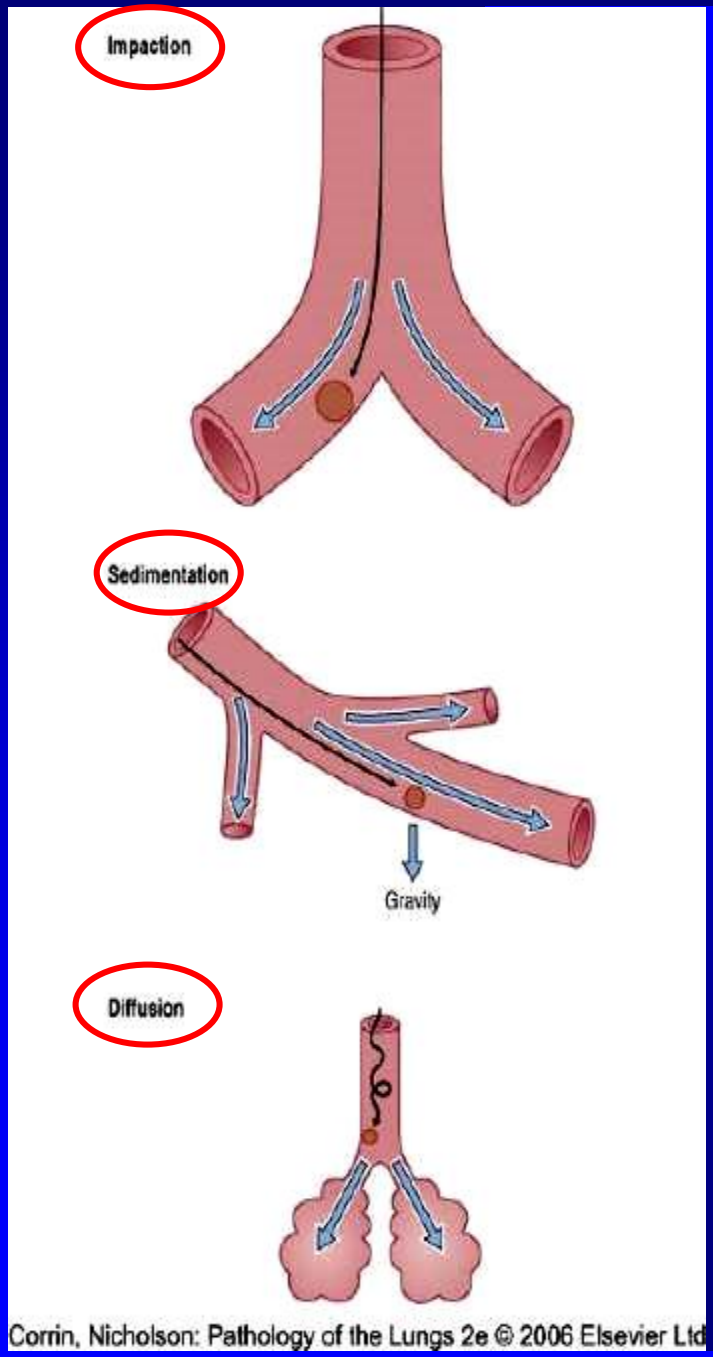
Pneumoconiosis

Doina Barba, MD, PhD,
associate professor



Mechanisms of Particle Deposition in the Respiratory Tract

Influenced by particle
- Size
- Shape
- Density

Stoke's diameter: size of an irregular particle relative to that of a sphere of unit density

Particle Clearance
- Mucociliary action
- Alveolar macrophages
- Pulmonary lymphatics

Occupational Respiratory Diseases

Size, Location, Outcome

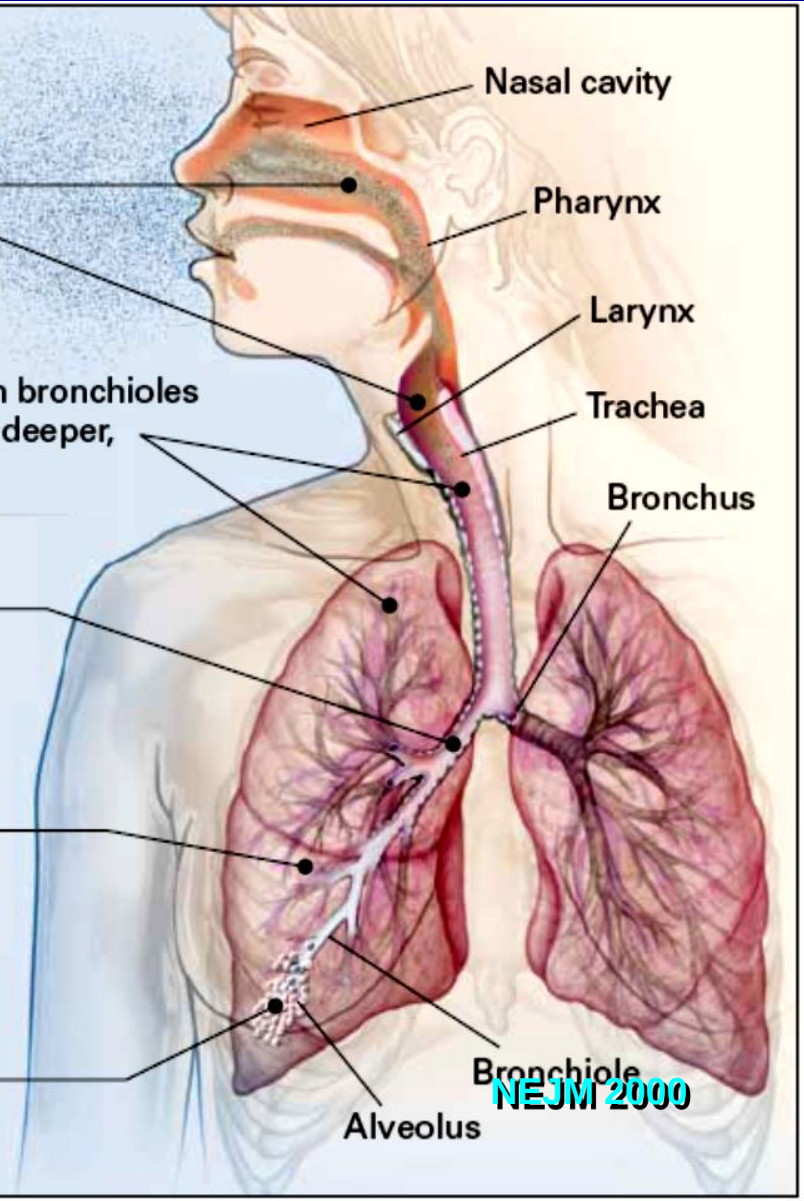
Rhinitis and laryngitis
Large particles are deposited in the nose, pharynx, and larynx. More soluble gases (e.g., sulfur dioxide) are absorbed by upper respiratory tract mucous membranes, causing edema and mucus hypersecretion.

Tracheitis, bronchitis, and bronchiolitis
Large particles (more than 10 μm in diameter) are deposited and then cleared by cilia. Small particles and fine fibers are deposited in bronchioles and bifurcations of alveolar ducts. Less soluble gases penetrate to deeper, small airways.

Asthma and chronic obstructive pulmonary disease
Allergens and irritants are deposited in large airways by turbulent flow, causing chronic inflammatory changes.

Cancer
Carcinogens (asbestos and polycyclic aromatic hydrocarbons) come into contact with bronchial epithelial cells, causing mutations in proto-oncogenes and tumor-suppressor genes. More than one such contact results in malignant transformation.

Interstitial disease
Small particles (less than 10 μm in diameter) and fibers are deposited in terminal bronchioles, alveolar ducts, and alveoli. Penetration to the interstitium results in fibrosis and the formation of granulomas.



Selected Common Causes of Occupational Upper Respiratory Tract Disease

Rhinitis and laryngitis†

Allergic sensitizers

- Dust from flour used in baking (wheat, rye, soy, and buckwheat flour and gluten and amylase), can contain mites and fungi
- Dusts from animal feeds and grains
- Ethylenediamine in adhesives
- Latex on cornstarch granules from latex gloves
- Pollens/mold spores (in plants, on moist, dark surfaces)
- Proteins from laboratory animals (i.e., guinea pigs and rats)
- Acid anhydrides (used in adhesives and coatings with epoxy resin, circuit boards, and plasticizers)
- Psyllium (a pharmaceutical stool-bulking agent)

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Upper Respiratory Tract Disease

Rhinitis and Laryngitis†

Irritants

- Acidic or alkaline cleaning solutions and powders
- Ammonia
- Environmental tobacco smoke
- Hypochlorous acid (bleach)
- Metalworking fluids (cutting oils)
- Ozone (in aluminum welding)
- Sulfur dioxide
- Volatile organic compounds (in paints, thinners, solvents, and industrial cleaning solutions)

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Upper Respiratory Tract Disease

Rhinitis and Laryngitis†

- *Rhinorrhea*
  - Cold air
  - Certain pesticides (carbaryl, malathion, parathion, mevinphos, pyrethrum)
- *Nasal ulceration and perforation of septum*
  - Arsenic
  - Chromic acid and chromates
  - Copper dusts and mists

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Airway Disease - *Bronchitis*

- Sulfur dioxide (used in chemical manufacturing)
- Rock and mineral dusts (used in road construction and digging of foundations)
- Cement dust
- Smoke from welding or cutting with acetylene torch

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Airway Disease - *Bronchiolitis*

- Acetaldehyde
- Ammonia (used in farm-crop preservation)
- Chlorine gas
- Hydrogen fluoride
- Hydrogen sulfide (used in oil refining)
- Nitrogen dioxide (generated by freshly stored hay in silos)
- Nitric acid, nitrous acid, and nitric oxide
- Phosgene (used in chemical manufacturing)

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Airway Disease - *Asthma with latency*

- Acid anhydrides (used in epoxy adhesives and paints, coatings, circuit boards, polymers, polyesters, plasticizers)
- Aldehydes
- Acrylates (used in paints and adhesives)
- Animal proteins (in laboratory animals, farming, and veterinary medicine)
- Cobalt (used in carbide-tipped tools)
- Dusts from flours and grains (found in bakeries)
- Dusts from wood (used in furniture making and cabinetry)
- Ethylenediamine, monoethanolamine, and other amines

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Airway Disease - *Asthma*

- Formaldehyde and glutaraldehyde (used in sterilizing medical instruments)
- Isocyanates (hexamethylene diisocyanate, diphenylmethane diisocyanate, and toluene diisocyanate) used in polyurethane paint (used in auto-body repair) and the manufacture and application of foam (used in roofing foams)
- Latex (used in health care facilities)
- Asthma without latency (irritants that cause reactive airway dysfunction syndrome - RADS)
- Contaminants in metalworking fluids
- Chlorine gas (pulp from paper mills)
- Bleach (sodium hypochlorite)
- Strong acids

NEJM 2000 Volume 342 Number 6

Selected Common Causes of Occupational Airway Disease

COPD and Chronic Airflow Limitation

- Coal dust (causes emphysema with nodular fibrosis)
- Crystalline silica (causes chronic airflow limitation)
- Cotton dust (causes chronic airflow limitation)
- Cadmium (causes emphysema)
  (used in electronics, metal plating, and batteries)
- Toluene diisocyanate (causes chronic airflow obstruction)

NEJM 2000 Volume 342 Number 6

Notifiable Industrial Respiratory Diseases

- Tuberculosis caused by workplace exposure to sources of infection
- Legionellosis caused by workplace exposure to sources of infection
- Barotrauma resulting in lung or other organ damage

InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

Notifiable Industrial Respiratory Diseases

- Pneumoconiosis (mineral dust)
- Asbestosis (Mesothelioma)
- Byssinosis in cotton or flax workers
- Extrinsic alveolitis caused by workplace exposure to animals, birds or fungal spores
- Occupational asthma
- Poisoning by industrial agents, i.e., beryllium, lead and oxides of nitrogen

InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

Notifiable Industrial Respiratory Diseases

- Cancer of bronchus or lung caused by industrial exposure to carcinogens
- Primary carcinoma of the lung where there is accompanying evidence of silicosis
- Nasal or sinus cancer caused by occupational exposure to carcinogens (wood, fibreboard, nickel and leather workers)

InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

History May Lead to Suspicion of Occupational Environmental Cause of Cough

- Almost any cause of cough may have an occupational or environmental cause or contribution
- Determine the relationship of these occupational and environmental factors to confirm or refute their role in cough and to modify or eliminate exposure to the relevant agents.

Chest 2006;129;186-196

Taking An Occupational History
Needs to be comprehensive and specific.
Include the following

Time

- From school until present
- Have there been any periods of military service?
- Jobs held from school until present
- (Recent) changes in production processes
- Describe a typical working day/week

Space

- Exact name and address of the workplace
- The layout of the workplace (make a diagram)

Taking An Occupational History
Needs to be comprehensive and specific.
Include the following

Type of work

- Function (exact job description)
- Exposures and their circumstances (use MSDS (materials safety data sheets via internet search)
- Personal protective equipment
- Normal and occasional activities
- Have there been any accidents?
- What other activities are carried out nearby?

MSDS: Material Safety Data Sheets

Taking An Occupational History
Needs to be comprehensive and specific.
Include the following

Other factors

- Casual jobs
- Hobbies
- Domestic exposures (animals including birds, damp, mould, household members' jobs)
- Environmental exposures (home, travel)
- Smoking and other habits
- Cosmetics
- Medication

Value and Utility of Chest Imaging

- Detect abnormalities
- Identify co-existing or alternative diagnosis
- Quantify severity
- Predict prognosis

Detection and Diagnosis
Often requires the integration of clinical and pathological findings

- * Chest radiographs have low sensitivity and specificity:
  - 5-30% of patients with asbestosis have normal chest film
- ** Computed Tomography:
  - Sensitivity is higher than sensitivity of chest radiograph, but not 100%
  - Specificity - Variable

* Meyer et al: Chest 1997,
Paris et al : Scand. J Work Environ Health 2004
Lee et al: Am J Ind Med 2003

** Akira et al: Radiology 1991
Aberle et al: AJR 1988
Jones: Am Rev Respir Dis1991

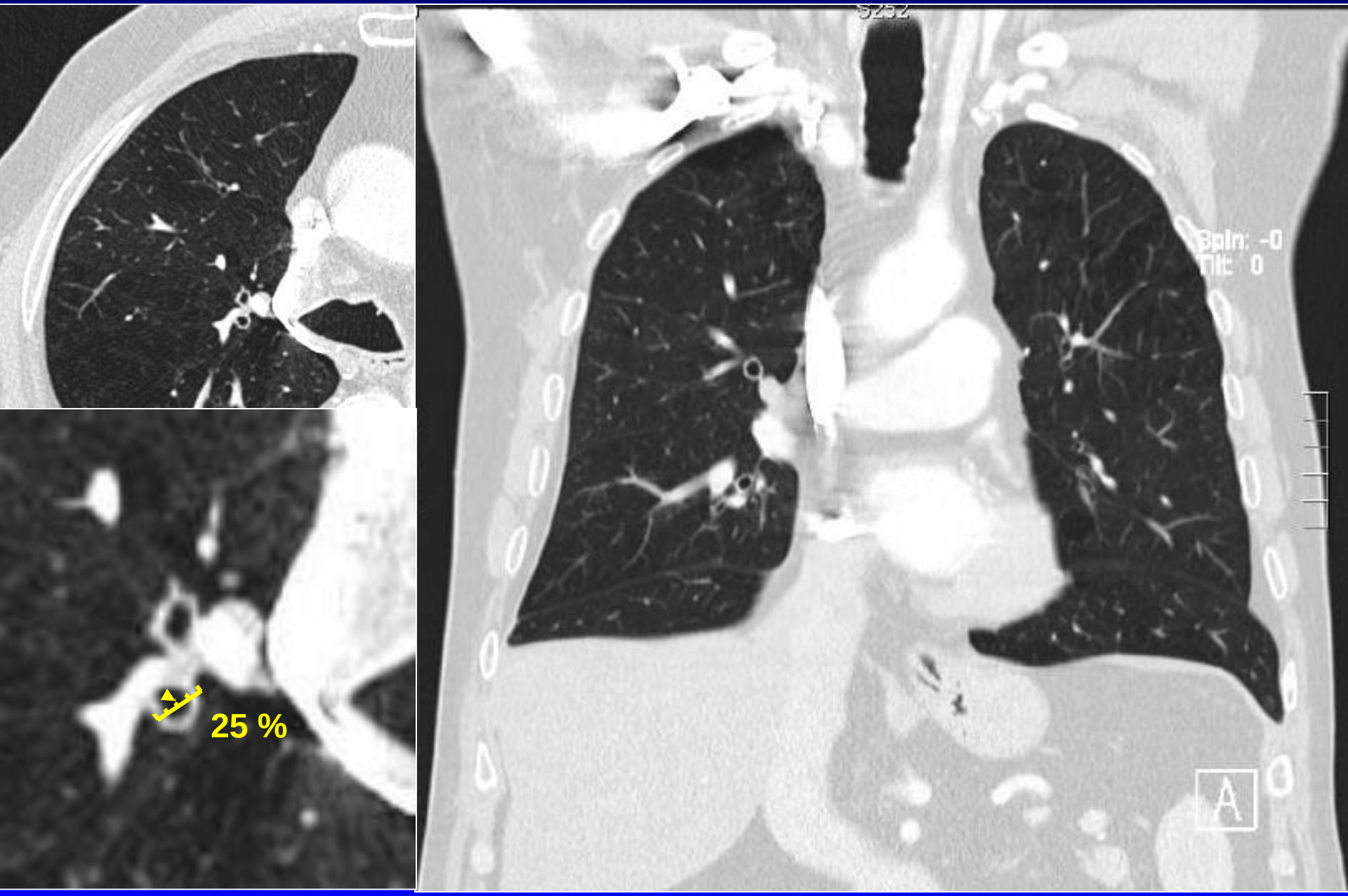
Detection and Diagnosis

- Combined exposures are common
- Smoking is often a co-existing cause of lung changes
- Emphysema can change appearance and distribution patterns
- Differential diagnosis with other (idiopathic) DILD's, especially with idiopathic interstitial fibrosis (IPF), is important but sometimes difficult to establish

Copley et al: Radiology 2003
Coggon and Newman: Thorax 2004

Imaging Features of Large Airways Involvement

- Bronchial wall thickening
  - Increased markings: subjective sign
  - Parallel line shadows: tramline opacities
  - Ring shadows
- Bronchiectasis: enlarged tramline opacities & ring shadows


25 %
A

Terminal bronchiole: branches near the centre of the secondary pulmonary lobule

Respiratory bronchiole: preferential deposition of disease because of increase of cross-sectional area of the total of airways

Small Airways Direct signs

- Centrilobular nodules
- Rosette of small nodules
- Centrilobular branching lines
- Tree-in-bud

Pneumoconiosis
“Dusty lung".

- “Permanent alteration of lung structure due to the inhalation of mineral dust and the tissue reactions of the lung to its presence,

  excluding bronchitis and emphysema“

  The British Industrial Injuries Advisory Council

- PARKES recommends that cancer and asthma caused by mineral dust should also be excluded from the definition

Breathe | September 2007 | Volume 4 | No 1

Pneumoconiosis
“Dusty lung".

- Confined to effects of mineral dust on the lungs
- Organic dusts are not included

- In medicolegal practice at least, presence of dust alone is insufficient to indicate pneumoconiosis
- For compensation to be considered, the mineral dust must alter the structure of the lung and cause disability

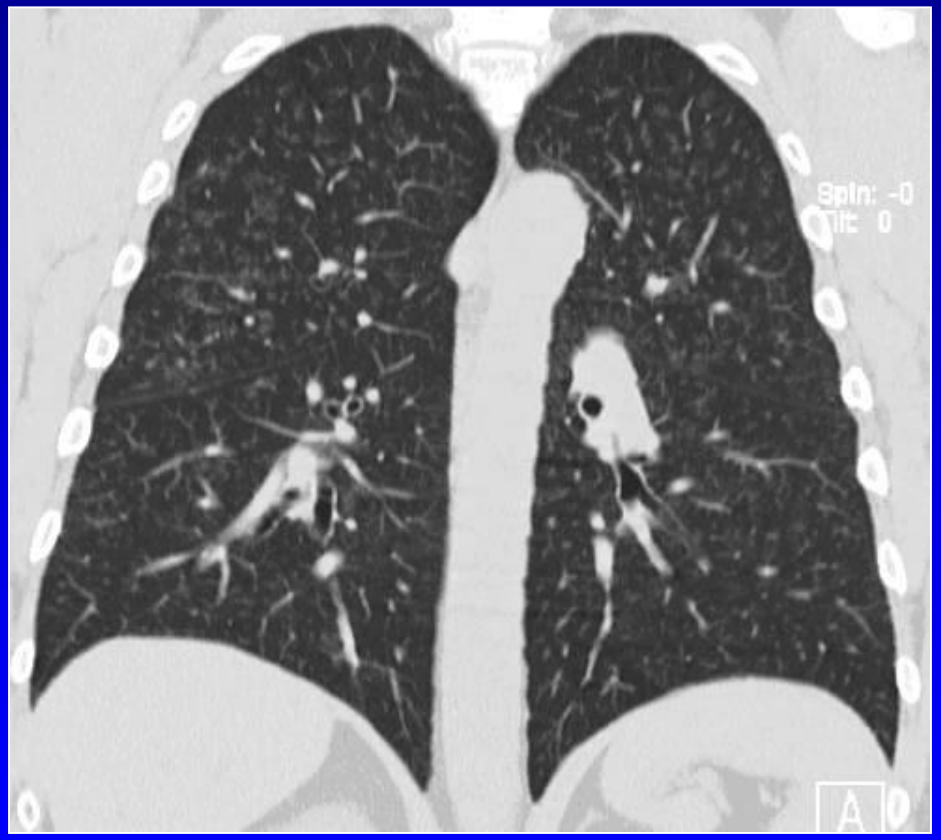
Breathe | September 2007 | Volume 4 | No 1

Pulmonary Reactions to Mineral Dust

Pulmonary reaction	*Examples*
Macrophage accumulation with a little reticulin deposition	Anthracosis
	Siderosis
	Stannosis
	Baritosis
	Coal pneumoconiosis (macules)
	Aluminium pneumoconiosis (granular aluminium)
Nodular or massive fibrosis	Silicosis
	Mixed dust pneumoconiosis
	Coal pneumoconiosis (nodules)
Diffuse fibrosis	Asbestosis
	Hard metal pneumoconiosis
	Aluminium pneumoconiosis (aluminium fume and stamped aluminium)
Epithelioid and giant cell granulomas	Chronic berylliosis
Alveolar lipoproteinosis	'Acute' silicosis, but also seen with heavy exposure to other dusts (see p. 338)
Small airway disease	Various dusts

‘ Pneumoconiosis ’
Coal dust

1. *Simple Pneumoconiosis*
   - Deposition of coal dust in the lung and tissue reaction to its presence
   - Incidence is related to total dust exposure
   - Changes are graded on chest X-ray appearance
   - Predisposes to progressive massive fibrosis



InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

2. Progressive Massive Fibrosis

- Round fibrotic masses several centimetres in diameter form in the upper lobes
- Presents with exertional dyspnoea, cough, black sputum and eventually respiratory failure
- Symptoms progress, or may even start, after exposure to coal dust has ceased
- Lung function tests show a mixed restrictive and obstructive picture with loss of lung volume, irreversible airflow limitation and reduced gas transfer

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Fibers, Fine Particles, and Dust (Asbestos)

- Human carcinogens. Increased rates of mesothelioma, a rare cancer of the lining of the lung and abdominal cavity, and cancer of the lung in a variety of occupations

- Fibers are released into the environment from the use and deterioration of more than 5,000 asbestos products: roofing, thermal, and electrical insulation; cement pipe and sheet; flooring; gaskets; plastics; and textile and paper products

Fibers, Fine Particles, and Dust (Asbestos)

Greatest risks among workers who smoke.

Workers in asbestos insulation,

brake maintenance and repair, and building demolition jobs are exposed to high levels of asbestos.

CANCER AND THE ENVIRONMENT
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health
National Cancer Institute
National Institute of Environmental Health Sciences

Asbestosis

- Should only be used to label the parenchymal disease caused by asbestos exposure

- Should not be used when only the pleura is involved
- Presence of (uni- or bilateral) localized thickening of the parietal pleura (*i.e.* plaques) or diffuse pleural thickening in cases of pulmonary fibrosis strongly points to a diagnosis of asbestosis
- The absence of pleural lesions, however, does not exclude the existence of asbestosis

Conditions caused by Asbestos Exposure

Condition	Asbestos exposure	Features/management
Benign pleural effusion	Usually occurs less than 20 years after exposure	Increasing dyspnoea with or without pleuritic pain Refer for drainage of effusion May be recurrent and require pleurodesis
Bilateral diffuse pleural thickening[a]	Follows light or moderate exposure to asbestos May progress even in the absence of further exposure	Defined as pleural thickening of greater than 5-mm covering over a quarter of the chest wall Symptoms: Exertional dyspnoea Lung function tests: Restrictive picture Treatment is symptomatic
Asbestosis[a]	Follows heavy exposure after a 5- to 10-year interval	Presents with progressive dyspnoea, finger clubbing and basal end-expiratory crackles. Chest X-ray: 'honeycomb lung'—diffuse streaky shadowing. Lung function tests: severe restrictive defect and reduced gas transfer Treatment is symptomatic
Mesothelioma[a]	Can follow even light exposure to asbestos. There is a 20- to 40-year time lag between exposure and appearance of disease	Presents with increasing shortness of breath with or without pleuritic pain Examination and chest X-ray reveal unilateral (rarely bilateral) effusion There is no effective active treatment Median survival is 2 years from diagnosis
Asbestosis-related lung cancer[a]	Patients exposed to asbestos who have evidence of that exposure (pleural plaques, bilateral pleural thickening or asbestosis) have an increased risk of bronchial carcinoma—usually adenocarcinoma. Smokers exposed to asbestos have a five times increased risk compared to non-smokers exposed to asbestos	

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Deaths from Mesothelioma

- Consider this diagnosis in relatives of asbestos workers who came into contact with asbestos indirectly, for example through washing asbestos workers ’ clothes.

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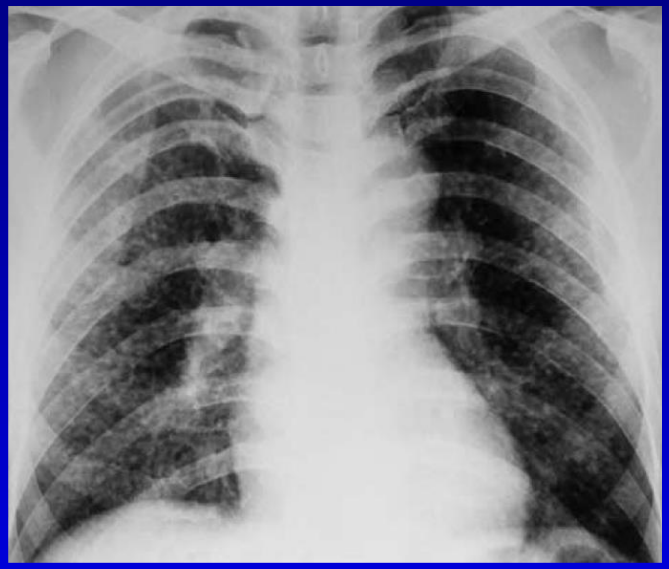
Mean Fall in Lung Function in Subjects who Deteriorated Over 10 Years Prior to Death

	Fall as % of Initial Result
Vital capacity	6 ± 5%
FEV1	5 ± 4%
DLCO	27 ± 7%
KCO	36 ± 17%

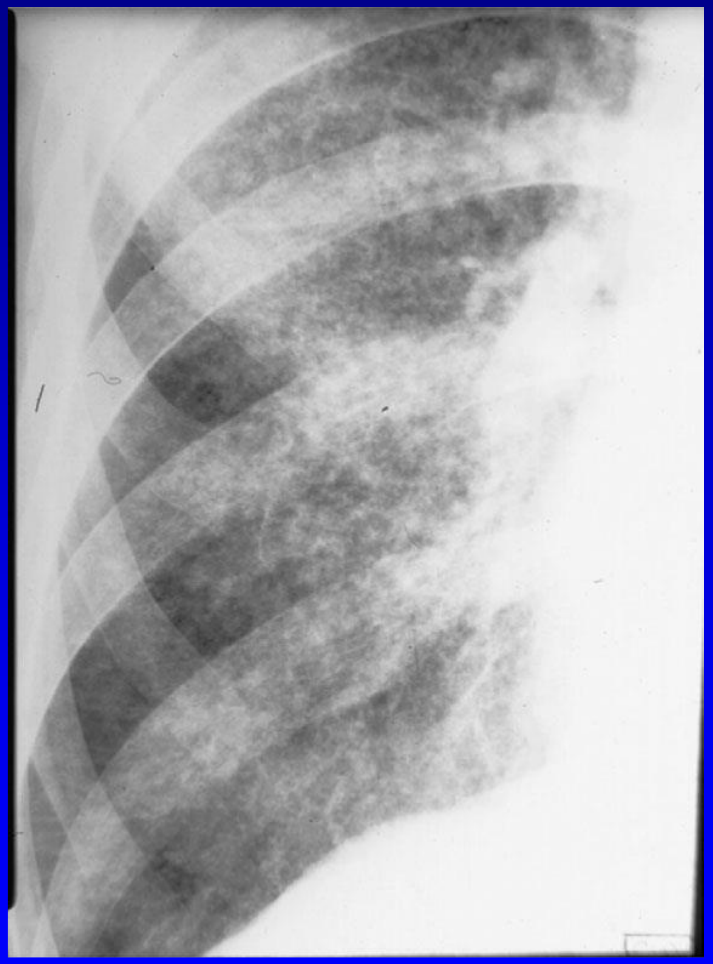
Simple Silicosis



- Industrial exposures are free silica in mining, quarrying, and tunneling; stonecutting, polishing, and cleaning monumental masonry; sandblasting and glass manufacturing; foundry work, pottery and porcelain manufacturing, brick lining, boiler scaling, and vitreous enameling.
- Coal miners are exposed to dusts that contain a mixture of coal, mica, kaolin, and silica in varying proportions

RadioGraphics 2001; 21:1371–1391

Silicosis is Uncommon



- Presents with exertional dyspnoea, sometimes accompanied by chronic cough
- Lung function tests show a mixed restrictive and obstructive picture with loss of lung volume, irreversible airflow limitation and reduced gas transfer

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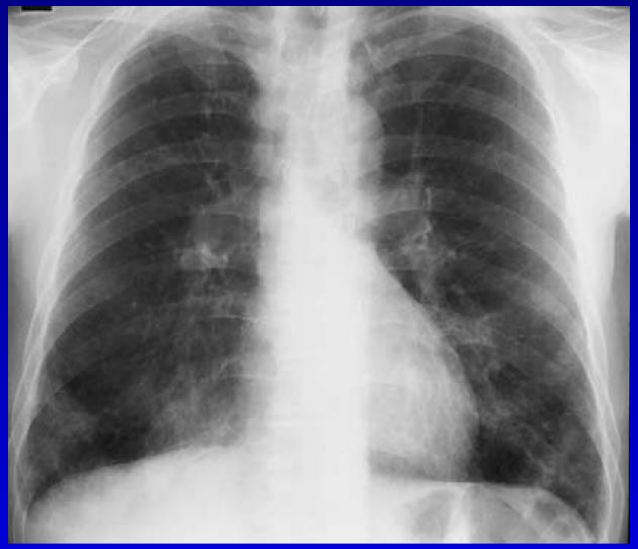
Less Common Mineral Pneumoconioses
Iron (Siderosis)

- Individual susceptibility does play a role in the occurrence and clinical course
- Disorders result mainly from excessive cumulative exposures to the offending mineral dusts
- In some parenchymal lung diseases, individual host susceptibility – rather than exposure intensity – is the main determinant of occurrence

Hard Metal Pneumoconiosis

Giant cell interstitial pneumonia in a 52-year-old man

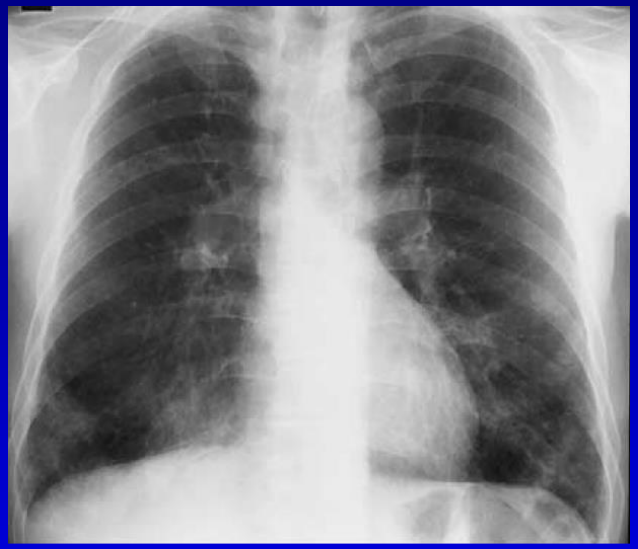


- *Hard metal* is usually used to refer to an alloy of tungsten, carbon, and cobalt, occasionally with the addition of small amounts of other metals such as titanium, tantalum, nickel, and chromium
- The resulting product is extremely hard and resistant to heat and is used extensively in the drilling and polishing of other metals

RadioGraphics 2001; 21:1371–1391

Hard Metal Pneumoconiosis

Giant cell interstitial pneumonia in a 52-year-old man



- May take the form of interstitial pneumonia, desquamative interstitial pneumonia, or giant cell interstitial pneumonia
- The finding of giant cell interstitial pneumonia is almost pathognomonic for hard metal pneumoconiosis

RadioGraphics 2001; 21:1371–1391

Berylliosis is Rare

- Affects workers in the aerospace, nuclear power and electrical industries and their close relatives
- Can result from a single exposure to beryllium dust. Usually more associated with prolonged exposure
- Lungs become hypersensitive to beryllium causing the development of granulomas; ultimately, leads to a chronic, restrictive lung disease

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Berylliosis is Rare

- Onset of symptoms may range from weeks to decades after exposure
  - Chest pain, cough and shortness of breath on exertion, and systemic symptoms, such as fever, weight loss and joint pains.
  - Inspiratory crackles, lymphadenopathy and/or hepatosplenomegaly.

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Berylliosis is Rare

- Chest X-ray is normal in about half of all cases. Significant findings include hilar lymphadenopathy and increased lung markings.
- Specialist diagnosis is with high-resolution CT and the beryllium lymphocyte proliferation test.
- If patients are asymptomatic and their lung function is stable, they are usually monitored.
- Treatment with steroids or methotrexate is used for patients with symptoms or progressive decline in lung function.

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Hard-metal lung disease is a rare condition
Cobalt-containing particles

- May present clinically as hypersensitivity pneumonitis

- Pathology is characterized, by the presence of bizarre "cannibalistic" multinuclear cells in bronchoalveolar lavage and in lung tissue (giant cell interstitial pneumonitis)

Byssinosis

- Affects cotton mill and yarn workers.
- Tightness in the chest, cough and breathlessness
- Start on first day back at work after a break
- Colloquially known as ‘ Monday sickness ’
- Symptoms improve as the week progresses
- Chest X-ray is normal
- Treatment is symptomatic (antihistamines and bronchodilators)
- Workers affected should be moved to work in a less contaminated area.

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Dust inhalation

- Iron (siderosis)
- Barium (baritosis)
- Tin (stannosis)

- Inhalation results in dramatic dense nodular shadowing on chest X-ray but effects on lung function and symptoms are often minimal.

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Organic Dust
Occupations Exposed

- Farming
- Forestry
- Fishing
- Textile industry
- Paper industry
- Medical industry
- Animal feed industry
- Garbage-recycling industry
- Metal industry
- Research

Respiratory Hazards in Farming

Organic dusts (grain, straw, hay)

- Moulds and spores
- Bacteria
- Mites and their excreta
- Animal dander
- Animal urine and faeces
- Animal feeds

Inorganic dusts

- Low molecular weight minerals (e.g. silicates)

Chemicals

- Pesticides
- Fertilizers
- Paints
- Preservatives
- Disinfectants

Occup. Med. Vol. 52 No. 8, pp. 451–459, 2002

Respiratory Hazards in Farming

Gases and fumes

- Slurry (ammonia, methane, hydrogen sulphide, carbon dioxide)
- Silage (nitrogen dioxide, carbon dioxide)
- Welding fumes (oxides of nitrogen, ozone, metals)
- Engine exhaust fumes (oxides of nitrogen, particulate matter)

Infectious agents

- Bovine tuberculosis (Mycobacterium bovis)
- Psittacosis (Chlamydia psittaci)
- Q fever (Coxiella burnetii)

Occup. Med. Vol. 52 No. 8, pp. 451–459, 2002

High Molecular Weight Agents

1. Products of animal origin

   Originate from mammals (farm animals, pets, laboratory animals), birds (excreta, eggs), arthropods (insects, mites), or fish and crustaceans.

   Allergic sensitization and occupational asthma caused by such products also occur in people engaged in agriculture, the food industry, research, *etc*.

High Molecular Weight Agents

2. Products of plant origin

Comprise grain and flour (wheat, rye), beans (soya, coffee, castor), flowers, herbs, spices, vegetables, fruit, as well as natural rubber latex (*Hevea brasiliensis*) or vegetable gums (acacia, guar).

Occupational asthma to such plant-derived protein allergens also occur in agriculture, food, healthcare, research, transport and other sectors.

High Molecular Weight Agents

3. Products of microbial origin

Derived from fungi (*e.g*. spores) or other microbiological agents that may contaminate food or feed, humidifiers, air-conditioning equipment or that may be encountered in biotechnology.

A special category of often highly allergenic substances of microbial origin consists of enzymes (such as proteases, amylase, *etc*.) that are increasingly used in industrial and consumer products (detergents, food feeds, cleaning agents, pharmaceuticals, *etc*.).

Low Molecular Weight Agents

1. Synthetic chemicals –
   a. Isocyanate

   Function consists of a -N=C=O group; has high reactivity for alcohol (OH) groups

- Used for making polyurethanes, which result from the condensation of diisocyanates (or polyisocyanates) with polyols
- Frequently used diisocyanates are toluene diisocyanate (TDI), methylene diphenyl diisocyanate (MDI) and hexamethylene diisocyanate (HDI)

Low Molecular Weight Agents

1. Synthetic chemicals –
   b. TDI and MDI

- Used for making polyurethane elastomers, plastics and flexible or rigid foams, utilized for insulation, seats and other vehicle parts, furniture, shoe soles, carpet backings, cable sheathing, *etc*.
- Heavily used in coatings (paints, lacquers, varnish), adhesives and binders, as the hardener (HDI) in two-component spray-paints for cars, in print-laminating and concrete flooring, or in wood products (particle/fibre board), foundry resins or sealants

- Not all “plastic materials” or paints are made of isocyanates

Low Molecular Weight Agents

1. Other synthetic chemicals –
   c. Acid anhydrides; acrylates

- Chemicals in the composition of polymeric materials are acid anhydrides, such as phthalic anhydride or trimellitic anhydride

- Used for making epoxy resins, and some acrylates, eg., methyl methacrylate, used for making composites or glues

Low Molecular Weight Agents

1. Synthetic chemicals –

   d. Amines or reactive dyes

- In the health and pharmaceutical sector, caused by aldehydes, such as formaldehyde or glutaraldehyde (used for disinfection), or antiseptics, antibiotics and other drugs (and their precursors)

- Persulfates that are used for bleaching hair are a frequent cause of asthma in hairdressers

Low Molecular Weight Agents

2. Natural chemicals

- Occupational asthma caused by wood, such as Western red cedar, or asthma in electronic workers who are exposed to the fumes of colophony (derived from pine), which is often used as a flux for soldering in electronics

Low Molecular Weight Agents

3. Metallic agents - salts of platinum; cobalt, chromium; nickel

- The most notorious is caused by the complex salts of platinum in refiners of precious metals.

- Cobalt, chromium (hexavalent chromates) and nickel are possible causes of occupational asthma.

Diseases Caused by Exposure to Organic Dust

- Work related cough
- Asthma
  - Allergic
  - Inflammatory
  - Byssinosis
- COPD
  - Loss of dynamic lung volume
- Extrinsic allergic alveolitis, HP
- Toxic pneumonitis (ODTS)
- Mucus membrane irritation

Hypersensitivity Pneumonitis formerly known as Extrinsic Allergic Alveolitis

- Colloquially known as ‘ farmer’s ’ or ‘ bird fancier’s ’ lung
- Inhaled particles, such as fungal spores or avian proteins, provoke an allergic reaction in the lungs of hypersensitive individuals
- Count as an industrial disease if the exposure was as a result of the individual’s work

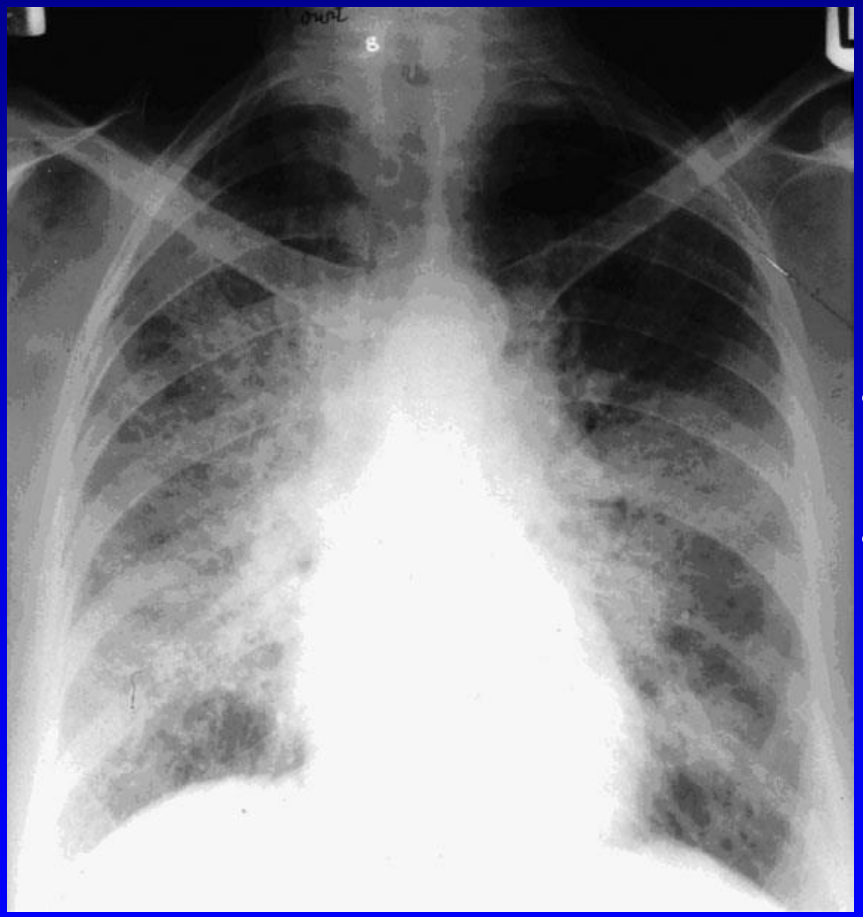
InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

Hypersensitivity Pneumonitis

- Causative particulate organism or protein complex is small, typically 1–2 µm and always less than µ5 m in diameter
- Deposition of 1–2 µm particles occurs predominantly in the distal airspaces of the lung
- Type III and type IV immune reactions resulting in alveolitis and granuloma, usually most severe in the peribronchiolar region
- Even mild degrees of pathologic involvement may cause severe impairment of pulmonary function because of the strategic location of the granulomas within the respiratory bronchioles

RadioGraphics 2001; 21:1371–1391

Hypersensitivity Pneumonitis Chest X-ray



- The most common diffuse lung disease exhibiting normal radiographic findings
- Characteristically, widespread small nodules or a ground glass appearance.
- Confirmation of the diagnosis based on
  - HRCT findings
  - Presence of serum precipitins to the provoking factor (found in more than 90% of patients).

RadioGraphics 2001; 21:1371–1391
InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

Hypersensitivity Pneumonitis formerly known as Extrinsic Allergic Alveolitis

Presents in 2 ways that can occur simultaneously:

- Acute reactions:
  - Occur 2 – 4 hours after exposure to the allergen.
  - Develops fever, malaise, dry cough and shortness of breath.
  - Neutrophil count and ESR are both raised.
- Chronic reactions:
  - Ongoing symptoms of malaise, weight loss and exertional dyspnoea. Examination reveals fine crepitations in both lung fields.

InnovAiT, Vol. 1, No. 10, pp. 686–692, 2008

Farmer's Lung:
Biopsy findings in 60 patients

• Interstitial pneumonitis	60	(100%)
• Interstitial fibrosis	39	(66%)
• Intra-alveolar fibrosis	39	(66%)
• Foam cells	39	(66%)
• Bronchiolitis obliterans	30	(50%)
• Granulomas	42	(70%)
• Solitary giant cells	32	(32%)
• Vasculitis	0	

Reyes et al. Chest 1982;81:142

Occupational Asthma

Briefly, OA is a disease characterized by variable airflow limitation and/or airway hyperresponsiveness due to causes and conditions attributable to a particular occupational environment and not to stimuli encountered outside the workplace

Bernstein IL, Bernstein DI, Chan-Yeung M, Malo JL. Definition and classification of asthma. In: Asthma in the workplace. Bernstein IL, Chan-Yeung M, Malo JL, Bernstein DI, editors. New York: Marcel Dekker; 1999. p. 1–3.

Chan-Yeung M, American College of Chest Physicians. Assessment of asthma in the workplace: ACCP consensus statement. *Chest* 1995;108: 1084–1117.

OA is defined as asthma caused by work exposure

American Thoracic Society. Guidelines for assessing and managing asthma risk at work, school, and recreation. *Am J Respir Crit Care Med* 2004;169:873–881.

Some of the Most Common Workplace Sensitizers to Which Workers in Various Jobs May Be Exposed

Sensitizer*	Occupation
Diisocyanates	Painters, automotive workers, manufacture of rigid or flexible polyurethane foam and glues, insulation installers
Dusts from woods, phenol formaldehyde resins, diisocyanates in glues	Woodworkers, carpenters, forest workers
Natural rubber latex in gloves, glutaraldehyde, formaldehyde, penicillin and other aerosolized or powdered medications, methyl methacrylate	Health care workers
Anhydrides	Users of plastics
Epoxy compounds in spray paints	Automotive workers
Animal, plant, insect, and fungal allergens	Farmers and gardeners
Enzymes or cleaning agents	Cleaners and laboratory workers
Food or animal protein allergens (e.g., egg proteins, wheat, fungal amylase)	Food processors and animal workers
Flour dust	Flour mills, bakeries
Persulfate	Hairdressers
Solder flux containing pine products	Electronic workers
Metal dusts, fumes (e.g., cobalt, chromium, nickel, platinum salts)	Welders, other metal workers, platinum-refining workers

* More than 300 sensitizers have been reported to induce occupational asthma. Lists are available in textbooks (17, 66), review articles (67–70), and websites (e.g., www.asmanet.com; www.asthme.csst.qc.ca) (71, 72).

State of the Art Occupational Asthma

Am J Respir Crit Care Med Vol 172. pp 280–305, 2005

Why Diagnosis of OA is Important?

- Wrong advise based on medical impression without objective testing cause

  workers to remain exposed to offending agent(s) leading to worsening asthma or death

- Unnecessary removal from a job

  with considerable financial consequences if there is no OA

Eur Respir J 2003; 21: 879–885

“The clinician should always consider the possibility that asthma may have an occupational etiology, not only in new patients, but also in well-known asthmatics.”

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Main Forms of Work-related Asthma

Characteristics

Characteristic	Occupational asthma: Immunologic OA (Sensitizer-induced)	Occupational asthma: Irritant-induced OA	Aggravation of Preexisting or Coincident Asthma
Clinical and occupational history			
Asthmatic symptoms	Yes	Yes	Yes
Onset	During working life	Within 24 h of exposure to high levels of a respiratory irritant‡	Before or during working life
Relation to work	Symptoms worsen during the working day, and may improve away from work	Reexposure to the same exposure conditions as occurred in the acute incident is not recommended; persistence of symptoms for at least 12 wk	Symptoms worsen while at work
Other characteristics	Exposure to a known sensitizer	No previous diagnosis of asthma or other chronic lung diseases	Presence in the workplace of triggers of asthma, such as dusts, fumes, cold air, smoke, or exercise
Investigation			
Confirm asthma and work relationship			
Lung tests	Objective evidence of asthma*	Objective evidence of asthma*	Objective evidence of asthma*
Serial PEFR plus symptoms and medication diaries	Worse during periods of regular work than when off work	No changes unless the irritant is also a sensitizer	Worse during periods of regular work than when off work
Methacholine challenge	Airway hyperresponsiveness usually present; often worse at the end of a work week than at the end of a holiday period	Airway hyperresponsiveness usually present	Airway hyperresponsiveness usually present; no difference between work periods and when off work
Specific challenge	Positive response to the causal agent	Not feasible	—
Immunologic tests	Positive response to the sensitizer	—	—
Induced sputum test	Eosinophilia, ECP increase during periods of work exposure	Not investigated **NO EOSINOPHILIA**	Baseline eosinophilia, no further increase after exposure to a sensitizer at work
Assess exposure	Review MSDS† and patient's history to confirm exposure to a respiratory sensitizer in the workplace	Review patient's history to confirm temporal relationship between exposure to large quantities of a respiratory irritant and onset of asthma, usually requiring "medical attention"§	Review patient's history to confirm temporal relationship between exposure to dust, fumes, smoke, or exercise and respiratory symptoms

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“Occupational asthma
may be found in very many jobs,
not only in industry but also in
agriculture and the service industry.”

“Occupational asthma does not
necessarily mean
asthma AT work,
but
asthma FROM work.”

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To Detect Occupational Asthma

it is not appropriate, nor sufficient, to ask

“is your asthma worse at work?”
it is more efficient to ask

“does your breathing get better during the weekend or holiday?”

Burge PS. Br J Dis Chest 1987; 81: 105–115

Diagnostic Approach Occupational Asthma

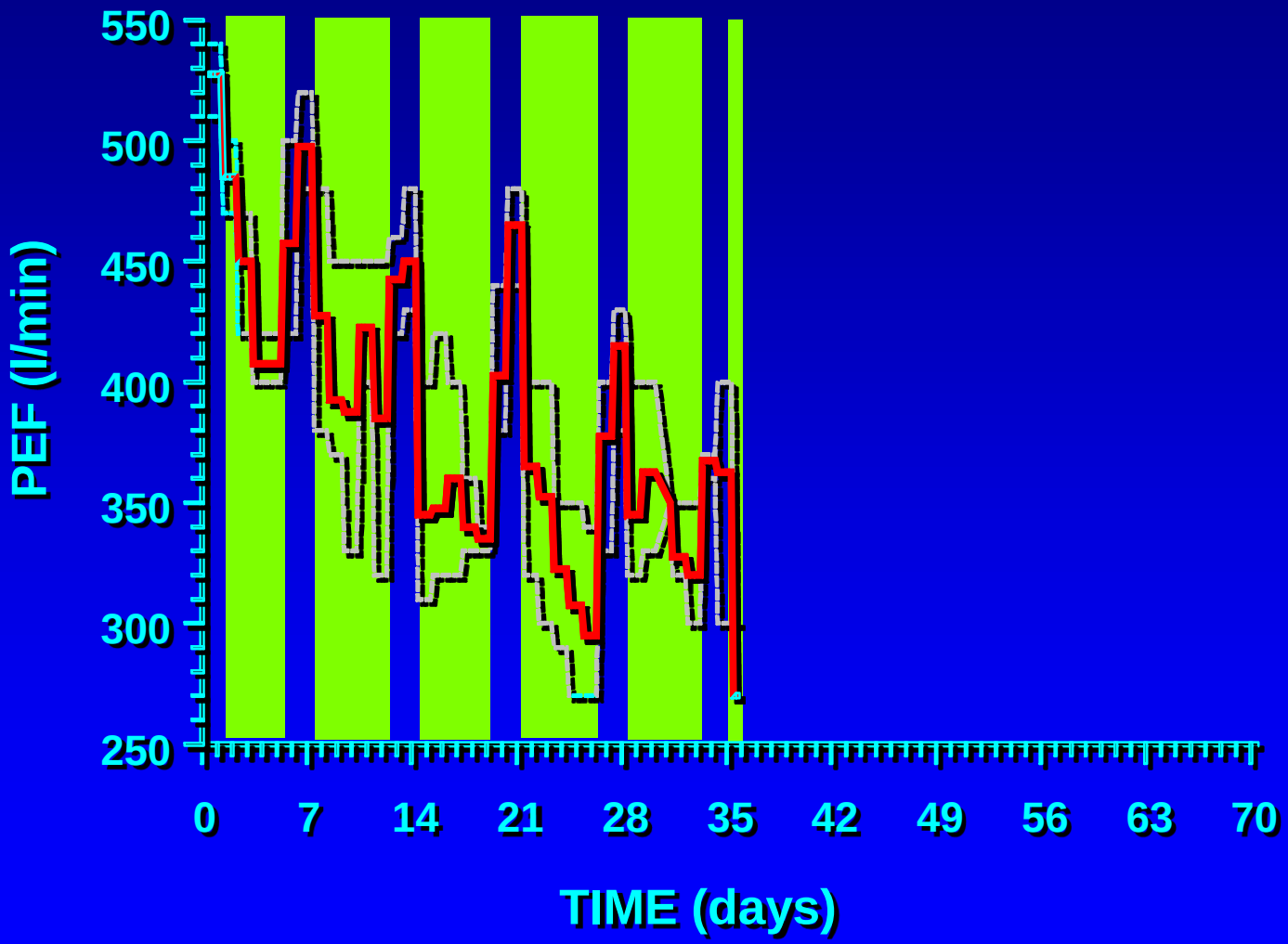
- The easiest way to document work-relatedness of asthma is to *do a "stop and-resume work" test*
- Monitor patient for
  - Changes in respiratory symptoms
    (*e.g*. using an asthma severity symptom score)
  - Medication need
  - Spirometry; sequential measurements of peak-flow
  - Non-specific bronchial responsiveness (good quantification of degree of hyperresponsiveness, PC20)

How to Identify Cause of Occupational Asthma

- Ask the worker to provide the Material Safety Data Sheets (MSDS) or labels of the products used
- Demonstrate sensitization against a particular substance (does not constitute proof that asthma is effectively caused by this sensitizer)

- Do a specific bronchial provocation test, the “gold standard” for definitive identification of the cause

Male, 41y,
Operative in Polyurethane Factory



OA Management

Optimizing Patient's Status as Productive and Functional Individual

- Accommodation: work modification to allow continuation of work
- Prompt and strict exposure control to control symptoms and reduce likelihood of permanent AHR
- Hierarchy of exposure controls to control trigger and exacerbations in workplace
- After exposure control, initiate work practices and job organization changes

Guidelines for Assessing and Managing Asthma Risk at Work, School, and Recreation

This official statement of the American Thoracic Society was approved by the ATS Board of Directors March 2003

Am J Respir Crit Care Med Vol 169. pp 873–881, 2004

Optimizing Patient's Status as Productive and Functional Individual

- Respiratory protection – prolonged or regular use should not be requested

- Periodic monitoring of symptoms and lung function as feedback assessment of exposure control efforts

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Work-aggravated Asthma

Management* to Allow Workers to Resume Work

- Reducing workplace exposure to respiratory irritants
- Limiting exposure to relevant environ allergens and nonoccupational irritants e.g., tobacco smoke
- Optimizing anti-asthma therapy
- Education patient on how to use drugs
- Emphasizing compliance

*Not sufficient to prevent relapse of true OA. Some workers may develop true OA due to new exposure to specific workplace agents.

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Definitions of Respirable Agents by Physical Form

Gas	A formless compressible fluid in which all molecules of the agent move freely at room temperature (25°C) and standard pressure (760 mmHg) to fill the space available
Vapour	Gaseous state of an agent which is normally liquid or solid at room temperature and standard pressure
Aerosol	Dispersion of solid or liquid particles of microscopic size in a gaseous medium. The following are all examples:
Dust	Dispersion of solid particles. Those of respirable size are not readily seen with the naked eye unless they are bathed in bright light
Fog	Dispersion of liquid particles generated by condensation from the vapour state
Fume	Dispersion of solid particles generated by condensation from the vapour state
Mist	Dispersion of liquid particles generated by condensation or mechanical means (e.g. nebulisation). The droplets are generally larger than those of a fog and may be visible individually to the naked eye
Smog	Mixture of smoke and fog: the former being the result of industrial pollution, the latter of natural climatic factors
Smoke	Dispersion of small particles (usually less than 0.1 µm diameter) resulting from incomplete combustion of organic substances

Highly Irritant Fumes and Gases: Mucosal Damage

Survivors are liable to develop:

- Bronchiectasis
- Bronchiolitis obliterans
- Pulmonary fibrosis