Environmental Pathology

By

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Never does a man portray his character more vividly than when he is proclaiming the character of another…!

Winston Churchill
1874-1965, Former British Prime Minister
Pathology

An Introduction....
Clinical

Bridging Subject

Foundation
### Medical Knowledge

<table>
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<td>Epidemiology</td>
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<td>Etiology</td>
<td>What is the cause?</td>
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When we know “Where, Why, When & What”
then we can answer the all important question
How (to *solve*)
What is Disease?

• dis + ease (not at ease…)

WHO def. Complete physical, mental and social well being not merely absence of disease…

“Expression of discomfort due to structural or functional abnormality”

What is normal? “norm”
Disease Types

Inflammatory / Neoplastic / Degenerative •

Acute / Chronic •

Acute – short days to weeks. –

Chronic – long – months to years. –

Congenital / Familial / Acquired •

Genetic / Environmental •

Mild / Moderate / Severe •
Disease & Person

Physical / Mental

Disease can cause Stress & stress causes disease.

“Person is more important than disease”

“Pat on the back” helps more often than medicine. — I care…!
Pathology

“Scientific Study of Disease”

Study of what is abnormal or wrong or disease…!

Normal → Abnormal → Treat

Diagnosis of disease is the aim of clinical pathology *

Without diagnosis….Quackery…!
What is Diagnosis?

The formal name(s) used to describe a patient’s disease.

Based on the symptoms & Signs and the results of Pathology tests

Needs Knowledge of different diseases, their characteristics.

Important for management & knowing prognosis.
"Is the foundation of medical science and practice. Without pathology, the practice of medicine would be reduced to myths and folklore"
History of Pathology

“animism” – Philosophies of Plato – God/devil

Magic – Primitive thoughts

Humors – Phlegm – excess/def – c300

Abiogenesis – Spontaneous – to c1800

Environmental – Modern - from 1850.

Genetic – Molecular – from 20th century
In the past, people mistook magic for medicine...

Now people mistake medicine for magic....!
Scope of Pathology

Clinical Pathology •
Experimental Pathology •
Molecular Pathology •
Forensic Pathology •
Chemical / Microbiology •
Immunopathology •
Genetics & Disease.
Subdivisions of Pathology

- Histopathology
- Cytopathology
- Haematology
- Microbiology
- Immunology
- Chemical Pathology
- Genetic Pathology (pathogenetics)
- Toxicology
- Forensic Pathology
Please God - If you can't make me thin

make my friends fat!!
Learning Pathology

General Pathology •
Common changes in all tissues—
e.g. Inflammation, cancer, aging •

Systemic Pathology •
Specific changes in organs.—
e.g. Goiter, pneumonia, breast cancer. •
“While much still needs to be uncovered to link abnormal genes and the expression of disease, gone are the time when the mechanisms of most diseases were unknown? or obscure? or mysterious?”
One agent $\rightarrow$ One disease - Malaria
Several agents $\rightarrow$ One disease - Diabetes
One agent $\rightarrow$ Several diseases - Smoking
Etiology: What is the cause?

Environmental agents:
- Physical
- Chemical
- Nutritional
- Infections
- Immunological
- Psychological

Genetic Factors:
- Age
- Gender

Multifactorial: Diabetes, Hypertension, Cancer
Causes of cell injury and disease

- Oxygen deprivation (hypoxia, ischemia)
- Nutritional imbalances
- Physical agents
- Chemical agents and drugs
- Infectious agents
- Immunologic reactions
- Genetic derangements
Pathogenesis: Development

“Sequence of events in the response of cells & tissues to a stimulus/pathogen” starting from the initial stimulus to the ultimate expression of disease.”

Gross and microscopic Structure, Function, Chemical & molecular mechanisms.
Morphology: Structure Change

- Structural changes in disease.
  - Tumor in a cancer.
  - Ulcer in a infection.
  - Atrophy is dementia.

- Gross & Microscopic.
Clinical Significance

Patient Signs and symptoms are related to underlying pathology…

Why a malaria patient has fever? — Why not diarrhea? —

Prognosis of disease depends on inside pathology.

What treatment is suitable for this patient?

Is he going to recover or die soon?
Classification of Diseases

- **Developmental / Metabolic** — hereditary, congenital.
- **Inflammatory** — infections, immune, etc.
- **Neoplastic** — tumors, cancers
- **Degenerative / Functional** — aging.
- **Environmental / Occupational** — toxicities, trauma
Sample Patient Case:
Clinical Details:

34 year male. •
Neck swelling, 2-3 months. •
Fever, weight loss. •
no other abnormality. •
Biopsy of mass done. •
Right neck mass

- Temp 39.2
- ESR – 120 mm/h
- LDH – High
- Hb – 7.2
- Sugar - normal.
- Bilirubin - High
- WBC – 28,370
- Lymphocytes 78%
- Biopsy of mass done.
Lymph node Biopsy

- Diffuse tumour
- Capsule
Lymph node Biopsy

• Large cells
• Mitotic figures
Lymphoma / T NHL

- Enlarged lymph nodes
- Fever, weight loss
- Loss of lymph node architecture
- Large cells with less cytoplasm
- Diffuse pattern – no follicles
- Plenty of mitotic figures
- T-cell NHL – malignant lymphoma
Pathology Summary:

“Scientific Study of Disease” •
Scope of Pathology •
Subdivisions of Pathology •
Study of Pathology •

Etiology: What causes disease? —
Pathogenesis: How does disease develop? —
Morphology: Structural change in disease? —
Clinical Significance: Link to clinical F? —
I hear, I forget
I see, I remember
I do, I understand

Chinese Proverb..
1-What is this scar tissue caused by?
silicosis
2-Which substance is likely to produce this lesion?
Asbestos
3-This lesion is called..........

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Silicotic nodule
4-Simple Coal Workers’ Pneumoconiosis frequently leads to PMF?

True •
false •
5-Golden brown, fusiform, beaded rod with Fe containing proteinaceous material derived from phagocytes’ ferritin is seen in……?
Asbestosis
6-Caplan syndrome is the coexistence of pneumoconiosis with ........?

SLE
RA
RHEUMATIC HEART DISEASE
TB
7-Granulomatous reaction is seen in which type of pneumoconiosis?
Berylliosis
8-In Berylliosis Granulomatous reaction is seen exclusively in lungs?

True
False
9-Increased risk of T.B or lung cancer is associated with coal workers’ pneumoconiosis?

TRUE
FALSE
10-Which abnormality is caused by Maternal smoking?

1- Spontaneous abortion
2- Preterm births
3- IUGR
4- All of the above
11-What is this lesion called?
Complicated CWP or PMF
12-The fibrocalcified nodules on diaphragm is seen in....?
Asbestosis
13-Vinyl chloride causes?
Liver angiosarcoma
14-Concomitant smoking increases risk of mesothelioma?

True
False
1-In adults, wrist & foot drop are due to.....toxicity

1-heroin •
2-lead •
3-alcohol •
4-Acetaminophen •
2-Basophilic stippling of RBCs is seen in poisoning due to:

1. carbon monoxide
2. lead
3. aspirin
4. cocaine
3-All members of a family were found dead. Autopsy showed: cherry-red skin & mucosae, brain edema & hemorrhage. What is the cause?

1-lead poisoning •
2-carbon monoxide •
3-alcohol •
4-heroin •
4-What is the pathology due to?
5-Which drug of abuse is a sympathomimetic?

1-heroin •
2-cocaine •
3- Marijuana •
4-morphine •
6-What is this lesion?
Abrasion
7-What is this liver biopsy showing?
8-Describe the difference between these two types of wounds

A

B

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9-A Full-thickness burn is not.....

1- Pink, mottled, painful •
2- Anesthetic •
3- III & IV degree •
4- White, charred or dry •
Which cells are resistant to radiation?

1. Gastrointestinal tract cells
2. Lymphocytes
3. Red blood cells
4. Granulocytes
Finding the answers is fun!
Environmental Diseases

- Physical
- Chemical
- Occupational
- Nutritional
Air Pollution
Outdoor Air Pollution

- Smog, major particulates
- Ozone, highly reactive & irritant
- Nitrogen & sulphur dioxide, form acids & irritate
- Carbon monoxide (asphyxia)
- Lead
- Particulates (plaster, asbestos)
Outdoor Air Pollution

- Hazardous particles < 10 µm reach airspaces & release mediators
- Pollutants act in combination to amplify their effects (ozone & particulates)
- Lung injury types:
  - Inflammation, emphysema, asthma, hypersensitivity, pneumoconiosis, neoplasia
Indoor Air Pollution

- Tobacco
- Carbon monoxide
- Wood smoke
- Radon → Lung ca
- Asbestos → Lung ca & mesothelioma
- Bio aerosols: pet dander, dust mite, fungi, viruses
Industrial Exposures

- Many symptoms due to various organic agents:
  - Acute exposure to vapours: coma
  - Polycyclic hydrocarbons: lung, bladder cancer
  - Vinyl chloride: liver angiosarcoma
  - Metals: lead
  - Arsenic, chromium, nickel: lung cancer
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<th>Organ/System</th>
<th>Effect</th>
<th>Toxicant</th>
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</thead>
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<tr>
<td>Cardiovascular system</td>
<td>Heart disease</td>
<td>Carbon monoxide, lead, solvents, cobalt, cadmium</td>
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<tr>
<td></td>
<td>Nasal cancer</td>
<td>Isopropyl alcohol, wood dust</td>
</tr>
<tr>
<td>Respiratory system</td>
<td>Lung cancer</td>
<td>Radon, asbestos, silica, bis(chloromethyl)ether, nickel, arsenic, chromium, mustard gas</td>
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<tr>
<td>Nervous system</td>
<td>Chronic obstructive lung disease</td>
<td>Grain dust, coal dust, cadmium</td>
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<tr>
<td></td>
<td>Hypersensitivity</td>
<td>Beryllium, isocyanates</td>
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<tr>
<td></td>
<td>Irritation</td>
<td>Ammonia, sulfur oxides, formaldehyde</td>
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<td></td>
<td>Fibrosis</td>
<td>Silica, asbestos, cobalt</td>
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<td></td>
<td>Peripheral neuropathies</td>
<td>Solvents, acrylamide, methyl chloride, mercury, lead, arsenic, DDT</td>
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<td></td>
<td>Ataxic gait</td>
<td>Chlordane, toluene, acrylamide, mercury</td>
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<td></td>
<td>Central nervous system depression</td>
<td>Alcohols, ketones, aldehydes, solvents</td>
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<td></td>
<td>Cataracts</td>
<td>Ultraviolet radiation</td>
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<tr>
<td>Urinary system</td>
<td>Toxicity</td>
<td>Mercury, lead, glycol ethers, solvents</td>
</tr>
<tr>
<td></td>
<td>Bladder cancer</td>
<td>Naphthalamines, 4-aminobiphenyl, benzidine, rubber products</td>
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<tr>
<td>Reproductive system</td>
<td>Male infertility</td>
<td>Lead, phthalate plasticizers</td>
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<td></td>
<td>Female infertility</td>
<td>Cadmium, lead</td>
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<td></td>
<td>Teratogenesis</td>
<td>Mercury, polychlorinated biphenyls</td>
</tr>
<tr>
<td>Hematopoietic system</td>
<td>Leukemia</td>
<td>Benzene, radon, uranium</td>
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<tr>
<td>Skin</td>
<td>Folliculitis and aciform dermatosis</td>
<td>Polychlorinated biphenyls, dioxins, herbicides</td>
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<tr>
<td>Gastrointestinal tract</td>
<td>Cancer</td>
<td>Ultraviolet radiation</td>
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<td>Liver angiosarcoma</td>
<td>Vinyl chloride</td>
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<tr>
<td>Metal</td>
<td>Disease</td>
<td>Occupation</td>
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<tr>
<td>Lead</td>
<td>Renal toxicity</td>
<td>Battery and ammunition workers, foundry workers, spray painters, radiator repairers</td>
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<tr>
<td></td>
<td>Anemia, colic</td>
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<td>Peripheral neuropathy</td>
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<td>Insomnia, fatigue</td>
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<td>Cognitive deficits</td>
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<tr>
<td>Mercury</td>
<td>Renal toxicity</td>
<td>Chlorine-alkali industry workers</td>
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<td>Muscle tremors, dementia</td>
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<td></td>
<td>Cerebral palsy</td>
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<td>Mental retardation</td>
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<tr>
<td>Arsenic</td>
<td>Cancer of skin, lung, liver</td>
<td>Miners, smelters, oil refinery workers, farm workers</td>
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<tr>
<td>Beryllium</td>
<td>Acute lung irritant</td>
<td>Beryllium refinery workers, aerospace manufacturing workers, ceramics workers</td>
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<td>Chronic lung hypersensitivity</td>
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<td></td>
<td>? Lung cancer</td>
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<tr>
<td>Cobalt and tungsten carbide</td>
<td>Lung fibrosis</td>
<td>Toolmakers, grinders, diamond polishiers</td>
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<tr>
<td></td>
<td>Asthma</td>
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<tr>
<td>Cadmium</td>
<td>Renal toxicity</td>
<td>Battery workers, smelters, welders, soldering workers</td>
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<tr>
<td></td>
<td>? Prostate cancer</td>
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<tr>
<td>Chromium</td>
<td>Cancer of lung and nasal cavity</td>
<td>Pigment workers, smelters, steel workers</td>
</tr>
<tr>
<td>Nickel</td>
<td>Cancer of lung and nasal sinuses</td>
<td>Smelters, steel workers, electroplating workers</td>
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Pneumoconiosis

Mineral dust & organic or inorganic particulates, even fumes

- Non-neoplastic lung reaction
- Types:
  - Coal dust, silica, asbestos, beryllium
Pathogenesis

- **Size:**
  - 5-10 μm, unlikely to reach distal airways
  - 1-5 μm, most dangerous impact on distal airway bifurcation
  - <0.5 μm acts like gases

- **Reactivity:** coal dust almost inert
  - others more reactive
Pathogenesis

- Mucus blanket
- Macrophages, mediators, fibroblasts
- Free radicals: tissue damage
- Chemotactic agents: LTB4, IL8, IL6, TNF
- Fibrogenic cytokines: IL1, TNF, PDGF, IGF1
- Tobacco worsens their effects, particularly with asbestos
Coal Workers’ Pneumoconiosis (CWP)

- Asymptomatic anthracosis
- Simple CWP: no lung dysfunction with accumulation of macrophages
- Complicated CWP (PMF)
  - <10% of simple cases lead to PMF
  - Pulmonary HTN & Cor pulmonale
  - No increased risk of T.B or lung ca
Pulmonary Anthracosis

- Seen in coal miners, urban dwellers, smokers
- Alveolar or interstitial macrophages along lymphatic, lymphoid tissue or lung hilum
Simple CWP

- Coal Maculae & Nodules
- More notable in upper parts of lungs
- Later → Centrilobular Emphysema
Complicated CWP (PMF)

- Nodules coalesce after years
- Black Scars 2 -10 cm
- Dense collagen & pigment with central necrosis
Caplan Syndrome

- RA & pneumoconiosis coexist
- Rapidly developing nodules with central necrosis, palisade fibroblasts, plasma cells, macrophages & collagen
- Also seen with asbestos & silica
Silicosis

- Quartz most commonly implicated
- <5 μm particles reach distal airways
- ~1 μm particles cause fibrosis
- Acute form: high level exposure, rapid onset, cough, cyanosis, failure, silicoproteinosis
Silicosis

- Chronic (nodular) silicosis: prolonged exposure
  Upper zones, subpleural nodules
Silicosis

- Complicated (conglomerate) form:
  Nodules coalesce (>2 cm)
  PMF
- Others:
  T.B risk due to impaired CMI
  Caplan syndrome
  Carcinogen(lung), due to reactive oxygen
Advanced silicosis

- Upper lobe scar
- Pleural thickening
Silicoses nodules

- Pale to black in upper lobes
- Whorled, concentric collagen fibres
- Weakly birefringent centre
- Later hard scars form $\rightarrow$ PMF
- Honeycomb pattern of lung
- Eggshell lymph node (X-ray)
- Cor pulmonale with PMF
Silicoses nodules

- Coalescent
- Collagenous

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Asbestosis

- Crystalline hydrated silicates
  - Asbestosis: parenchyma fibrosis
  - Lung ca
  - Pleural effusion
  - Localized plaques
  - Mesothelioma
  - Laryngeal ca
Pathogenesis

- Serpentine, flexible & soluble
- Amphibole, stiff & penetrating tissue
- Diffuse fibrosis vs. silicoses nodules
- Tumour initiator & promoter
- Forming radicals near mesothelium
- Tobacco has synergy with asbestos
Morphological findings

- Diffuse interstitial fibrosis, DDx : IPF
- Asbestos bodies: golden brown, fusiform, beaded rod with Fe containing proteinaceous material derived from phagocytes’ ferritin
  Also found less frequently in nl people
- Honeycomb lung
  Begins in lower lobes & subpleurally
Morphological findings

- Pleural plaques, most common
  Dense collagen, calcium
  Parietal pleura & diaphragm domes
  Do not contain asbestos bodies
  Rare in people without prior exposure
Morphological findings

- Effusions
  - Serous or bloody
Asbestos body

- Beading
- Knobbed ends
Asbestosis

- Discrete nodules
- Fibrocalcification
Mesothelioma

- Thick
- Firm
- White
- Tumoral nodules

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Asbestos exposure

- Five-fold increase in lung cancer risk
- >1000-fold increase in mesothelioma risk
Concomitant smoking

- Increases lung ca risk greatly
- Doesn’t increase risk of mesothelioma
Clinical course

- Dyspnea after 10-20 yrs
- Productive cough
- May lead to CHF & death or may be static
- Caplan syndrome accelerates the course
- Pleural plaques have no symptoms
- Cancers have grim prognosis
Berylliosis

- Heavy exposure: acute pneumonitis
- Granulomatous reaction in long-term low-dose exposure, DDx: sarcoidosis
- CMI & MHC II involved
- Acts as a hapten → helper T cells
- Lesions also in spleen, liver, kidneys, adrenals, distant LN
Berylliosis

- Chronic cases:
  - Some stabilize
  - Others remit & relapse
  - Still others progress to failure
  - Heavy exposure increases cancer risk
TOBACCO SMOKE

- In the U.S 400,000 deaths/yr
- 1/3 of victims die of lung ca
Constituents

- Carcinogens: Tar, polycyclic aromatic hydrocarbons, Nitrosamine, Benzopyrene
- Impaired oxygen transport: Carbon monoxide
- Toxic to cilia: Formaldehyde, Nitrogen oxide
- Tumor promotion: Phenol, Nicotine
Pathogenesis

- Emphysema, chronic bronchitis
- Lung ca
- Atherosclerosis, MI (1/3 related to smoking)
  Plt aggregation, imbalanced supply & demand of O2, decreased VF threshold
Figure 8-7

Adverse effects of smoking: the more common on the left and the somewhat less common on the right.
Cessation of smoking

Reduces the risk of death within a year & that of lung ca for at least 15 years
Maternal smoking

- Spontaneous abortion
- Preterm births
- IUGR
Passive smoke inhalation

- Lung cancer 1.3 times more prevalent compared to those not exposed
- Also increases risk of MI
- More respiratory illnesses & asthma in children
MCQ 1

Which lesion starts from lower parts of the lung?

1- anthracosis
2- silicosis
3- asbestosis
4- all of the above
MCQ 2

Which metal has renal toxicity?
1-arsenic
2-chromium
3-nickel
4-cadmium
MCQ 3

- Whorled collagen fibres that are weakly birefringent are distinctive for which pulmonary lesion?
  - 1-anthracosis
  - 2-asbestosis
  - 3-silicosis
  - 4-berylliosis
Which of the following is NOT associated with smoking?

1-pancreatic ca
2-bladder ca
3-prostatic ca
4-peptic ulcer disease
THE END