Introduction

- Recent decades have seen a marked increase in concern about the adverse health effects of hazardous exposures in the workplace and elsewhere in the environment.

- Endless array of hazardous substances in industrial and agriculture sectors.

- The lung – with its extensive surface area, high blood flow and thin alveolar epithelium – is an important site of contact with these substances in the environment.
Definitions

- Damage to the lungs caused by dusts or fumes or noxious substances inhaled by the workers in certain specific occupations is known as "Occupational Lung Diseases".

- Pneumoconiosis – the accumulation of the dust in the lungs and the tissue reactions to its presence.

- Dust – an aerosol composed of solid inanimate particles.
Importance of Occupational Lung Diseases

- Knowledge of cause may affect patient management and prognosis and may prevent further disease progression in the affected person.

- Establishment of cause may have significant legal, financial, and social implications for the patient.

- The recognition of occupational and environmental risk factors can also have important public health and policy consequences.

- Occupational and environmental lung diseases can also serve as important disease models.
**Global burden**

- Health burden: **2 million work related death per year.**
- Fatalities Attributable to work:
  - Circulatory diseases 23%
  - Respiratory diseases 7%
  - Cancer 32%
  - Contagious diseases 17%
  - Accidents and violence 19%
  - Other causes 2%

- **Tip of the iceberg:** **160 million nonfatal diseases.**

  # ILO Statistics 2002

- Occupational risk factors account for:
  - Injuries: 10%
  - Back pain: 37%
  - Hearing loss: 16%
  - Cancer:
    - lung: 10%
    - leukemia: 2%
  - Lung diseases:
    - COPD: 13%
    - Asthma: 11%
    - Silicosis, Asbestosis, CWP: 100%
Classification

Occupational lung diseases can be classified according to several schemes.

- Clinical presentation
- Type of exposure to agent
  - Organic dusts
  - Inorganic dusts
  - Metals
  - Biological factors
- Types of industry potentially associated with respiratory diseases
<table>
<thead>
<tr>
<th>Major Disease Category</th>
<th>Representative Causative Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper respiratory tract irritation</td>
<td>Irritant gases, solvents</td>
</tr>
<tr>
<td>Airway disorders</td>
<td></td>
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<tr>
<td>Occupational asthma</td>
<td></td>
</tr>
<tr>
<td>Sensitization</td>
<td></td>
</tr>
<tr>
<td>Low molecular weight</td>
<td>Diisocyanates, anhydrides, wood dusts</td>
</tr>
<tr>
<td>High molecular weight</td>
<td>Animal-derived allergens, latex</td>
</tr>
<tr>
<td>Irritant-induced, RADS</td>
<td>Irritant gases</td>
</tr>
<tr>
<td>Byssinosis</td>
<td>Cotton dust</td>
</tr>
<tr>
<td>Grain dust effects</td>
<td>Grain</td>
</tr>
<tr>
<td>Chronic bronchitis / COPD</td>
<td>Mineral dusts, coal</td>
</tr>
<tr>
<td>Acute inhalation injury</td>
<td></td>
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<tr>
<td>Toxic pneumonitis</td>
<td></td>
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<tr>
<td>Metal fume fever</td>
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<tr>
<td>Polymer fume fever</td>
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<tr>
<td>Smoke inhalation</td>
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<tr>
<td>Hypersensitivity pneumonitis</td>
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<tr>
<td>Infectious disorders</td>
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<tr>
<td>Pneumoconioses</td>
<td></td>
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<tr>
<td>Malignancies</td>
<td></td>
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<tr>
<td>Sinonasal cancer</td>
<td></td>
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<tr>
<td>Lung cancer</td>
<td></td>
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<tr>
<td>Mesothelioma</td>
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</tbody>
</table>

Note: RADS = reactive airway dysfunction syndrome; COPD = chronic obstructive pulmonary disease.
International Labour organization, Geneva.
List of occupational Diseases (2002)

1. Diseases caused by agents
   1.1 Chemical agents (32 items)
   1.2 Physical agents (8 items)
   1.3 Biological agents (infectious and parasitic diseases contracted in an occupation where there is a particular risk of contamination)

2. Diseases by target organ systems
   2.1 Occupational respiratory diseases
   2.2 Occupational skin diseases
   2.3 Occupational musculoskeletal disorders
3. Occupational cancer (15 items)

(Asbestos, Benzidine and compounds, Bischloromethyl ether, chromium and compounds, coal tar, beta- naphthylamine, Vinyl chloride, Benzene, Toxic nitro- and amino derivatives of benzene, Ionizing radiations, Tar, pitch bitumen, mineral oil, and related compounds, coke oven emission, wood dust)

4. Other diseases

4.1 Miner’s nystagmus
2.1 Occupational respiratory diseases

- 2.1.1 Pneumoconioses caused by sclerogenic mineral dusts
- 2.1.2 Bronchopulmonary disease caused by hard-metal dust
- 2.1.3 Bronchopulmonary disease caused by cotton, flax, hemp or sisal dust
- 2.1.4 Occupational asthma
- 2.1.5 Extrinsic allergic alveolitis
- 2.1.5 Siderosis
- 2.1.6 Chronic obstructive pulmonary diseases
- 2.1.7 Diseases caused by aluminium
- 2.1.9 Upper airways disorders
- 2.1.10 Any other respiratory disease not mentioned in the proceeding items caused by an agent where the casual relationship is established.
**Basic principles of occupational lung diseases**

Certain principles apply broadly to the full range of occupational respiratory disorders.

- While a few environmental and occupational lung diseases may present with pathognomonic features, most are difficult to distinguish from disorders of nonenvironmental origin.

- A given substance in the workplace or environment can cause more than one clinical or pathologic entity.
The etiology of many lung diseases may be multifactorial and occupational factors may interact with other factors.

The dose of exposure is an important determinant of the proportion of people affected or the severity of disease.

Individual differences in susceptibility to exposures do exist.

The effects of a given occupational or environmental lung exposure occur after the exposure with a predictable latency interval.
Pathogenesis

The effects of an inhaled agent depend on many factors:

- its physical and chemical properties
- the susceptibility of the exposed person
- the site of deposition within the bronchial tree
Physical properties

- physical state (solid particulates, mist, vapor and gases)
- solubility
- size, shape and density
- concentration
- penetrability
- radioactivity
- Chemical properties
  - alkalinity and acidity
  - fibrogenicity
  - antigenicity

- Susceptibility of exposed person
  - Integrity of local defense mechanisms
  - Immunological status (atopy, HLA type)
  - Airway geometry
Site of deposition

When airborne particles come in contact with the wall of the conducting airway or a respiratory unit they do not become airborne again.

Governs the lung response substantially

Mechanisms of dust deposition:
- Sedimentation
- Inertial impaction
- Diffusion
- Interception
- Electrostatic precipitation
<table>
<thead>
<tr>
<th>Size of particle</th>
<th>mechanism of deposition</th>
<th>site of deposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large particles</td>
<td>Sedimentation and inertial impaction</td>
<td>Nose, trachea and conducting airways</td>
</tr>
<tr>
<td>(6 – 25 um)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smaller particles</td>
<td>diffusion</td>
<td>gas exchanging portions of lungs</td>
</tr>
<tr>
<td>(0.5 – 6um)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particles of &lt; 1 um</td>
<td>diffusion</td>
<td>most of them exhaled out,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;10% of them deposited in alveoli</td>
</tr>
</tbody>
</table>
Diagnostic criteria

- The clinical presentation and workup are consistent with the diagnosis.

- A casual relationship between the exposure and the diagnosed condition has been previously established or strongly suggested in the medical, epidemiologic or toxicologic literature.

- There is sufficient exposure to cause the disease.
The details of the particular case, such as the temporal relationship between exposure and disease, are consistent with known information about the exposure-disease association.

There is no other, more likely diagnosis.
Determination of casual relationship

Three main types of information can be used to establish a casual relationship between an exposure and a respiratory condition:

- Case series or reports
- Epidemiologic studies
- Toxicologic studies
Clinical approach to the patient

There are two important phases in the workup of any patient with a potential occupational or environmental lung disease.

1. General approach: To define and characterize the nature and extent of the respiratory illness, regardless of the suspected origin.
   - A detailed history
   - Physical examination
   - Appropriate diagnostic tools
2. To determine the extent to which the disease or symptom complex is caused or exacerbated by an exposure at work or in the environment.

**Occupational and environmental history** – single most helpful tool in the diagnostic workup
**Occupational and environmental history**

- **Employment details**
  - Job title
  - Type of industry and specific work
  - Name of employer
  - Years employed

- **Exposure information**
  - General description of job process and overall hygiene
  - Materials used by worker and others
  - Specific workplace exposures
  - Ventilation / exhaust system
  - Use of respiratory protection
  - Industrial hygiene informations provided by the employer to the employee.
- **Environmental nonoccupational factors**
  - Smoking
  - Diet
  - Hobbies
  - Pets

- **Details about past employments in chronological order**

- **Other details**
  - Does the patient think symptoms / problem is related to anything at work?
  - Are other workers affected?
  - Work absenteeism
  - Prior pulmonary problems and medications used
Physical examinations

- Generally unrevealing about specific cause.

- It is most helpful in ruling out nonoccupational causes of respiratory symptoms or diseases (cardiac problems or connective tissue disorders).
Diagnosis
Chest radiography

- It is the most important diagnostic test for occupational lung disease.

- Under certain circumstances, the chest radiograph can be unique or highly suggestive of an occupational disorder and may be sufficient, along with an appropriate exposure history, to establish a diagnosis.
Silicosis
Asbestosis
Limitations:

- The chest radiographic findings can be nonspecific.

- Conventional chest radiography is insensitive, missing as many as 10 to 15 percent of cases with pathologically documented disease.

- Interpersonal variations
**ILO – International Classification of radiographs of pneumoconiosis 1971.**

- To evaluate chest radiographs for epidemiologic studies, clinical evaluation and screening.

- The system require a PA radiograph and comparison to a standard set of radiographs
**ILO – International Classification of radiographs of pneumoconiosis 1971.**

- **Film quality:** Grades I to IV

- **Small opacities:**
  - Round opacities:
    - p (<1.5mm)
    - q (1.5 – 3mm)
    - r (3–10mm)

- Irregular opacities:
  - s (<1.5mm)
  - t (1.5 – 3mm)
  - u (3 – 10mm)
Profusion:

**Category 0:** small rounded opacities absent or less profuse than in category 1.

**Category 1:** small rounded opacities definitely present but few in number.

**Category 2:** small rounded opacities numerous. The normal lung markings are still visible.

**Category 3:** small rounded opacities very numerous. The lung markings are partially or totally obscured.

- Large opacities:

**Category A**: one or more large opacities not exceeding a combined diameter of 5 cm

**Category B**: large opacities with combined diameter greater than 5 cm but does not exceed the equivalent of the right upper zone

**Category C**: bigger than B

- Pleural Abnormalities:
  - Location
  - width
  - extent
  - degree of calcification

- Other abnormal features: Symbols as prescribed by ILO.
<table>
<thead>
<tr>
<th>Film Quality</th>
<th>Grade 1-4</th>
<th>Comment made (y/n)</th>
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</thead>
<tbody>
<tr>
<td>Small Opacities</td>
<td>Profusion</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Shape and size</td>
<td></td>
</tr>
<tr>
<td>Large opacities</td>
<td>Presence (y/n)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size (A,B,C)</td>
<td></td>
</tr>
<tr>
<td>Pleural thickening</td>
<td>Chest wall</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Circumscribed Presence (y/n)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Face on (y/n)</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Width (a,b,c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extent (1,2,3)</td>
<td></td>
</tr>
<tr>
<td>Pleural thickening</td>
<td>Chest wall Diffuse Presence (y/n)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Face on (y/n)</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Width (a,b,c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extent (1,2,3)</td>
<td></td>
</tr>
<tr>
<td>Pleural thickening</td>
<td>(Diaphragm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Presence (y/n)</td>
<td>R</td>
</tr>
<tr>
<td>Costophrenic Angle Obliteration</td>
<td>Presence (y/n)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>Pleural Calcification</td>
<td>Presence (y/n)</td>
<td>R</td>
</tr>
<tr>
<td>Chest wall</td>
<td>Diaphragm</td>
<td>Other</td>
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<tr>
<td>Symbols</td>
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<td></td>
</tr>
<tr>
<td>Comments</td>
<td>Made (y/n)</td>
<td></td>
</tr>
</tbody>
</table>
Computed tomography

- Conventional and HRCT scanning are highly sensitive for diagnosis of pleural diseases and useful for improved visualization of parenchymal abnormalities.

- HRCT findings are usually non-specific, but occasionally certain features and distribution pattern may suggest a specific cause and may help narrow the differential diagnosis.
PA radiograph (left) which shows a localized area of pleural thickening along the left lateral chest wall (A). HRCT scan (right) shows an area of "rounded atelectasis" (B) that is contiguous with a large pleural plaque.
Asbestosis
Chronic beryllium disease
Hypersensitivity pneumonitis (Farmer’s Lung)
Physiological methods

- The most important tool to assess functional respiratory status in patients with occupational lung disease.

- Generally not specific but useful in
  - Evaluating dyspnoea of various causes.
  - Differentiating obstructive from restrictive defects.
  - Assessing the degree of pulmonary impairment.
Methods

- Spirometry
- Lung volumes
- Diffusing capacity
- Methocholine challenge test
- Preshift and postshift FEV1 measurements
- Serial measurements of peak expiratory flow rates
- Specific inhalation challenge tests
Cardiopulmonary exercise testing

- Used to assess functional impairment and disease progression
- Can help distinguish among cardiac, pulmonary and deconditioning causes of dyspnoea.
- Not helpful in determining the specific origin of the lung diseases.
Pathologic examination

Methods used to obtain specimens for pathologic examination

- Bronchoscopy
- Thoracoscopy
- Open lung biopsy
Bronchoalveolar lavage

- A predominance of lymphocytes suggests certain diagnoses such as sarcoidosis, hypersensitivity pneumonitis or beryllium disease (but is not by itself diagnostic).

- The diagnosis of beryllium disease can be established with the finding of a positive lymphocyte transformation in the BAL cells of exposed patients.

- Characteristic multinucleated giant cells may be seen in the BAL fluid of patients with hard-metal lung disease.
Transbronchial lung biopsies

- TBLB yield only small tissue samples that may be adequate to diagnose disorders such as interstitial fibrosis, but are often unable to shed light on the reason for the pathology that is noted.

- They are most helpful in diagnosing granulomatous interstitial diseases such as sarcoidosis, beryllium disease and hypersensitivity pneumonitis and diffuse malignant processes.
Asbestosis
Chronic Beryllium Disease
Hard-metal disease
Hypersensitivity pneumonitis
Methods used to analyze dust content of lung tissue

- Light microscopic evaluation with polarization
- Radiographic fluorescence scanning electron microscopy
- Energy dispersion radiographic spectroscopy
Asbestos fibre seen under polarized light microscope
Limitations

- Only particulates that are insoluble and retained in tissue at sufficient concentration will be detected.

- These methods can be tedious and there can be significant differences in results from different laboratories.

- Most importantly, a positive finding documents biologically detectable exposure but does not demonstrate disease or establish a casual relationship.
Impact of diagnosis

- **For the clinician**: important social, economic, legal and public health considerations.

- **For the patient**: a profound impact on the work, income and social situation.
Prevention
Prevention – central to the practice of occupational and environmental medicine.

Two main strategies:

- **Primary prevention** – removal or modification of hazardous risk or exposure before disease has occurred.

- **Secondary prevention** – early detection and prompt treatment of adverse effects of the exposure.
The various measures for the prevention of occupational diseases may be grouped as:

- Medical measures
- Engineering measures.
Medical measures

- Pre-placement examination
- Periodical examination
- Medical and health care services
- Notification
- Supervision of working environment
- Maintenance and analysis of records
- Health education and counselling
Engineering measures

- Design of building
- Good housekeeping
- Ventilation and exhaust systems
- Mechanization
- Substitution
- Dust control
- Enclosure / isolation
- Protective devices
- Environmental monitoring
- Statistical monitoring
- Research
Respirators

- Mask respirator
- Canister and cartridge Respirators
Respirators

- Powered air purifying respirators
- Self contained breathing apparatus
Ventilation and exhaust systems

- Electrostatic filtration system
- Fume extractor system
Impairment assessment
Impairment Assessment guidelines used for calculating pulmonary disability of affected workers.

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 25% Impairment</td>
<td>26% - 50% Impairment</td>
<td>51% - 75% Impairment</td>
<td>76% - 100% Impairment</td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>Does not occur at rest and seldom occurs during the performance of the usual activities of daily living. The patient can keep pace with persons of same age and body build on the level without breathlessness but not on hills or stairs</td>
<td>Does not occur at rest but does occur during the usual activities of daily living. However, the patient can walk a mile at his own pace without dyspnoea although he cannot keep pace on the level with others of the same age and body build</td>
<td>Occurs during such activities as climbing one flight of stairs or walking 100 yards on the level, on less exertion, or even at rest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FEV₁</th>
<th>&gt; 80% of predicted</th>
<th>60 - 79% of predicted</th>
<th>51 - 59% of predicted</th>
<th>&lt; 50% of predicted</th>
</tr>
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<tbody>
<tr>
<td>AND</td>
<td>OR</td>
<td>OR</td>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>FVC</td>
<td>&gt; 80% of predicted</td>
<td>60 - 79% of predicted</td>
<td>51 - 59% of predicted</td>
<td>&lt; 50% of predicted</td>
</tr>
<tr>
<td>AND</td>
<td>OR</td>
<td>OR</td>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>(FEV₁/FVC) x 100</td>
<td>&gt; 75% of predicted</td>
<td>60 - 74% of predicted</td>
<td>41 - 59% of predicted</td>
<td>&lt; 40% of predicted</td>
</tr>
</tbody>
</table>

Recommended by OHSC, Mumbai.
Indian scenario
Past two decades have seen a rapid growth in the industrial and agricultural sector.

However, new economic policies and globalization of world trade have resulted in certain downfalls especially in industrial sector

- Shutdown of major industries
- Emerging small illegal production units

The diagnosis and follow-up of occupational diseases are to be looked at in this background where survival is at stake and workers’ morale for struggle is low
**Major hurdles**

- Poor training in OEH.
- Bias of the professional class against the workers
- Studies done on workers not available to anyone except to the select few who are conducting the study.
- Medical certification not given to workers easily.
- Disability certification, which is required for compensation, not understood by doctors and hence not given to workers.

# Murlidhar.V, Demystifying occupational and environmental health: experience in India, PRIA publication.
Difficult access to the Internet due to shortage of resources.

All information being in English (some Latin and Greek), there is a serious difficulty in understanding the language.

Under funded workers insurance system (the ESI), and understaffed and poorly trained personnel and also general apathy among the staff of ESI scheme.

Lawyers (pro-worker) having poor knowledge of many progressive legislations in OEH.
Legislations

- The Factories Act, 1948
- The Employees’ State Insurance Act 1948
- The Mines Act
- The Plantation Act
- The Minimum Wages Act
- The Maternity Benefit Act
The Factories Act, 1948

- **The First Schedule** – List of industries involving hazardous processes

- **The Second Schedule** – Permissible levels of certain chemical substances in work environment

- **The third schedule** – List of notifiable diseases

Silicosis
Asbestosis
Coal miner’s pneumoconiosis
Byssinosis
Berylliosis
Various radiation induced diseases
Occupational cancers
Chrome ulcerations and sequelae
Carbon monoxide poisoning
Isocyanates poisoning
Organizations involved in occupational Health

- Directorate General, Factory Inspection and Advisory Services, Ministry of Labour, Govt. of India
- Central Labour institute, Mumbai
- Regional Labour Institutes at Kanpur, Kolkata and Chennai.
Research Institutes

- The Central Mining and Research Station, Dhanbad (CSIR)
- Industrial Toxicology Research Centre, Lucknow (CSIR)
- Occupational Health Research Institute, Ahmedabad (ICMR)
- National Environmental Engineering Research Institute, Nagpur
- All India Institute of Hygiene and Public Health, Kolkata
All the best..