

OCCUPATIONAL HEALTH

10

Chemical Hazards



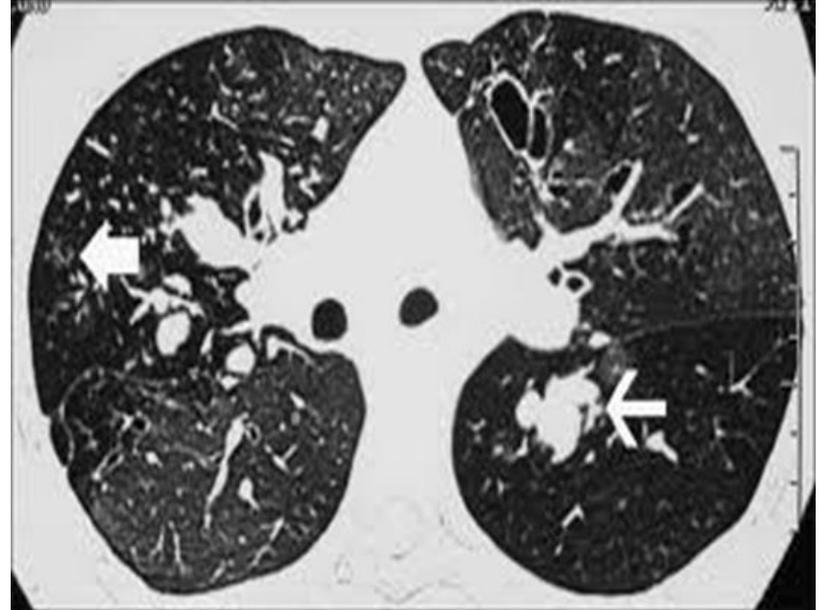
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Pneumoconiosis

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- **Pathogenesis**
- **Types**
- **Individual diseases**
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 - **Asbestosis**
 - **Anthracosis**
- **Preventive measures**



Asbestosis & Anthracosis

<https://www.amazon.com/Best-Sellers-Books-Biostatistics/zgbs/books/227277>

Asbestosis

- Scarring of lung tissue reducing ability to take oxygen.
- Dose related disease ;repeated regular exposures.
- Debilitating disease and can be fatal.
- Latency period 10-20 years



Asbestos fibers



Figure 220 of Asbestos



ASBESTOSIS

- Asbestosis is **diffuse interstitial pulmonary fibrosis** that occurs secondary to the inhalation of asbestos fibers.

Asbestos

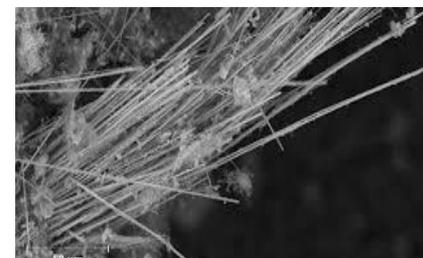
is the commercial name given to certain types of fibrous materials.

Asbestos is a naturally occurring fibrous silicate mineral

They are silicates of varying composition; the silica is combined with **such bases** as **magnesium, iron, calcium, sodium** and aluminium.

Formed of fibrous ***magnesium silicate***.

Asbestos fibers



- **Asbestos Posses** thermal ,noise , water and chemical **resistance**,
- **flexible** and high tensile strength

❑ Asbestos Posses

thermal ,noise , water and chemical resistance,

❑ flexible and high tensile strength

❑ Asbestos fibres are usually from
20 to 500 μ in length and
0.5 to 50 μ in diameter.

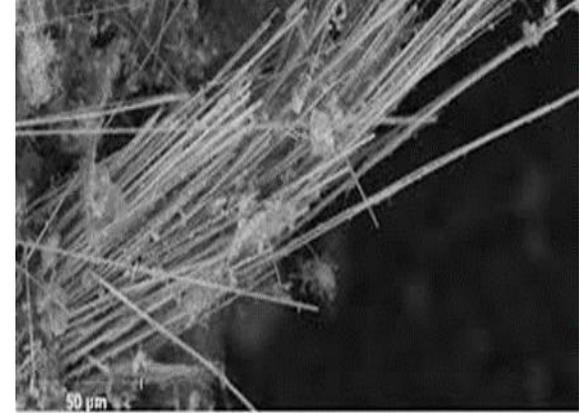


Figure: SEM of Asbestos

● Uses:

- Due to its physical properties, it is used in manufacture of
- fire proof textile,
- wire insulation,
- friction materials (brake lining),
- roofing and floor products,
- ship construction and
- paints.

Asbestos is used

- in the manufacture of asbestos cement,
- brake lining بطانة الفرامل,
- gaskets and
- several other items.



Figure 202 of Asbestos

- **Asbestos is classified into two groups:**
 - **Serpentine (93% of commercial use)** which is hydrated magnesium silicate
Chrysotile fibers have curved appearance (white asbestos).
 - **Amphibole. (7% of commercial use) contains little magnesium.**
chain silicate with straight line, This type occurs in different varieties, e.g.
 - **Chrysotile Actinolite, Amosite (brown asbestos), Anthophyllite, Crocidolite (blue asbestos), Richterite, Trem Richterite, Tremolite**

ASBESTOSIS

	
Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
Chrysotile	Actinolite, Amosite, Anthophyllite, Crocidolite, Richterite, Tremolite

	
Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
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ASBESTOSIS



Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
Chrysolite	Actinolite, Amosite, Anthophyllite, Crocidolite, Richterite, Tremolite

ASBESTOSIS

• Types of exposures:

1) Direct:

primary → miners and millers

Secondary → manufacturing plants

2) Indirect:

bystander (observer) exposure **تعرض المتفرجين** and household contact

■ At risk groups:

■ plumbers, السباكين,

■ insulation workers, عمال العزل,

■ carpenters, لنجارين,

■ welders, الحام,

■ Miners and millers of asbestos.

- **Prevalence increase** with length of employment (dose response)

- **Smokers and x smokers** carry greater risk and **higher mortality**

ASBESTOSIS



ASBESTOSIS



- **Asbestos enters** the body by **inhalation**, and the fine dust may be deposited in the alveoli.
- The fibers are insoluble.
- The dust deposited in the lungs causes **pulmonary fibrosis** leading to
 - **respiratory insufficiency** and **death**;
- ❖ The **fibrosis in** asbestosis is due to **mechanical irritation**, and is
 - **peribronchial, diffuse in character**, and **basal in location** interstitium (peribronchial, diffuse and basal fibrosis).
 - **in contrast** to silicosis in which the fibrosis is nodular in character and present in the upper part of the lungs.
 - The lung architecture is changed leading to **honeycomb**



- The **lung architecture** is changed leading to **honeycomb**
- changes and intense **peribronchial cellular reaction** may cause **narrowing**
- or **obstruction** of airway lumen.
- Average latency period **is 20-30 years**
- ❖ **carcinoma of the bronchus;**
- ❑ The **risk of bronchial cancer** is reported to **be high** if occupational **exposure to asbestos** is combined with **cigarette smoking**
- ❖ **mesothelioma** of the pleura or peritoneum;
- **In Great Britain, an association was reported between mesothelioma and living within 1 km of an asbestos factory**
- ❑ **Mesothelioma, a rare form of cancer of the pleura and peritoneum,**

ASBESTOSIS

- has been shown to have a strong **association with the crocidolite (blue asbestos)** variety of asbestos .
- The disease does not usually appear until **after 5 to 10 years** of exposure **and**
- ❖ cancer of the **gastro-intestinal tract**.

Clinically the disease is **characterized by**

- Dyspnoea gradually increases
- Cough
- Chest pain
- .Bilateral late inspiratory crepitation on posterior Lung bases

❖ **In advanced cases**, there may be

- **Clubbing of fingers,**
- **cardiac distress and**
- **cyanosis.**

16/4/2024

- The sputum shows "asbestos bodies" which are a

ASBESTOSIS

- The sputum shows "**asbestos bodies**" which are asbestos fibres coated with fibrin

Lung function change:

Restrictive impairment with ↓ lung volumes (FVC, TLC)
FEV1/FVC ratio is usually preserved.

❖ X-ray picture:

Bilateral diffuse nodular & or irregular **oval opacities**
predominant in **lower lung zones**, Interstitial fibrosis and
“**Shaggy heart sign**”

❖ At histopathologic analysis,

asbestos bodies, which may consist of a single asbestos fibre surrounded by a segmented protein-iron coat, can be identified in intraalveolar macrophages





Diagnosis:

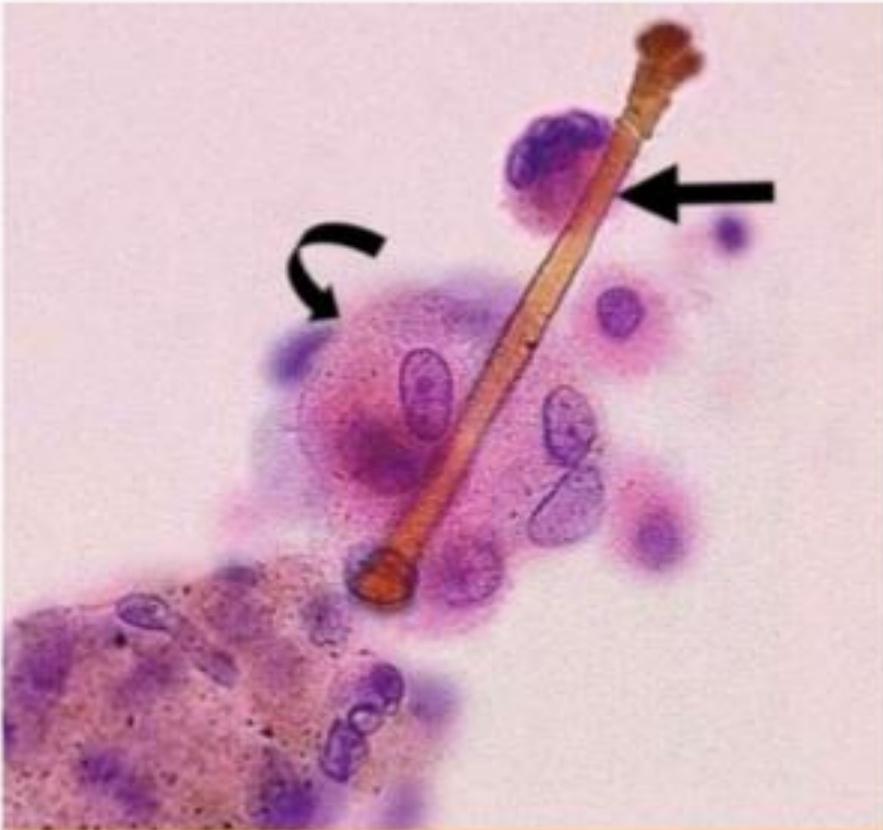
- 1- History of **exposure**: exposure **over (10-20)** years is usually necessary.
- 2- **Clinical** picture: particularly **dyspnea** and **clubbing** of fingers.
- 3- **X-ray** picture: **irregular basal opacities (ground glass)** .
- 4- Pulmonary **function**: restrictive abnormality.
- 5- Broncho-alveolar lavage (BAL): **Contain Asbestos bodies**

D.D:

- **Idiopathic pulmonary** fibrosis (I.P.F): the patient **is younger**, clinically and physiological impairment is **more sever** and progress **rapidly**.
- (pseudo asbestos bodies) such as silica, kaolinite, **silicates** or **man-made mineral fibers**. They **contain no asbestos core**.

	
Serpentine (85% of commercial use)	Amphibole (% of commercial use)
Chrysotile	Actinolite, Amosite, Anthophyllite, Crocidolite, Riebeckite, Tremolite

ASBESTOSIS



Translucent asbestos fiber (straight arrow) surrounded by a protein-iron coat and an alveolar macrophage (curved arrow)



Chest x-ray showing Small, irregular oval opacities Interstitial fibrosis and "Shaggy heart sign"

Treatment Strategy:

Once established, the disease is progressive even after removal of the worker from contact

- Stopping additional exposure
- Careful monitoring to facilitate **early diagnosis**
- **Smoking cessation**
- Regular **influenza and pneumococcal vaccines**
- **Disability assessment**
- Pulmonary **rehabilitation** as needed
- Aggressive **treatment** of **respiratory infections**
- Health **education** to patient

The preventive measures consists of :

- (1) use of safer types of asbestos (chrysolite and amosite);
- (2) substitution of other insulants: glass fibre, mineral wool, calcium silicate, plastic foams, etc.;
- (3) rigorous dust control;
- (4) periodic examination of workers; biological monitoring (clinical, X-ray, lung function), and
- (5) continuing research.

Control Measures Of Asbestos

- PEL 0.1 fiber/CM³ (TWA8).
- Switch to alternate material, **man-made fibers (MMF)** are considered .
- **Engineering controls** include enclosure, increased ventilation, wet manufacturing.
- Use of personal respirators.
- Stop tobacco smoking.



❖ **Permissible** Exposure Limit (PEL) for asbestos is **0.1** fiber per cubic centimetre of air as an **eight-hour time-weighted average** (TWA),), with an excursion limit (EL) of 1.0 asbestos fibers per cubic centimetre over a 30-minute period.

The employer must ensure that no one is exposed above these limits

❖ **Man-made vitreous fibers** الألياف الزجاجية, MMVF (MM mineral fibers):

- **Constitute 3 main species:**
 - **Glass fibers** (glass wool, continuous glass filaments)
 - **Mineral wool** (rock wool and slag wool)
 - **Ceramic fiber.**
- **They used as a substitute** for asbestos since the latter were banned due to its bad health effects.
- They possess high tensile strength, perfect elasticity, thermal and electrical properties and moist and corrosion resistance.
- They have a toxic effect on peritoneal and pulmonary macrophages and structure chromosome alteration in mammalian cells.
- **TWA8 should keep below 1 fiber /CM³ as asbestos.**

Significant occupational exposure to asbestos occurs mainly in

- Asbestos cement factories
- Asbestos textile industry and
- Asbestos mining and milling.

ASBESTOSIS



Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
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ASBESTOSIS

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Asbestos cement factories



Asbestos textile industry



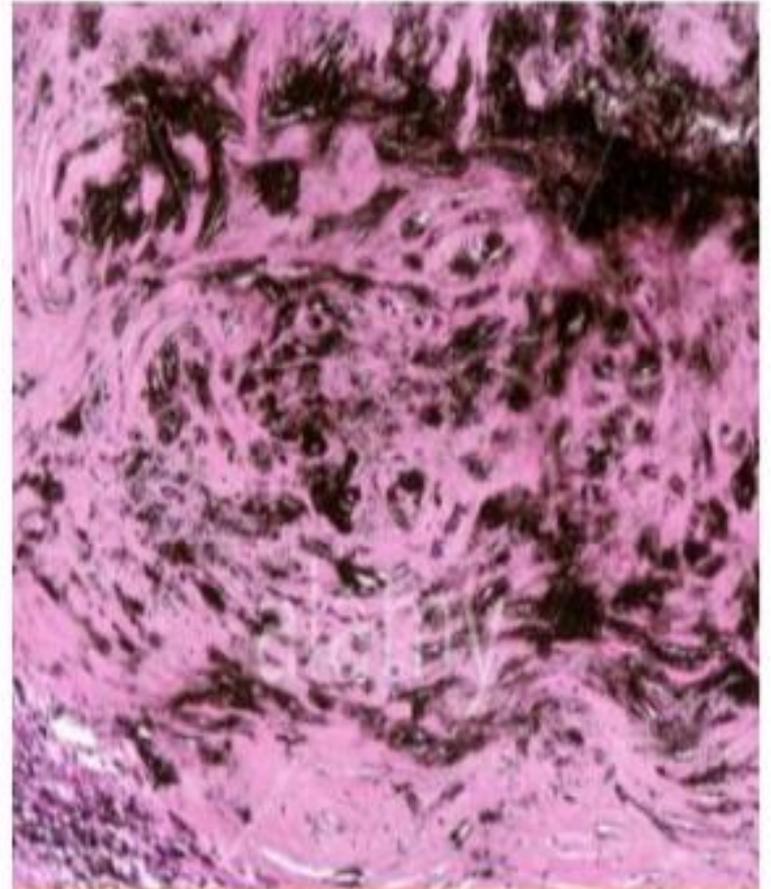
Asbestos mining

Cut section of lungs in anthracosis On histopathological examination

Anthracosis



Cut section of lungs in anthracosis



On histopathological examination

Anthracosis

Anthracosis:

Coal Worker's Pneumoconiosis (CWP) / Black lung disease:

- **Accumulation of coal dust in the lungs and the tissue's reaction** to its presence.
- **Associated with coal mining industry**
- Takes **one or two decades** to cause symptoms
- **The disease is divided into 2 categories:**
 - I. **Simple CWP** and
 - II. **Complicated CWP** or **Progressive Massive Fibrosis (PMF)**.
- I. **Simple Coal Worker's Pneumoconiosis:**
 - the presence of **radiological opacities < 1cm** in diameter.
 - **Benign disease** if no complications.
 - **is associated with little ventilatory impairment.**
 - This phase may require **about 12 years** of work exposure for its development

❖ **Common symptoms:**

- cough,
- expectoration (black in colour) and
- dyspnea.
- – Slight decrease in FVC and FEV1/FVC??

❖ Once a background of simple pneumoconiosis has been attained in the coal worker, a **progressive massive fibrosis** may develop out of it without further exposure to it.

❖ From the epidemiology point of view

❖ the **risk of death** among coal miners has been nearly **twice** that of the general population .

II. **Complicated Coal Worker's Pneumoconiosis** or **Progressive Massive Fibrosis (PMF)**.

- ❖ Is diagnosed when **large opacity of 1cm or more** in diameter is observed in the CXR
 - ❑ Pathologically it is characterized by **large masses of black colour fibrous tissue**.
 - ❑ Symptoms are similar but **more severe**
- ❖ The large lesions **may cavitate** as a result of **ischemic necrosis** or **infection (T.B)**.
- ❖ **Recurrent pulmonary infection**
- ❖ PFT (Pulmonary function test) reveals **decreased FVC, FEV1/FVC** and **increased residual volume**.
- ❑ **The Second phase** is characterised by
 - ❖ *progressive massive fibrosis (PMF)* this causes
 - ❖ **severe respiratory disability** and frequently results in
 - ❖ **premature death**

- ❑ **Special type of PMF associated with rheumatoid disease** (rheumatoid pneumoconiosis or **Caplan syndrome**) occur and is characterized by
- ❑ **typically smooth rounded nodule 1-5 cm in** diameter with **concentric internal lamination and relatively little coal dust** compared with other PMF lesions.
- ❖ **Pulmonary function changes: obstructive or mixed lesion.**
 - decrease in FEV 1 and FEV1/FVC ratio

X-ray picture:

❖ **Simple CWP**

- frequently **mixed nodular and irregular** and
- **occasionally exclusively irregular opacities** was noted
- first in **upper and middle lung zone.**
- **irregular opacities** raises the possibility of previous exposure to asbestos.

❖ PMF appear radiologically as



❖ **PMF appear** radiologically as

➤ **nodular opacity 1cm or larger**

➤ **usually found posteriorly in upper lung zone.**

▪ **D.D of small opacities in x-ray picture includes:**

Miliary T.B and viral pneumonia

Other pneumoconiosis, metastatic carcinoma, chronic T.B

❖ PMF should be differentiated from malignancy,

❖ **Diagnosis and clinical assessment:**

➤ History of present and past exposure .

➤ Look for previous chest X- ray and lung function tests.

➤ S. & S. including cough, sputum, dyspnea or cardiovascular symptoms

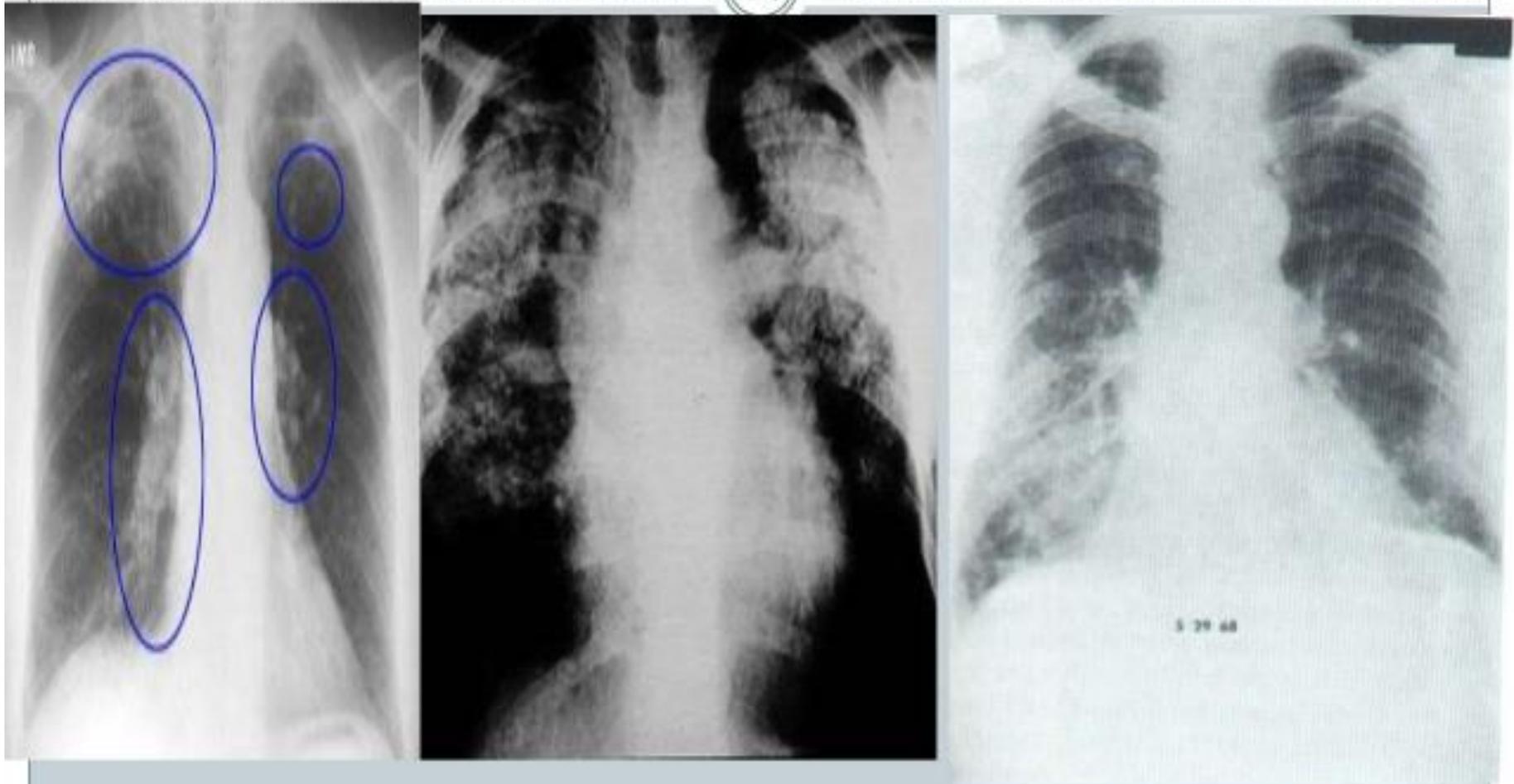
❖ **Treatment and clinical care:**

Symptomatic, for dyspnea , ch. bronchitis and congestive H.F

Silicosis, Anthracosis & asbestosis

X-ray findings

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Caplan's syndrome (Caplan disease or (Rheumatoid pneumoconiosis)

is a **combination** of **rheumatoid arthritis** (RA) & **pneumoconiosis**

- manifests as intrapulmonary nodules,
- which appear **homogenous** and **well-defined** on chest X ray
- The nodules in the lung **typically occur bilaterally** and **peripherally**, on a *background of simple coal worker's pneumoconiosis*
- There are usually **multiple nodules**, varying in size from **0.5 to 5.0 cm**.
- The nodules typically **appear rapidly**, often in **only a few weeks**.
- Nodules may grow, remain unchanged in size,

Cont. ...Caplan's syndrome

- Nodules may grow, remain unchanged in size,
- **resolve**, or **disappear** and **then reappear**.
- They **can cavitate**, calcify, or **develop air-fluid levels**
- ❖ **Caplan syndrome** occurs **only in patients with both RA and pneumoconiosis** related to mining dust (coal, asbestos, silica).
- ❖ . There is probably also a genetic predisposition, and
- ❖ smoking is thought to be an aggravating factor

Comparative features of different types

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Features	Silicosis	Asbestosis	Anthracosis
1. Agent/ dust	<ul style="list-style-type: none">•Silica free or silicon dioxid or silicic acid•Particles are 0.5 - 3 μ are most dangerous.	<ul style="list-style-type: none">•Asbestos fibres<ol style="list-style-type: none">1. Serpentine or chrysolite (safer)2. Amphibole<ol style="list-style-type: none">i. Crocidolite (blue)ii. Amosite (brown, safer)iii. Anthrophyllite (white)• 20-500μ in length and 0.5-50 μ in diameter	<ul style="list-style-type: none">• Coal dust

Comparative features of different types

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Features	Silicosis	Asbestosis	Anthracosis
Occupational exposure	Mining, pottery, ceramic, sand blasting, metal grinding, building & construction work, rock mining, iron & steel industry.	Manufacturers of Asbestos cement, fire proof textiles, roof tiling, brake lining & gaskets.	Coal miners, coal processors & coal handlers and those manufacturing carbon electrodes.
Incubation period	6 months to 6 years		12 years

Comparative features of different types

Features	Silicosis	Asbestosis	Anthracosis
Pathogenesis	<p>Fibrosis is initiated by silicic acid leading to nodular fibrosis, emphysema, and right heart failure. Pulmonary tuberculosis may intervene in 50% of cases. Fibrosis is nodular and in upper part of lung.</p>	<p>Asbestos fibers initiate fibrosis of pulmonary tissue, emphysema and its associated complications. Fibrosis is due to mechanical irritation, it is peri-bronchial, diffuse and basal in location</p>	<p>•Coal dust initiates diffuse and massive fibrosis</p> <ol style="list-style-type: none"> Simple pneumoconiosis with ventilatory impairment. Progressive massive fibrosis leading to emphysema and right heart failure
Clinico-Pathologic features	<p>Irritant cough, dyspnea on exertion & pain in chest. Dense nodular fibrosis 3-4 mm nodules. X-ray shows “snow-storm” appearance</p>	<p>Dyspnea out of proportion, clubbing, cyanosis, cardiac distress. Sputum shows “asbestos bodies”. X-ray shows ground glass appearance.</p>	<p>•From little ventilatory impairment to severe respiratory disability leading to pre-mat death.</p>

Control of pneumoconiosis

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- **Rigorous dust control measures**
 - × Substitution, enclosure, isolation, hydroblasting, good house keeping, personal protective measures
 - × Regular physical examination of workers.
- **Periodic examination of workers, biological monitoring (X-ray & Lung function)**
- **Personal protection**
 - × Masks, respirators with mechanical filters
- **Regulated exposure**
- **Health education**



**Thank
you**



Any questions?
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Chemical hazards

Occupational exposure to Toxic Metals

"heavy metals"



LEAD POISONING

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