EPIDEMIOLOGY AND CLASSIFICATION OF PNEUMOCONIOSES

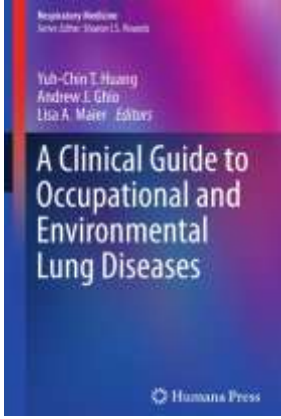
Carlos Robalo Cordeiro
carlos.crobalo@gmail.com

Definition

- Pneumoconiosis is a 19th century Greek term (pneumo=lung; konis=dust) that describes lung diseases associated with mineral dust exposure

Chapter 9
Pneumoconiosis in the Twenty-First Century

Andrew J. Ghio



- 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 occuring 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

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- 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

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

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)

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Gibson GJ, Loddenkemper R, Sibille Y, Lundbäck B, Eds

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

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Epidemiology

- China

80% occupational respiratory diseases

6 million coal miners

- Vietnam

75.7% of ocuppational diseases with compensation

- Brasil

6.6 million exposed to crystalline silica

ILO. The Prevention of Occupational Diseases. Geneva 2013.

Epidemiology

- Developing countries

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

ILO. The Prevention of Occupational Diseases. Geneva 2013.

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

ILO. The Prevention of Occupational Diseases. Geneva 2013.

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

ILO. The Prevention of Occupational Diseases. Geneva 2013.

Occupational lung diseases

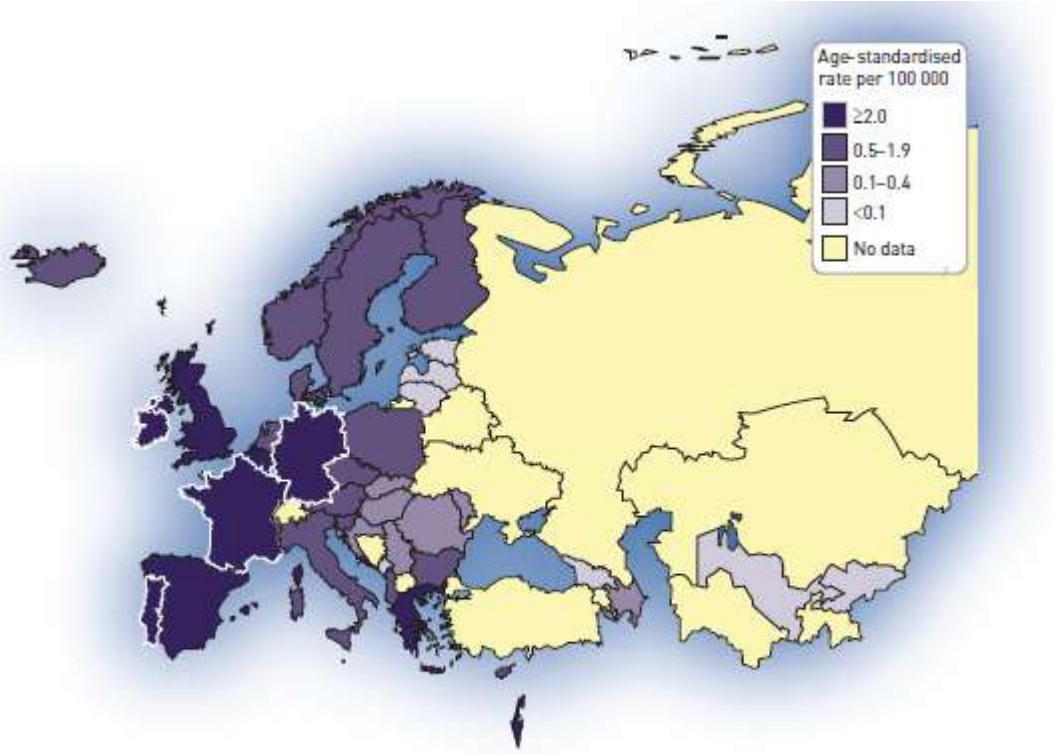


Figure 1 – Mortality rate for pneumoconiosis. Data from the World Health Organization World and Europe Mortality Databases, November 2011 update.

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

Rare Interstitial Lung Diseases of Environmental origin

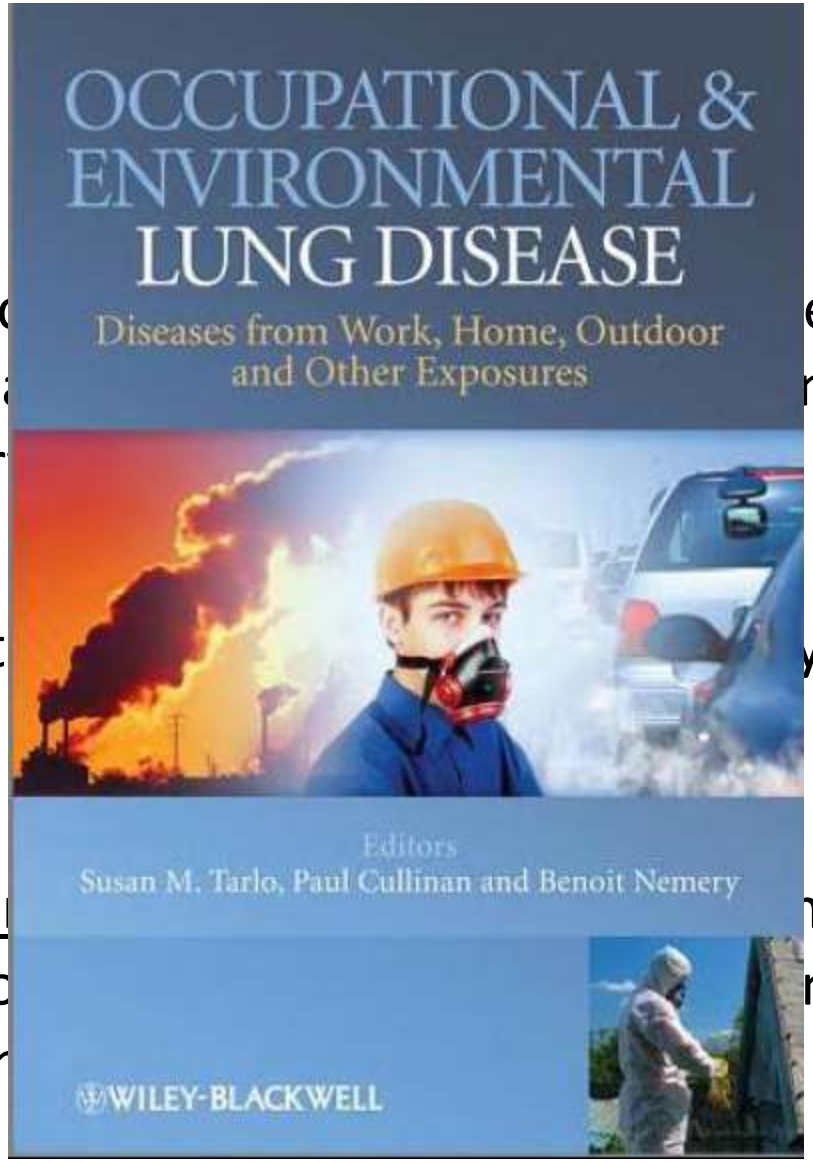
C Robalo Cordeiro, TM Alfaro, S Freitas, J Cemlyn-Jones, AJ Ferreira

Table 3. Schematic classification of pneumoconiosis and exposure scenarios

Classification	Agent	Exposure scenarios
Nonfibrous mineral dusts	Crystalline silica	Hard rock mining, construction, road work, tunnelling, sandblasting, foundry work, granite/stone work, silica flour production/use, ceramics and glass manufacture
	Coal dust	Exposure to coal mine dust
	Other carbon compounds (graphite and carbon black)	Tyres, pigments, paints, pencils, foundry linings, mining, metallurgy, carbon electrodes and plastics
	Mica	Boiler and furnace lining, electronics industry and building materials (tiles and cements)
	Kaolin	Kaolin mining, paper product manufacture, ceramics, refractory materials, ceramics and plastics
	Talc	Numerous uses, such as paint, paper, cosmetics, roofing products, rubber, dry lubricant and textile manufacture
	Diatomaceous earth	Foundries, filter production, abrasives, dry lubricant; when heated above 450°C it converts to crystalline silica
Fibrous mineral dusts	Asbestos	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
	Zeolites	Environmental exposure
	Silicon carbide	Abrasive, refractory materials, ceramics and metal matrix composites
	Aluminium oxide	Aluminium oxide abrasives manufacture
	Nylon flock	Production of nylon flock (especially the random-cut method)
Metals and fumes	Beryllium	Nuclear weapons, electronics, aerospace, ceramics, metal recycling, dental prostheses, alloy machining, defence industries, automotive and beryllium mining
	Cobalt	Hard metal production, grinding, use and maintenance of hard metal tools and diamond polishing
	Aluminium	Abrasives, metals, alloys, explosives (pyro powder), building materials, glass manufacture, ceramics and welding
	Titanium	Metal products, paints, aerospace, defence industry and electronics
	Iron	Iron welding and metal polishers
	Tin	Tin production: smelting and bagging

Eur Respir Mon 2011, 54: 301-316

- The life expec e rock face in mines with ha more than 5 years from the star
- Since the latt y, mines have been subject
- In <u>smaller mi</u> ne <u>industrializing countries</u>, wo nd the prevalence of occupatior



Occupational and Environmental Lung Diseases
SM Tarlo, P Cullinan and B Nemery Eds 2010
RL Cowie. Mining: 177-189

The Classic Pneumoconioses
New Epidemiological and Laboratory Observations

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

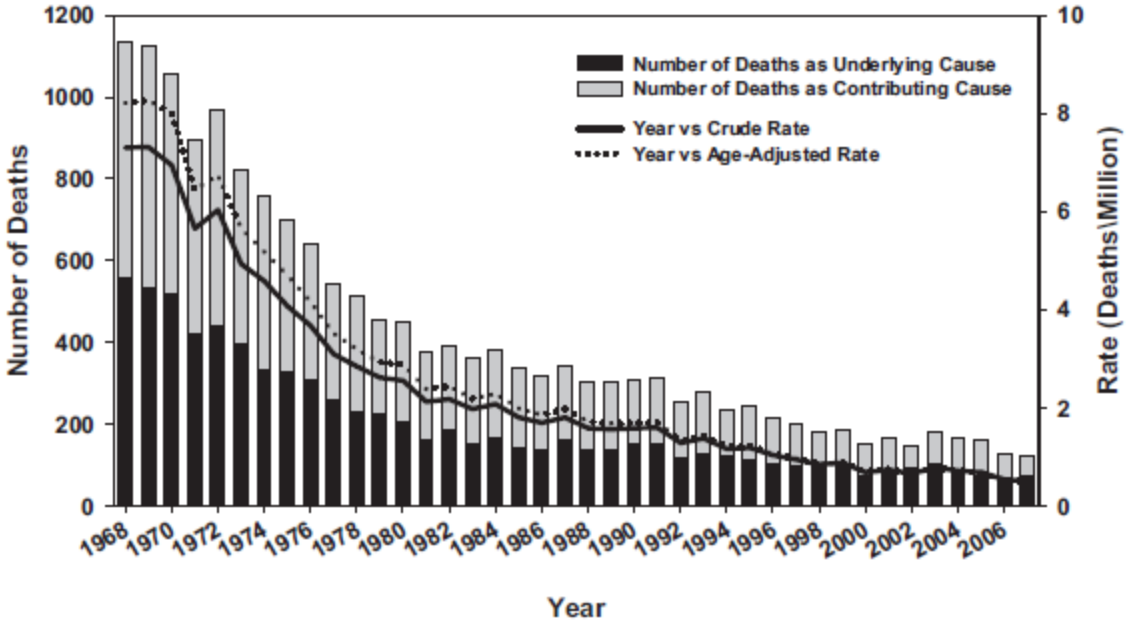


Fig. 2. Silicosis: number of deaths, crude and age-adjusted death rates, US residents aged 15 years and older, 1968–2007. (*From* CDC/NIOSH. Work-Related Lung Disease Surveillance System (eWoRLD) Silicosis and Related Exposures. Available at: http://www2a.cdc.gov/drds/WorldReportData/FigureTableDetails.asp?FigureTableID=2595&GroupRefNumber=F03-01. Accessed August 14. 2012.)

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
Lancet 2012; 379: 2008-18

Silicosis - Epidemiology

Developed countries

- UK

About 600.000 workers 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
Lancet 2012; 379: 2008-18

Silicosis

Chi Chiu Leung, Ignatius Tak Sun Yu, Weihong Chen

	Industries or occupational activities
Breaking down substances or materials	
Drilling	Construction Quarrying and related milling Mining and related milling Tunnelling
Breaking and crushing	Construction Quarrying and related milling Mining and related milling Tunnelling
Cutting	Arts, crafts, and sculpture Jewellery Construction Quarrying and related milling Grindstone production
Abrasive blasting and sand blasting	Boiler scaling Production of dental material Metal products Automobile repair (removal of paint and rust) Arts, crafts, and sculpture Shipbuilding and repair Foundries Construction Quarrying and related milling Production of denim jeans Tombstone production
Grinding	Arts, crafts, and sculpture Jewellery Construction Quarrying and related milling
Sanding	Automobile repair (removal of paint and rust) Construction
Excavation and digging	Agriculture Construction Quarrying and related milling Mining and related milling Tunnelling
Hammering	Boiler scaling Construction
Casting and moulding	Jewellery Foundries Ceramics
Furnace installation and repair (refractory materials)	Iron and steel mills Foundries Glass, including fibreglass

(Continues in next column)

	Industries or occupational activities
(Continued from previous column)	
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[16] and Akgun et al.[21]

Table 1: **Common operations or tasks that involve exposure to free crystalline silica**

Lancet 2012; 379: 2008–18

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

Clin Chest Med 33 (2012) 745–758

Rare Interstitial Lung Diseases of Environmental origin
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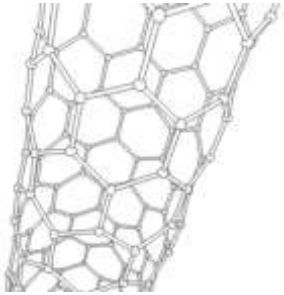
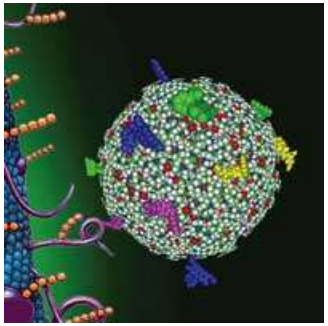
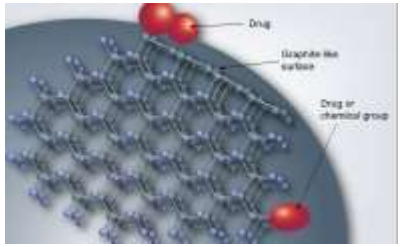
Eur Respir Mon 2011, 54: 301-316

New sources of exposure/Emerging aetiological agents

- Nanoparticles







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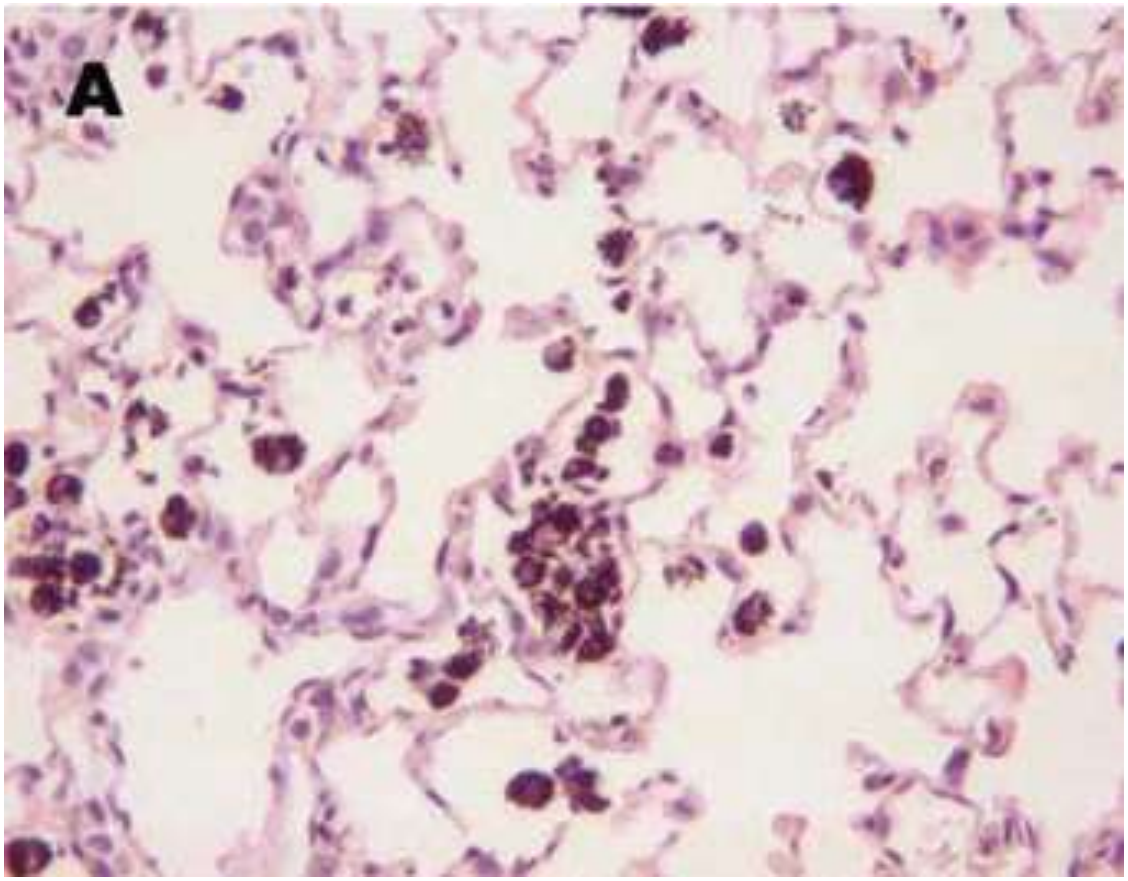
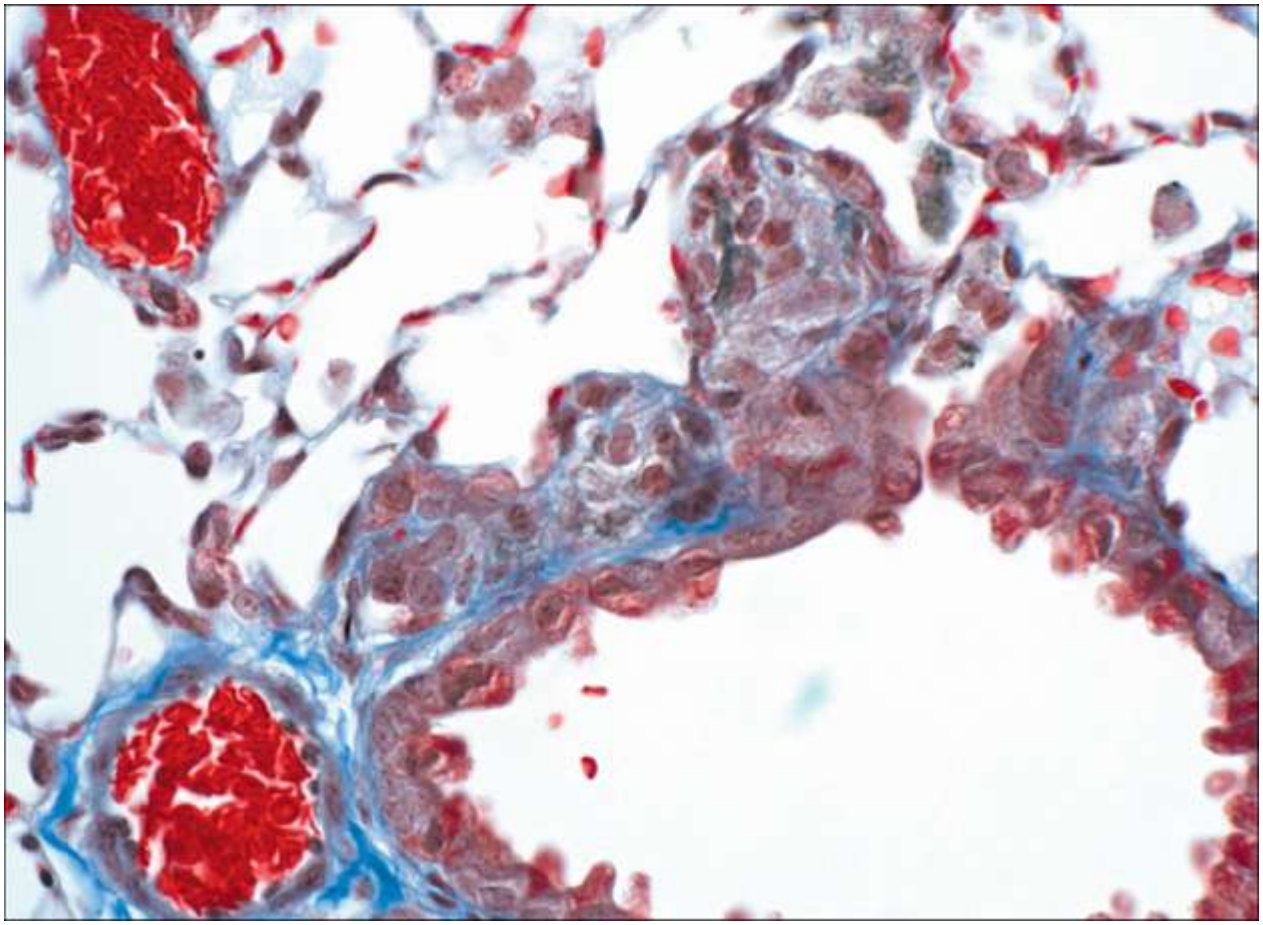


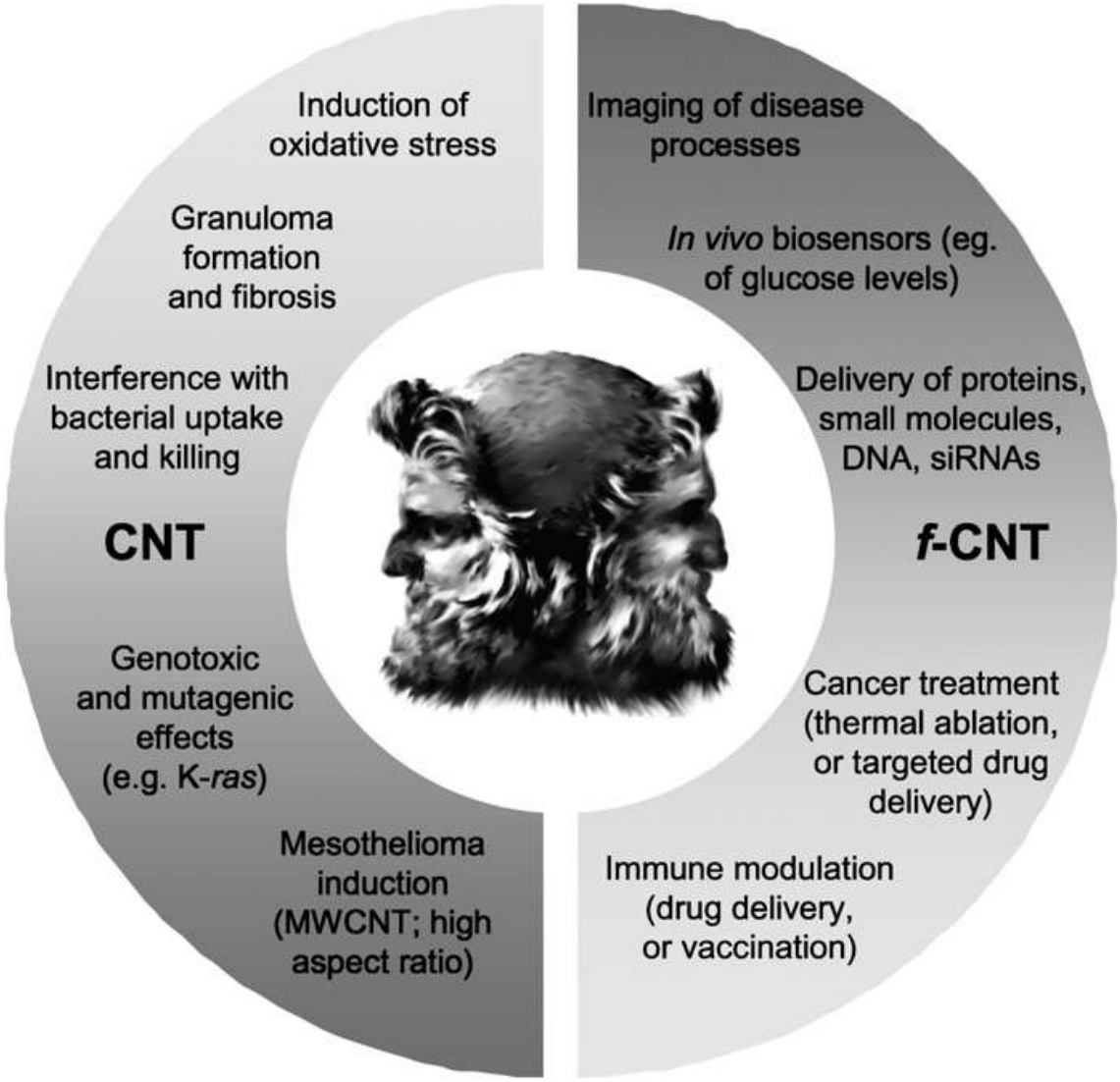
coal – macroaggregates (*carbon black)*
particles spread in alveoli, without tissue reaction or fibrosis

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] Education and Information Division, National Institute for Occupational Safety and Health, Cincinnati, OH, United States
[d] Department of Environmental and Occupational Health, University of Pittsburgh, Pittsburgh, PA, United States
[e] Division of Biochemical Toxicology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

Pharmacol Therap. 2009;121:192-204

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

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Silicosis

- Chronic (10 to 15 years of exposure)

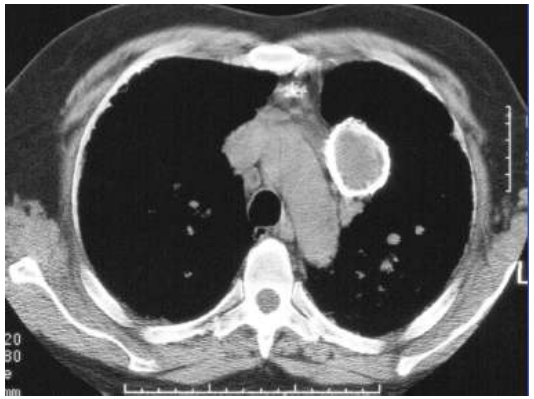
  Simple

  Small nodular opacities (upper lobes)

  Hilar and mediastinal lymph nodes (egshell)

  Complicated/progressive massive fibrosis

  Confluent lesions



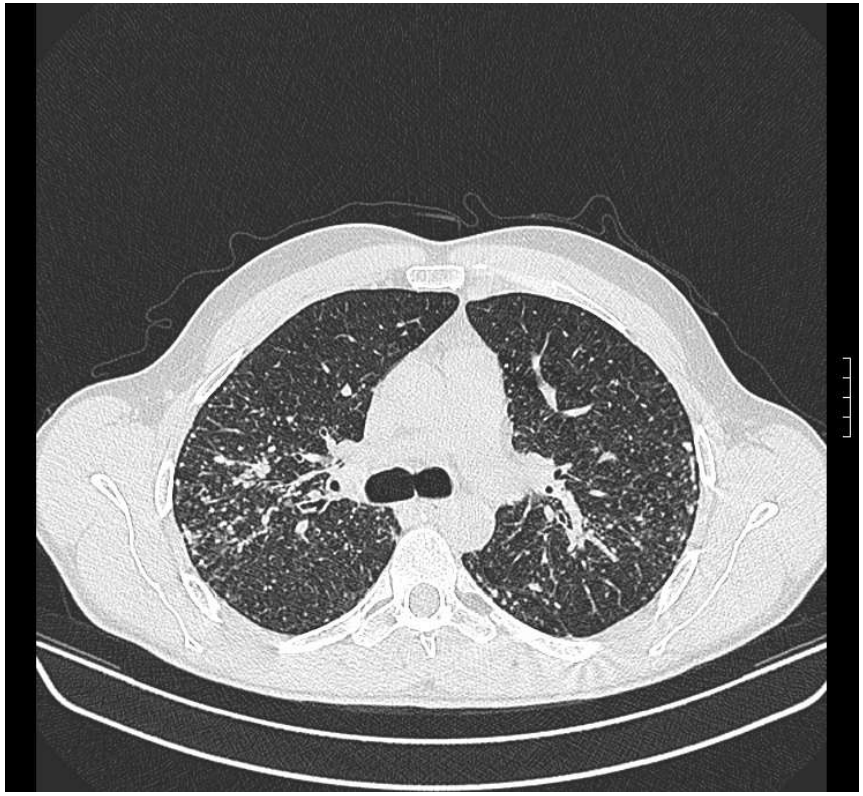
- Accelerated (5 to 10 years of exposure)

  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*

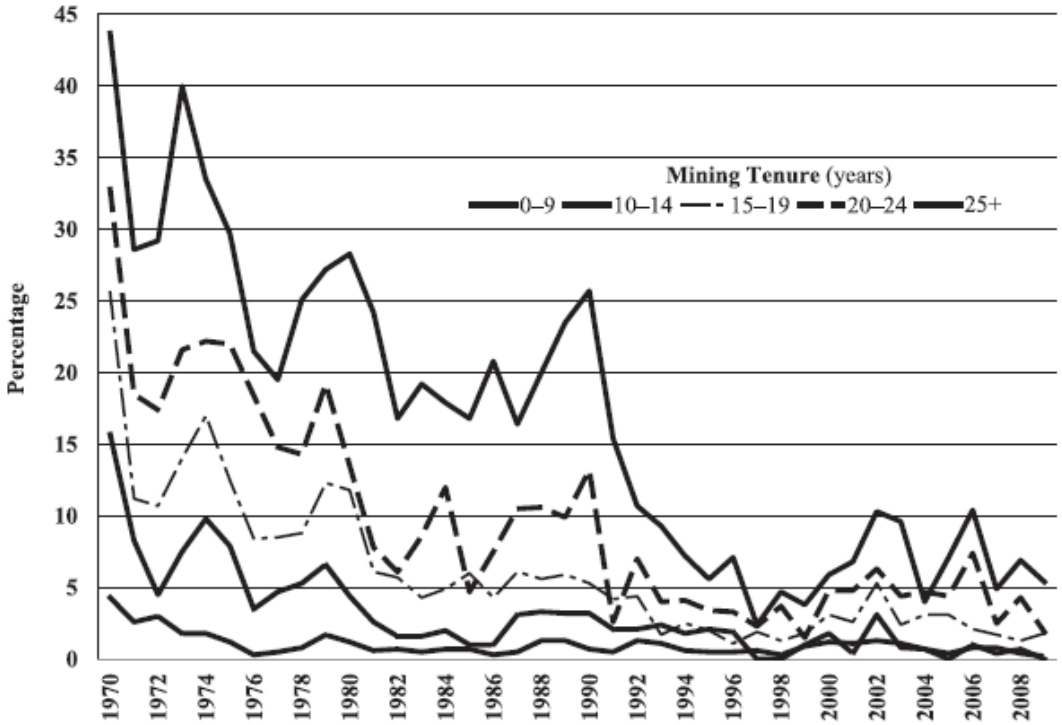


Fig. 1. Percentage of examined underground miners with coal workers' pneumoconiosis (ILO category 1/0+) by tenure in mining, 1970–2009. (*From* CDC/NIOSH. Work-Related Lung Disease Surveillance System (eWoRLD) Coal Workers' Pneumoconiosis and Related Exposures. Available at: http://www2a.cdc.gov/drds/WorldReportData/FigureTableDetails.asp?FigureTableID=2549&Grou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

  $\rightarrow$ less fibrogenic than silica

  $\rightarrow$ chest radiograph is insensitive (?) to the diagnosis

Coal Worker's Pneumoconiosis

Johny A. Verschakelen and Pierre Alain Gevenois

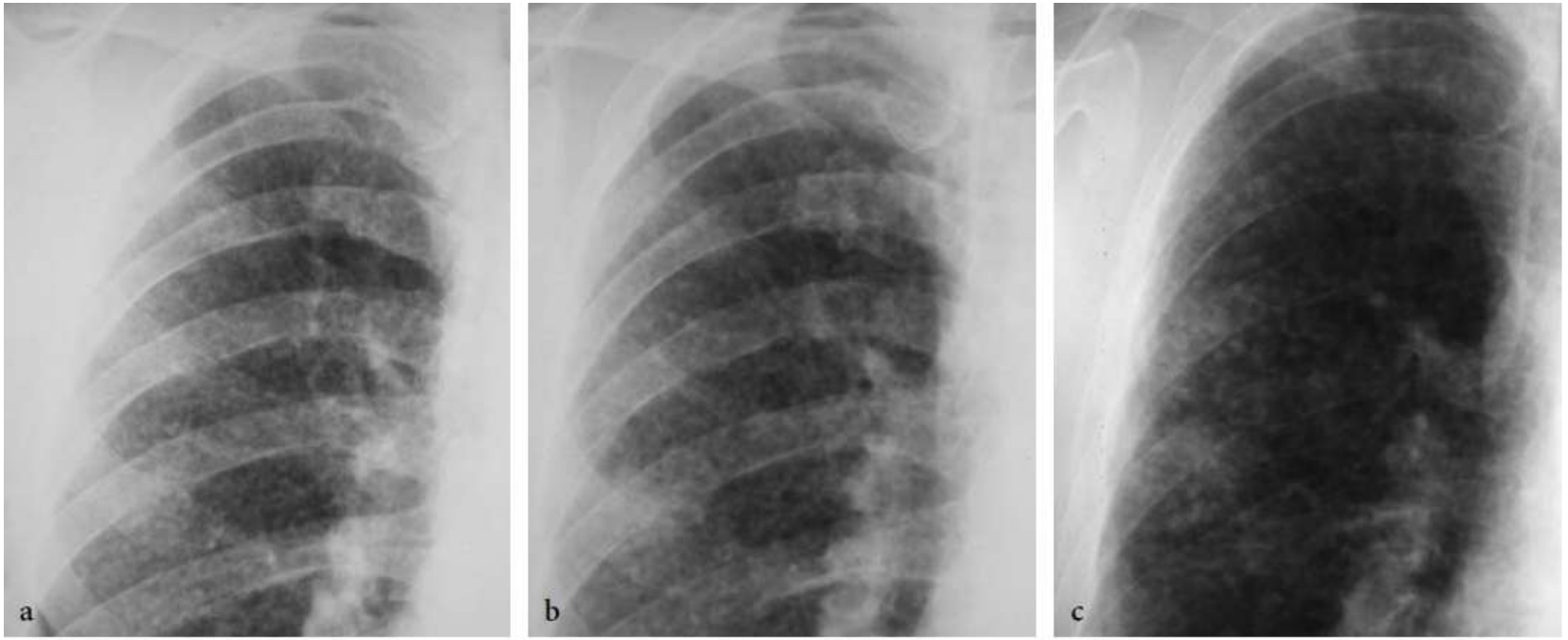


Fig. 6.1a–c. Coal worker's pneumoconiosis: three postero–anterior chest radiographs obtained at 7-year intervals in a coal miner showing increasing profusion of small round opacities

Imaging of Occupational and Environmental Disorders of the Chest
PA Gevenois and P De Vuyst Eds. Springer 2006

Coal Worker's Pneumoconiosis

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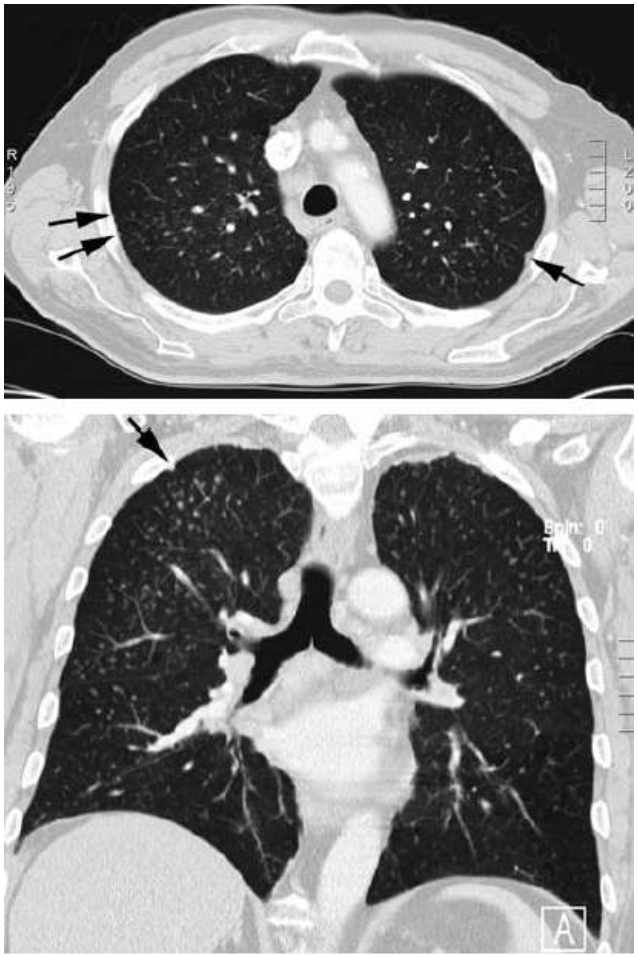

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Asbestosis

- Greek-derived term for “inextinguishable”
- Naturally occuring silicate fibers ideal for construction
- Maximum consumption close to the eighties, end of asbestos use in EU adopted in July 1999, efective banning 1st January 2005

Occupational risk factors

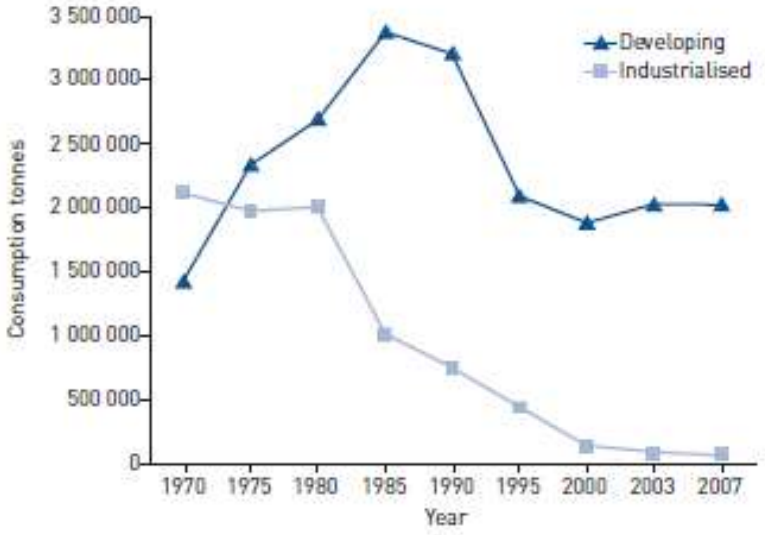


Figure 1 - Change in worldwide asbestos consumption, 1970–2007, in developing and industrialised nations. Reproduced from Rice, 2011, with permission from the publisher.

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

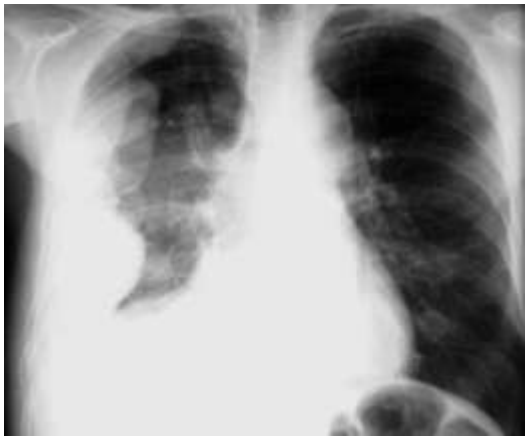
- Fibrous minerals with properties such as strenght, flexibility, resistance to thermal and chemical degradation, and electrical resistance

- Currently 6 regulated types of asbestos fibers:

  1 serpentine mineral (chrysotile)

  5 amphibole minerals (amosite, crocidolite, actinolite, anthophylite, tremolite)

Asbestosis



- Pleural effects

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

- Pulmonary effects

  asbestosis

  lung cancer

Occupational risk factors

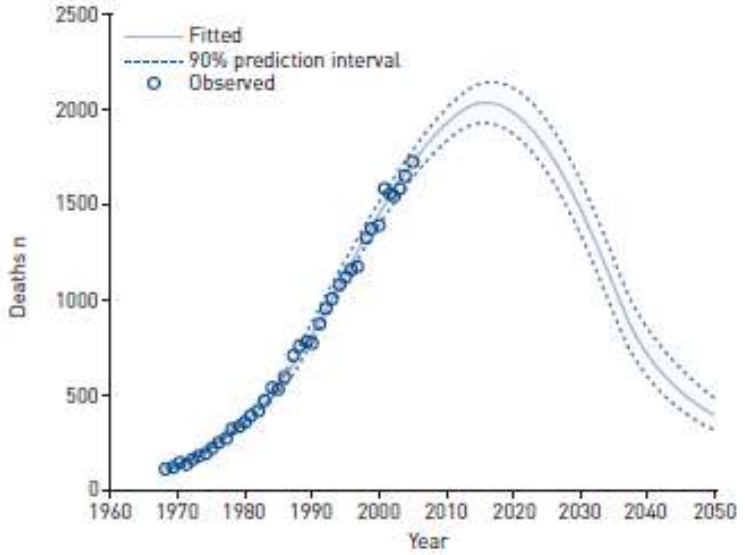


Figure 2 - Observed and projected deaths from mesothelioma in the UK with fitted 50th percentile curve and 90% prediction interval. Reproduced from Tan *et al.*, 2010.

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