicosis*
• Airways obstruction or restriction of lung capacity

The target for medical surveillance is NOT
• *Lung Cancer*
• *Autoimmune or renal disease*
• *Accelerated silicosis or progressive massive fibrosis*
• *Acute silicosis*
Alberta Regulations

“Restricted area” means an area of a work site where there is a reasonable chance that the concentration of silica exceeds the occupational exposure limit (OEL)

Any worker who may reasonably be expected to work in a restricted area for at least 30 work days per year requires medical surveillance every two years.
The Challenge for Regulators

How do you provide administrative criteria for medical surveillance that are applicable to smaller businesses, with changing workforces, work locations, and work processes ...

... but also provide exposure-based criteria for larger businesses with more stable workforces and well-characterized exposures?

... and can both types of criteria be based on a valid assessment of risk?
Occupational Exposure Limit (OEL)

1. the target (or allowable) **daily** exposure to a hazard achieved through exposure controls (including personal protective equipment)  
   ... *used by occupational hygienists*

2. a level of continuous, daily, occupational exposure that should not lead to serious adverse effects over a **working lifetime**  
   ... *more relevant for medical surveillance*
Exposure & Health Risk
One exposure scenario – Alberta Oilsands

Full-shift levels exceed the OEL: implement additional exposure controls; may require medical surveillance

Annual dose remains less than the ‘annual’ OEL

Alberta OEL = 0.025 mg/m³
On the other hand …
Similarly Exposed Groups

A group of employees who share similar tasks, tools, equipment, work locations, and schedules and are presumed to have similar ranges of exposure to a hazard.

At least 6-10 full-shift samples (ideally 20-30) are required per SEG to characterize exposure distribution through statistical methods.

Sampling must include all phases of the production cycle.
Number of full-shift samples

Full-shift exposure (ug/m3)

Detection limit

1. Small fraction of samples below detection limit = Parametric methods
2. Large fraction of sample below detection limit = Bayesian methods

What is the Geometric Mean Dose ... or the GMD 95%UCL?

What is the exceedance fraction (shifts above the OEL)?
Program Components & Process
Risk Communication & Consent

Risk Communication – an explanation of the health effects of silica, current exposure levels, estimated risks, and the elements and benefits of a medical surveillance program

Periodic Reassessment - *this should vary depending on the cumulative exposure assessment for the individual* ...

Voluntary - written refusal to undergo part or all of a health assessment
Baseline Questionnaire

Dust Exposure History
Exposures to asbestos, silica, coal, or other industrial dusts and carcinogens - occupational and non-occupational (smoking) = risk for airways obstruction

Silica Exposure History
History of work in jobs with silica exposure; correlate to published studies or job exposure matrices (JEM) to estimate past exposure to silica in mg/m3-years = risk for radiographic changes
Baseline Questionnaire

Medical History

- Cough, wheeze, dyspnea, sputum (i.e. standardized respiratory symptoms questionnaire)
- Past diagnoses relevant to the interpretation of the chest radiograph or spirometry
Digital imaging
Certified technician
Standard technique
Interpretation by a radiologist
Archival data files
May require ILO interpretation

Case Definition: work with a radiologist … “small diffuse nodular opacities OR eggshell calcification”
### Chest Radiograph

At autopsy, pathology findings correlate poorly with a recent chest radiograph (2-3 years):

<table>
<thead>
<tr>
<th>Pathology</th>
<th>% with rounded opacities (ILO 1/1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight silicosis</td>
<td>25%</td>
</tr>
<tr>
<td>Moderate silicosis</td>
<td>46%</td>
</tr>
<tr>
<td>Marked silicosis</td>
<td>74%</td>
</tr>
</tbody>
</table>

REFERENCE:
Spirometry

Certified testing equipment
Certified testing staff
Calibration

Technique and quality of testing *

Interpretation and recommendations
(ACOEM 2011 Guidance Statement)

Longitudinal analysis of FVC and FEV1
(Hnizdo 2010; Spirola software (CDC))

Case Definition = < LLN for FVC or FEV1
OR
> Normal longitudinal decline in capacity or flow
Can we do a better job?
The natural history of a disease

- Onset of Exposure
- Biological Onset of Disease
- Disease Detectable by Screening
- Clinical Presentation Of Disease
- Impairment Disability Death

- Biomarkers of Inflammation (exhaled nitrous oxide)
- High Resolution CT?
- Chest radiograph
- DLco?
- Spirometry
High Resolution Computed Tomography (HRCT)

HRCT is superior to chest radiograph for:

• the diagnosis of silicosis
• the early detection of air trapping and emphysema
• the monitoring of progressive silicosis and PMF
Radiation Dose

- High Resolution CT = 0.98 mSv
- standard CT scan = 6.5 mSv
- conventional chest examination = 0.085 mSv

Background annual radiation dose = 2-3 mSv

*Can exposure be reduced through a modified ‘silica’ protocol for HRCT?*
Thank you!