Actual challenges in occupational health surveillance of asbestos exposed workers

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Panel Discussion “Health policy and OSH”
What is asbestos?

Asbestos is a generic term for a group of naturally-occurring minerals - fibrous silicate, divided into two groups:

- **serpentine** (curly fibres) - chrysotile (white asbestos)
- **amphibole** (straight fibres) containing amosite (brown asbestos), crocidolite (blue asbestos), tremolite, actinolite and anthophyllite.

Asbestos fibers have great tensile strength, heat resistance, and acid resistance.
Workplace risks and occupational exposure

All workplaces:

- where asbestos or asbestos-containing materials are used, stored, handled or demolished
- where concentrations of airborne asbestos fibres are produced,
- where asbestos waste is produced, stored or disposed of
MONITORING THE WORKPLACE

- Measurement of the concentration of airborne asbestos fibres at workplace
- Area (distribution) and personal monitoring (individual risk) – level of exposure to airborne asbestos fibres
- Detection methods - light microscopy, electron microscopy, and energy dispersive X-ray analysis. Particles of asbestos minerals in air, at least 5 µm and with length: width ratios of 3:1 (regulatory agencies’ recommendations)
- (TLV®/8h-TWA): 0.1 fibers per cubic centimeter (f/cc)* - Carcinogenicity Designation A1 (the experts/agencies recommendation).
- The control limit is not a 'safe' level and exposure from work activities involving asbestos must be reduced to as far below the control limit as possible.
Asbestos exposed workers

- CAREX (CARcinogen EXposure) -based on occupational exposure to known and suspected carcinogens collected during 1990–93, the CAREX database estimates that a total of 1.2 million workers were exposed to asbestos in 41 industries in the 15 Member States of the EU.
- OSHA has estimated that 1.3 million employees in construction and general industry face significant asbestos exposure on the job (OSHA, 2008)
- Globally, each year, an estimated 125 million people are occupationally exposed to asbestos (WHO, 2006), more than 107 000 people die each year from asbestos-related diseases (ARDs)
National profile and National plan of action for elimination of ARDs

- National profile is compilation of all relevant information reflecting the baseline situation (current state):
  - consumption of various types of asbestos
  - populations at risk (current and past exposure; taking into consideration that some asbestos uses may have already been restricted or banned)
  - asbestos-related diseases (ARD)

- Instrument to measure the progress made towards the objectives and targets set by the NPEAD (National Programme for the Elimination of Asbestos-Related Diseases)

- The development of national approach (National profile and National plan of action) for elimination of ARDs is strongly recommended by WHO and ILO, including the OH surveillance of asbestos exposed workers as one important part.
Occupational health surveillance
What does it mean?

- OH surveillance was recognized previously as a process involving a range of strategies and methods used to systematically detect and assess the early signs of adverse effects of hazards on health and workability of exposed workers.

- OH surveillance is also viewed as the tracking of occupational diseases, hazards, and exposures. (NIOSH)

- The Joint ILO/WHO Committee on Occupational Health at its 12th Session in 1995 defined an occupational health surveillance system as “a system which includes a functional capacity for data collection, analysis and dissemination linked to occupational health programmes.”

- Occupational health surveillance system is never an alternative to the proper control of exposure. It is not the same as health screening or health promotion.

CDC.MMWR, report January 19th, 2007
Mission of the Occupational Health Surveillance Program

- To promote the health, safety and quality of life of working people
- Collecting, analyzing, interpreting and disseminating information about work-related injuries, illnesses, and hazards
- Using this information to target intervention activities, guide the development of prevention programs and policies, and raise public awareness of workplace risks.
- Educating workers, employers, and health care providers to address identified occupational health and safety problems
- Integrating occupational health into other ongoing public health activities at the state and local levels.

Statutory OH surveillance of asbestos exposed workers includes the registration and permanent medical surveillance of occupationally exposed subjects for early diagnosis and treatment of ARDs and should provide a relevant database of information to enable trend analysis (Occupational Diseases Register, Cancer Register, Register on Employees Exposed to Carcinogens) and to develop the prevention programs and policies.
While some countries have imposed strict regulations to limit exposure and others have adopted bans (EU), some have intervened less, and continue to use varying quantities of asbestos (Russia, China, India etc.).

- ILO Convention No.182; WHO documents- GPA on Workers Health, 2008; Elimination of ARD; Parma Declaration, 2010
- Directive 1999/77/EC of the European Union bans all types of utilization of the asbestos from 1st January 2005. In addition, the 2003/18/EC directive bans the extraction of asbestos and the manufacture and processing of asbestos products.
- Asbestos Laws and Regulations - US EPA, HSE-UK, OSHA, EU OSHA
Medical surveillance

- **Medical examinations-check ups**

  In many jurisdictions, regular medical monitoring is required for workers exposed to asbestos.

  This monitoring includes medical examinations of exposed worker (basic elements):
  - occupational history
  - health questionnaire
  - lung function tests
  - Chest X-ray.
  - CT scan, MRI additionally

  Personal records to show the exposure of a worker to asbestos at the workplace, including the TWA (worker’s exposure and asbestos concentrations)
ARD- Asbestos Related Diseases

- Asbestosis
- Asbestos Related Pleural Benign Diseases
- Lung Cancer
- Mesothelioma
- Asbestos and other malignancies
Asbestosis- fibrotic lung disease-pneumoconiosis, resulting from the inhalation of asbestos fibers

**Diagnostic criteria**

- Occupational and environmental history, slow progress
- Main symptoms: progressive dyspnea, dry cough
- Clinical examinations: inspiratory crackles
- Chest X-ray – fibrosis, pleural plaques (exposure sign)
- CT scan of the chest - lung fibrosis
- Lung function tests – spirometry (restrictive defects) decreased diffusion, and oxygen saturation

Histologic asbestosis: tissue ferruginous body associated with peribronchial fibrosis (Masson trichrome stain, 40×)

AR pleural benign diseases

- **Pleural plaques** - deposited collagen in parietal pleura mainly, usually bilateral, asymptomatic, a marker of asbestos exposure (Chest X-ray, high-resolution CT)

- **Diffuse pleural thickening** - less common than pleural plaques, involves diaphragmatic and lateral pleura, blunting of costophrenic sulci

- **Pleural calcification** occurs in about 50% with ARD, especially along the diaphragmatic pleura, seen *en face* have a characteristic *rolled edge* along their margins, denser than in the center of the plaque. The appearance of the plaque has been likened to a *holly leaf*

- **Pleural effusion** may occur early in the disease in about 3% of cases, exudative, occasionally bloody, one-sided or bilateral.

*American Thoracic Society. Diagnosis and initial management of nonmalignant diseases related to asbestos. Am J Respir Crit Care Med. 2004*
Lung cancer

Asbestos exposure significantly increases the risk of developing small cell and non–small cell lung carcinoma

• A person working with asbestos is 5 times more likely to develop lung cancer than someone who has not been exposed to asbestos
• Tobacco smokers who have been exposed to asbestos have a "far greater-than-additive" risk for lung cancer than do exposed nonsmokers
• A person who has been exposed to asbestos and also smokes is 50 times more likely to develop lung cancer than someone who does not smoke and has not had any exposure to asbestos.
• Symptoms- persistent cough, increasing dyspnea, blood-stained phlegm, chest pain, loss of weight, difficulty swallowing, fatigue
• Diagnosis - Chest X-Ray, CT scan, Bronchoscopy, sputum cytology
Mesothelioma
Diffuse malignant mesothelioma an aggressive tumor derived from mesothelial cells, outside the lung (pleura) or the abdominal contents (peritoneum).

- uniformly fatal, median survival time of 6 to 18 months from diagnosis.
- Symptoms-nonspecific: chest pain and dyspnea
- Chest X-ray most often will reveal a large, unilateral pleural effusion.
- Chest CT will demonstrate the same features; irregular thickening of the pleura also may be visible.
- In more advanced disease- superior vena cava syndrome, Horner's syndrome, dysphagia, or other complications resulting from the propensity of mesothelioma to invade neighboring structures.
- Pathologic diagnosis can prove difficult, and many cases are misdiagnosed initially.
- MRI-complementary role -high signal intensity on T1-weighted images and moderately high signal intensity on T2-weighted images.
Medical Research in Asbestos Related Diseases

What is new?

Pathogenesis Mesothelioma
- Asbestos Fibres: Size and Form related to Risk
- Chronic Inflammation (Genes)
- Latency Period
- Life Style?
- Virus?
- Immune System (Genes)
- Mutations
- Growth Factors

Needed is catalogue of genomic changes

Histology Gold Standard: Epithelial, Sarcomatous and Mixed Types, CT recommended, MRI can be useful, Staging: TNM system

Nico van Zandwijk
Director Asbestos Diseases Research Institute
Bernie Banton Centre, University of Sydney, Australia, 2008
Asbestos and other malignancies

A causal association between exposure to asbestos and ovarian cancer was clearly established, based on five strongly positive cohort mortality studies of women with heavy occupational exposure to asbestos (Wignall & Fox, 1982; Germani et al., 1999; Berry et al., 2000; Magnani et al., 2008)

A causal association between exposure to asbestos and cancer of the larynx and pharynx was clearly established, based on the occupational cohort Studies and the case-control studies (Selikoff, 1991; Sluis-Cremer et al., 1992; Reid et al., 2004; Pira et al., 2005)

The positive associations between asbestos exposure and death from stomach cancer and colorectal cancer observed in several of the cohort studies with heaviest asbestos exposure.
(Selikoff et al., 1964; Enterline et al., 1987; Liddell et al., 1997; Musk et al., 2008)
Oh surveillance
Registers for work-related diseases

**Occupational Disease Register (ODR)**
- One of the most important data sources on ARD
- ODR exists in almost all developed countries. But in others?
- Data on registered cases are reliable and well documented
- **Problems:** GP awareness? Availability of OH specialists and access to OHS? Diagnostic criteria? Local expertise? Availability of modern diagnostic technologies? Registration?

**Cancer Register**
- One of the important sources on ARD
- Provides only data on cancer cases
- In case of asbestos related carcinoma: good source for mesothelioma, unspecific for lung cancer (only indicative value)

**Register on Employees Exposed to Carcinogens**
- All workers exposed to carcinogens should be registered; Employers in charge for reporting lists of exposed workers and relevant carcinogens
- Data collection by responsible national institution (annually statistics publication)
- Reliable data source on asbestos exposure
- Available only in few developed countries, Coverage?
Chest X-ray and ventilatory lung function in asbestos-cement workers: Macedonian follow-up study
The role of OH surveillance

46 exposed workers in one Macedonian Asbestos-cement factory 1979/1996

<table>
<thead>
<tr>
<th>Occ. exposure limit</th>
<th>1979 (N=46)</th>
<th>1985</th>
<th>1996 (N=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos fibres (number/cm³) min-max (mean)</td>
<td>1</td>
<td>/</td>
<td>1-22 (7)</td>
</tr>
<tr>
<td>Workplace airborne dust (particles/cm³) min-max (mean)</td>
<td>175</td>
<td>30 - 1250 (355)</td>
<td>57-905 (263)</td>
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</tbody>
</table>

Table 1. Demographic characteristics of examinees in 1979, 1985 and 1996

Institute of Occupational health of RM,WHO CC
Statistics

<table>
<thead>
<tr>
<th></th>
<th>Lung function tests 1979 (N=46)</th>
<th>Lung function tests 1985</th>
<th>Lung function tests 1996 (N=46)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal lung function n (%)</td>
<td>42 (91.4)</td>
<td>79.2%</td>
<td>31 (67.8)</td>
<td>$\chi^2=6.64; P&lt;0.01$</td>
</tr>
<tr>
<td>Lung function impairment n (%)</td>
<td>4 (8.6%)</td>
<td>20.8%</td>
<td>15 (31.2)</td>
<td></td>
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</tbody>
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Table 3. Lung function tests in examined workers

<table>
<thead>
<tr>
<th></th>
<th>Lung function tests 1979 (N=46)</th>
<th>Lung function tests 1996 (N=46)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC (L) (mean ± SD)</td>
<td>4.69 ± 0.92</td>
<td>4.04 ± 0.99</td>
<td>$t=3.26; P&lt;0.01$</td>
</tr>
<tr>
<td>FEV1 (L) (mean ± SD)</td>
<td>3.85 ± 0.73</td>
<td>3.27 ± 0.84</td>
<td>$t=3.53; P&lt;0.01$</td>
</tr>
<tr>
<td>FEF25-75% (L/s) (mean ± SD)</td>
<td>4.24 ± 1.05</td>
<td>3.49 ± 1.28</td>
<td>$t=3.07; P&lt;0.01$</td>
</tr>
</tbody>
</table>

Table 4. Mean values of basic spirometry parameters (VC and FEV1 in L, and FEF25-75% in L/s) in examined workers
Table 5. Percentage of examinees with chest x-ray changes >0/1 and chest x-ray changes ≥1/0 in 1985, and 1996

<table>
<thead>
<tr>
<th></th>
<th>Chest x-ray 1985</th>
<th>Chest x-ray 1996</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>With chest x-ray changes &gt;0/1 (%)</td>
<td>22.2</td>
<td>54.4</td>
<td>( \chi^2=10.99; P=0.01 )</td>
</tr>
<tr>
<td>With chest x-ray changes ≥1/0 (%)</td>
<td>3.7</td>
<td>30.5</td>
<td>( \chi^2=13.21; P&lt;0.01 )</td>
</tr>
</tbody>
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Table 6. Relative decrease of basic spirometry parameters (VC, FEV1, and FEF25-75% in %) in examinees with or without chest x-ray changes in 1996 compared to 1979

<table>
<thead>
<tr>
<th></th>
<th>d%</th>
<th>Statistical significance</th>
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</thead>
<tbody>
<tr>
<td>Without chest x-ray changes (N=21)</td>
<td></td>
<td></td>
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<tr>
<td>ΔVC (%)</td>
<td>-8.59%</td>
<td>( t=5.72; P&lt;0.01 )</td>
</tr>
<tr>
<td>ΔFEV1 (%)</td>
<td>-5.85%</td>
<td>( t=2.62; P&lt;0.01 )</td>
</tr>
<tr>
<td>ΔFEF25-75% (%)</td>
<td>-4.63%</td>
<td>( t=0.02; P&gt;0.05 )</td>
</tr>
<tr>
<td>With chest x-ray changes (N=25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔVC (%)</td>
<td>-12.04%</td>
<td>( t=6.34; P&lt;0.01 )</td>
</tr>
<tr>
<td>ΔFEV1 (%)</td>
<td>-10.98%</td>
<td>( t=5.10; P&lt;0.01 )</td>
</tr>
<tr>
<td>ΔFEF25-75% (%)</td>
<td>-8.00%</td>
<td>( t=1.97; P&gt;0.05 )</td>
</tr>
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National epidemiological studies:
Cvetanov at all, 1979; Ezova and all 1983; Bislimovska and all, 1987, 1988; Stefanovski V.1996
“Background: Asbestos-related diseases are still a major public health problem. The World Health Organization (WHO) has estimated that 107,000 people worldwide die each year from mesothelioma, lung cancer, and asbestosis. Although worldwide consumption of asbestos has decreased, consumption is increasing in many developing countries. The limited data available suggest that exposures may also be high in developing countries. Mesothelioma is still increasing in most European countries and in Japan but has peaked in the United States and Sweden.

Although the epidemic of asbestos-related disease has plateaued or is expected to plateau in most of the developed world, little is known about the epidemic in developing countries. It is obvious that increased asbestos use by these countries will result in an increase in asbestos-related diseases in the future.”
OH surveillance data should be used to guide efforts to improve worker safety and health, and to monitor trends and progress over time.