EPIDEMIOLOGY AND CLASSIFICATION OF PNEUMOCONIOSES

FIBROSING INTERSTITIAL LUNG DISEASES OF IDIOPATHIC AND EXOGENOUS ORIGIN. PHENOTYPE APPROACH.
Conference, Postgraduate and Scientific Course

PRAGUE
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CZECH PNEUMOLOGICAL AND PHYSIOLOGICAL SOCIETY

Carlos Robalo Cordeiro
carlos.crobalo@gmail.com
Definition

• Pneumoconiosis is a 19th century Greek term (pneumo=lung; konis=dust) that describes lung diseases associated with mineral dust exposure.
• Disease of the lung caused by the deposition of dust
• Diffuse, nonmalignant-sometimes fibrosing-parenchymal lung disease caused by occupational exposures to mineral dusts
• Interstitial lung disease occurring after inhalational exposure to an inorganic dust (either a particle or a fiber). The responsible exposure most frequently are occupational but can occasionally be environmental
Epidemiology

• (Long) latency period of the disease

• Lack of standardised diagnostic criteria
Epidemiology

• (Long) latency period of the disease

• Lack of standardised diagnostic criteria
Epidemiology

• Some European countries do not register occupational diseases
• In others, registration is limited to cases where compensation is awarded
• This leads to bias and underestimation
• Underreporting > older patients
• No incentive to report occupational diseases
• Insufficient awareness among physicians
Epidemiology

• In some countries, schemes have been developed for the voluntary reporting of occupational respiratory diseases by respiratory and occupational physicians

• SWORD, UK 1989
  (Surveillance of Work Related and Occupational Respiratory Diseases)
Epidemiology

Occupational agents are responsible:

- 15% (men), 5% (women) of all respiratory cancers
- 17% of all adult asthma cases
- 15-20% of COPD cases
- 10-15% of ILD cases
Epidemiology

• China
80% occupational respiratory diseases
6 million coal miners

• Vietnam
75.7% of occupational diseases with compensation

• Brasil
6.6 million exposed to crystalline silica

Epidemiology

- Developing countries

30 to 50% of workers from primary industry and high risk sectors may have silicosis and other pneumoconiosis

Epidemiology

• USA

1.7 million exposed to respirable silica in industries including mining, quarries, foundries, construction, concrete rehabilitation, masonry and agriculture (10% in risk of developing silicosis)

The number of coal miners has decreased from 130,000 to 100,000 over last 20 years

Although asbestos mining has ceased, 1.3 million workers are currently exposed to asbestos in other occupations

Epidemiology

- Europe

In 2000 it was estimated that a total of 7200 cases of pneumoconiosis were related to occupational exposures to asbestos, silica and coal dust
Occupational lung diseases

Figure 1 – Mortality rate for pneumoconiosis. Data from the World Health Organization World and Europe Mortality Databases, November 2011 update.

European Lung White Book 2013
Gibson GJ, Loddenkemper R, Sibille Y, Lundbäck B, Eds
### Rare Interstitial Lung Diseases of Environmental origin
C Robalo Cordeiro, TM Alfaro, S Freitas, J Cemlyn-Jones, AJ Ferreira

**Table 3. Schematic classification of pneumoconiosis and exposure scenarios**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Agent</th>
<th>Exposure scenarios</th>
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<tbody>
<tr>
<td><strong>Nonfibrous mineral dusts</strong></td>
<td></td>
<td></td>
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<tr>
<td>Crystalline silica</td>
<td></td>
<td>Hard rock mining, construction, road work, tunnelling, sandblasting, foundry work, granite/stone work, silica flour production/use, ceramics and glass manufacture Exposure to coal mine dust</td>
</tr>
<tr>
<td>Coal dust</td>
<td></td>
<td>Tyres, pigments, paints, pencils, foundry linings, mining, metallurgy, carbon electrodes and plastics Boiler and furnace lining, electronics industry and building materials (tiles and cements)</td>
</tr>
<tr>
<td>Other carbon compounds</td>
<td></td>
<td>Boiler and furnace lining, electronics industry and building materials (tiles and cements)</td>
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<tr>
<td>(graphite and carbon black)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mica</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaolin</td>
<td></td>
<td>Kaolin mining, paper product manufacture, ceramics, refractory materials, ceramics and plastics</td>
</tr>
<tr>
<td>Talc</td>
<td></td>
<td>Numerous uses, such as paint, paper, cosmetics, roofing products, rubber, dry lubricant and textile manufacture</td>
</tr>
<tr>
<td>Diatomaceous earth</td>
<td></td>
<td>Foundries, fillers production, abrasives, dry lubricant; when heated above 450°C it converts to crystalline silica</td>
</tr>
<tr>
<td><strong>Fibrous mineral dusts</strong></td>
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<tr>
<td>Asbestos</td>
<td></td>
<td>Construction trades, building maintenance, mining, milling, production of asbestos products, shipbuilding and repair, automobile and railroad work, electrical wire insulation and as a contaminant in talc or vermiculite Environmental exposure</td>
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<tr>
<td>Zeolites</td>
<td></td>
<td>Abrasive, refractory materials, ceramics and metal matrix composites</td>
</tr>
<tr>
<td>Silicon carbide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium oxide</td>
<td></td>
<td>Aluminium oxide abrasives manufacture</td>
</tr>
<tr>
<td>Nylon floc</td>
<td></td>
<td>Production of nylon floc (especially the random-cut method)</td>
</tr>
<tr>
<td><strong>Metals and fumes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beryllium</td>
<td></td>
<td>Nuclear weapons, electronics, aerospace, ceramics, metal recycling, dental prostheses, alloy machining, defence industries, automotive and beryllium mining</td>
</tr>
<tr>
<td>Cobalt</td>
<td></td>
<td>Hard metal production, grinding, use and maintenance of hard metal tools and diamond polishing</td>
</tr>
<tr>
<td>Aluminium</td>
<td></td>
<td>Abrasives, metals, alloys, explosives (pyro powder), building materials, glass manufacture, ceramics and welding</td>
</tr>
<tr>
<td>Titanium</td>
<td></td>
<td>Metal products, paints, aerospace, defence industry and electronics</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
<td>Iron welding and metal polishers</td>
</tr>
<tr>
<td>Tin</td>
<td></td>
<td>Tin production: smelting and bagging</td>
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The life expectancy of a miner working at the rock face in mines with hard rock (quartz) was often no more than 5 years from the start of work.

Since the latter half of the twentieth century, mines have been subject to regulations and laws.

In smaller mining operations and mines in the industrializing countries, working conditions can be poor and the prevalence of occupational diseases high.
The Classic Pneumoconioses
New Epidemiological and Laboratory Observations

A. Scott Laney, PhD, David N. Weissman, MD*
Silicosis - Epidemiology

Countries of low and middle income (?)

• China
  More than 500,000 cases recorded between 1991 and 1995
  6,000 new cases and more than 24,000 deaths reported annually

• Brazil
  In gold-mining more than 4,500 cases recorded between 1978 and 1998

• South Africa
  Of gold miners dying from external causes (injuries, burns,...) proportions of silicosis identified at autopsy increased from 3% to 32% for black miners and from 18% to 22% for white miners between 1975 and 2007

C C Leung, I T Sun Yu, W Chen
Developed countries

• UK

About 600,000 workers exposed to crystalline silica from 1990 to 1993 (more than 3 million in Europe)
→ Less than 100 cases reported every year between 1996 and 2009
→ Deaths from silicosis declined from 28 in 1993 to 10 in 2008

• USA

→ Overall mortality rates declined from 8.9 million (?) in 1968 to 0.7 in 2004
→ Silicosis deaths in young adults (15-44) have not fallen since 1995 (intense and recent exposures)
→ New outbreaks still occur occasionally

C C Leung, I T Sun Yu, W Chen
Silicosis

Chi Chiu Leung, Ignatius Tak Sun Yu, Weihong Chen

<table>
<thead>
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<th>Industries or occupational activities</th>
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### Producing and handling materials

- **Cleaning (dry sweeping and brushing, and pressurised air blowing)**
  - Construction
  - Arts, crafts, and sculpture
  - Jewellery
- **Polishing and buffing**
  - Production of dental material
  - Arts, crafts, and sculpture
  - Jewellery
- **Mixing of silica flour and clay**
  - Arts, crafts, and sculpture
  - Paint fillers
  - Ceramics
  - Potteries
  - Production of rubber and plastics
  - Concrete production
- **Handling raw materials containing silica flour and sand**
  - Paint fillers
  - Glass, including fibreglass
  - Production of rubber and plastics
  - Foundries
  - Cement production
  - Roofing asphalt felt
  - Manufacturing or occupational use of abrasive soaps and scouring powders

Information taken from National Institute of Occupational Safety and Health and Akgun et al.

*Table 1: Common operations or tasks that involve exposure to free crystalline silica*
Emerging settings of Silica exposure

- Natural gas extraction by hydraulic fracturing
- Leaks in systems for transporting the sand
- Agriculture (farming dry, sandy soil)
- Denim sandblasters
- Textile industry
- China’s tatami mat manufacturers
- Dental supply factory workers
- Bystander exposures

Rare Interstitial Lung Diseases of Environmental origin
C Robalo Cordeiro, TM Alfaro, S Freitas, J Cemlyn-Jones, AJ Ferreira
Eur Respir Mon 2011, 54: 301-316
New sources of exposure/Emerging aetiological agents

- Nanoparticles

Rare Interstitial Lung Diseases of Environmental origin
C Robalo Cordeiro, TM Alfaro, S Freitas, J Cemlyn-Jones, AJ Ferreira

Eur Respir Mon 2011, 54: 301-316
coal – macroaggregates (carbon black) particles spread in alveoli, without tissue reaction or fibrosis

Lam et al., 2004
Inhalation of SWCNT (5 mg/m3, 5 h/day, 4 days) - granulomas and fibrosis

Shvedova et al., 2008
Mechanisms of pulmonary toxicity and medical applications of carbon nanotubes: Two faces of Janus?

A.A. Shvedova,a,b, E.R. Kisin,a D. Porter,a,b P. Schulte,c V.E. Kagan,d B. Fadeel,e V. Castranova*a

a Pathology and Physiology Research Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Morgantown, WV, United States
b Department of Physiology and Pharmacology, West Virginia University, Morgantown, WV, United States
c Department of Environmental and Occupational Medicine, Karolinska Institute, Stockholm, Sweden
d Department of Environmental Health, University of Pittsburgh, Pittsburgh, PA, United States
e Division of Biological Toxicology, Institute of Environmental Medicine, Karolinska Institute, Stockholm, Sweden
Idiopathic conditions

• Idiopathic Pulmonary Fibrosis

Linked with several dust occupations
excessive amount of silica and metals in lung mineralogical analysis

• Sarcoidosis

World Trade Center > 400 substances identified
sarcoidosis or sarcoid-like granuloma after inhalation of silica, fibers,…
incidence 86/100.000 during first year after 11.9 (13 new cases)
incidence 22/100.000 in the next 4 year after 11.9 (13 new cases)
incidence 15/100.000 during the 15 years before
Silicosis

• Chronic (10 to 15 years of exposure)
  Simple
  Small nodular opacities (upper lobes)
  Hilar and mediastinal lymph nodes (egshell)
  Complicated/progressive massive fibrosis
  Confluent lesions

• Accelerated (5 to 10 years of exposure)
  Nodular opacities (more uniformly distributed)

• Acute (weeks to 5 years of exposure)
  Greater evidence of inflammation
  silicoproteinosis
Coal Workers’ Pneumoconiosis

- **CWP**
  Interstitial lung disease following exposure of underground miners to coal dust

- **Black Lung**
  Any lung disease associated with the same exposure, eg. COPD, after coal dust exposure
The Classic Pneumoconioses
New Epidemiological and Laboratory Observations

A. Scott Laney, PhD, David N. Weissman, MD*

Fig. 1. Percentage of examined underground miners with coal workers’ pneumoconiosis (ILO category 1/0+) by tenure in mining, 1970–2009. (From CDC/NIOSH. Work-Related Lung Disease Surveillance System (eWoRLD) Coal Workers’ Pneumoconiosis and Related Exposures. Available at: http://www2a.cdc.gov/drrs.WorldReportData/ FigureTableDetails.asp?FigureTableID=2549&GroupRefNumber=F02-05. Accessed August 14, 2012.)
Coal Workers’ Pneumoconiosis

- Small nodules, often less well defined than those of Silicosis
  - Irregularly shaped opacities more common in Lower Lobes
  - Nodular opacities more present in Upper Lobes

Simple
Progressive Massive Fibrosis

→ less fibrogenic than silica
→ chest radiograph is insensitive (?) to the diagnosis
Coal Worker’s Pneumoconiosis

Johny A. Verschakelen and Pierre Alain Gevenois

Fig. 6.1a–c. Coal worker’s pneumoconiosis: three postero–anterior chest radiographs obtained at 7-year intervals in a coal miner showing increasing profusion of small round opacities
Coal Worker’s Pneumoconiosis

Johny A. Verschakelen and Pierre Alain Gevenois

Imaging of Occupational and Environmental Disorders of the Chest
PA Gevenois and P De Vuyst Eds. Springer 2006
Coal Worker’s Pneumoconiosis

JOHNY A. VERSCHAKELLEN and PIERRE ALAIN GEVENOIS

Imaging of Occupational and Environmental Disorders of the Chest
PA GEVENOIS and P DE VUYST Eds. SPRINGER 2006
Asbestosis

- Greek-derived term for “inextinguishable”

- Naturally occurring silicate fibers ideal for construction

- Maximum consumption close to the eighties, end of asbestos use in EU adopted in July 1999, effective banning 1st January 2005
Occupational risk factors

European Lung White Book 2013
Gibson GJ, Loddenkemper R, Sibille Y, Lundbäck B, Eds
Asbestosis

• Less often found in asbestos miners

• More often found in those who work:
  – Asbestos mills
  – Asbestos product manufacture

• Non-occupational exposure
Asbestosis

• Fibrous minerals with properties such as strength, flexibility, resistance to thermal and chemical degradation, and electrical resistance

• Currently 6 regulated types of asbestos fibers:
  1 serpentine mineral (chrysotile)
  5 amphibole minerals (amosite, crocidolite, actinolite, anthophyllite, tremolite)
Asbestosis

• Pleural effects
  Pleural effusion, parietal pleural plaque, visceral diffuse pleural disease, rounded atelectasis, mesothelioma

• Pulmonary effects
  asbestosis
  lung cancer
Occupational risk factors

Figure 2 - Observed and projected deaths from mesothelioma in the UK with fitted 50th percentile curve and 90% prediction interval. Reproduced from Tan et al., 2010.