Asbestos:  
The Range of Its Ill-Effects

Ezra Cohen, MS III  
Dr. Gillian Lieberman, MD  
Core Radiology Clerkship, BIDMC  
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Outline of Presentation

- Patient Presentation
- Anatomy
- Defining the disease
- Testing modalities and the spectrum of disease
- Patient follow-up
Patient Presentation
Our Patient: History

- 83 y/o male with history of high cholesterol referred to pulmonary clinic for follow-up on a computed tomography (CT) finding
- Worked as president of a company which imported asbestos in the 1950s and 1960s until 2000s with known heavy exposure
Our Patient: Review of Systems

- Denies all respiratory or cardiac symptoms
- Can walk 1-3 miles several times a week without difficulty
Our Patient: Past Medical History

- Past medical history
  - Melanoma status post (s/p) resection in February 2009
  - Subdural hematoma s/p burr hole drainage in June 2010
  - Paget’s disease
  - High cholesterol

- Medications
  - Lipitor 10 mg

- Allergies: none
Our Patient: Social History

Social History

- Drinks alcohol occasionally
- 32 pack-year smoking history, quit more than 30 years ago
- No known tuberculosis exposure
- Extensive travel through southeast Asia
Our Patient: Family History

- Family History
  - No family history of lung disease or lung cancer
Our Patient: Physical Exam and Spirometry

- Physical Exam
  - Vitals normal at rest with desaturation from 95% to 93% after 6 flights of stairs
  - General exam otherwise normal

- Spirometry
  - Notable for above-average forced expiratory volume in one second (FEV₁) and forced expiratory vital capacity (FVC)
Our Patient: Early Changes from Asbestos Exposure on Frontal Chest Radiograph

PA Chest Radiograph

Diffuse reticular pattern
Linear calcifications along diaphragm
Our Patient: Early Changes from Asbestos Exposure on Lateral Chest Radiograph

- Linear calcifications along diaphragm
Anatomy Review
Anatomy of the Lungs
Anatomy of the Lungs

WebMD. Available at http://www.ghi.com/WebMD/topics/pleura.jpg
Defining the Disease
Prevalence

- About 2-6 million people in the United States are estimated to have had significant levels of exposure
- Mortality was 6.73 per million persons in 2000 and now declining
- Average predicted death rate per year between 2005-2027 is 1,290 per year

1Ribak J, Ribak G. Human health effects associated with the commercial use of grunerite asbestos (amosite): Paterson, NJ; Tyler, TX; Uxbridge, UK. *Regul Toxicol Pharmacol*. Oct 11 2007


3National Institute for Occupational Safety and Health. Chest Radiography: B Reader Information for Medical Professionals. Centers for Disease Control
Pathogenesis

- Larger asbestos fibers (> 5 um) settle in the upper airways and are expelled by mucociliary clearance
- Smaller fibers settle in the lower airways where they penetrate cell membranes directly, stimulating fibrosis
Pleural Sensitivity

- Chrysotile (curved) fibers are the most common and are fibrogenic, amphibole (straight) are the most carcinogenic.
- The pleura is more sensitive to the parenchyma, and thus pleural disease is usually a harbinger.
Risk Factors

- History of exposure > 20 years prior
- Occupation as an insulation worker, pipefitter, boiler-maker, plumber, steamfitter and others
- Smoking history synergistically increases risk of mesothelioma and bronchogenic carcinoma
Clinical Manifestations

- Dyspnea on exertion is the most common symptom (followed by cough)
- Dry rales on clinical exam
- Finger clubbing
- Late findings of cor pulmonale: elevated jugular venous pressure, peripheral edema, right ventricular heave, and $S_3$
Making the Diagnosis

1) Exposure history with latency period of > 20 years
2) Fibrosis on chest radiographs, consistent physical exam findings, and evidence of a restrictive process on pulmonary function tests
3) Absence of other causes for fibrosis after reasonable search
Disease Course

- Usually leads to death due to respiratory failure 12-24 years after date of onset
- First radiographic sign: benign pleural plaques
Complications

- Diffuse pleural thickening
- Asbestosis
- Mesothelioma
- Bronchogenic carcinoma
- Cor pulmonale
Treatment

- Control of asbestos in the environment
- Smoking cessation
- Attention to new infections and vaccines against pneumococcus and influenza
- Oxygenation status and home oxygen if necessary
- Follow-up with a pulmonologist depending on disease severity
Radiologic Modalities and The Spectrum of Disease
Standard Imaging

- **CXR (Chest X-ray)**
  - 40-90% sensitivity for detecting interstitial fibrosis
  - Can visualize most of the complications

- **CT**
  - Criterion standard
  - Much more sensitive and specific than x-ray

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Lesser-Used Techniques

- MRI (Magnetic Resonance Imaging)
  - Limited role
- U/S (Ultrasound)
  - For pleural effusions, thickening and masses
- Nuclear imaging
  - $^{67}$Ga for distinguishing benign plaque from mesothelioma (increased uptake of marker in cells)$^1$

Let’s turn now to a companion patient for later changes of asbestos exposure…
Companion Patient #1: Moderate Changes from Asbestos Exposure on Frontal Chest Radiograph

- Linear calcifications along diaphragm
- Pleural plaque

PA Chest Radiograph

PACS, BIDMC
Companion Patient #1: Moderate Changes from Asbestos Exposure on Lateral Chest Radiograph

- Basilar fibrosis: “Spine Sign”
- Linear calcifications along diaphragm
Spine Sign on Lateral X-ray

- A positive lateral sign spine occurs with a basilar opacity.
- The thoracic spine should appear more lucent (black) as you descend.
- In this patient, the lowest thoracic vertebra is dense as labeled.
Companion Patient #1: Moderate Changes from Asbestos Exposure on Axial CT Scan

Axial CT Scan: Lung Windows

Pleural plaques
Companion Patient #1: Moderate Changes from Asbestos Exposure on Axial CT Scan

Pleural plaques
Benign Pleural Plaques

- Pleural plaques are the most common manifestation of asbestos exposure.
- Latency of 20-40 years.
- Composed of acellular collagen bundles that are woven together in the parietal pleura.
- Not pre-malignant.
Let’s turn now to this same patient a few years later...
Companion Patient #1: Late Changes from Asbestos Exposure on Frontal Chest Radiograph

Subpleural fibrosis
Linear calcifications along diaphragm

PA Chest Radiograph

PACS, BIDMC
Companion Patient #1: Late Changes from Asbestos Exposure on Lateral Chest Radiograph

Linear calcifications along diaphragm
Companion Patient #1: Late Changes from Asbestos Exposure on Axial CT Scan

Axial CT Scan: Lung Windows

Honeycombing

Pleural plaques
Companion Patient #1: Late Changes from Asbestos Exposure on Axial CT Scan

Pleural plaques
What do these new changes represent?
Differential for Basal Subpleural Fibrosis

- Asbestosis
- Idiopathic pulmonary fibrosis
- Drug-induced fibrosis (amiodarone, bleomycin)
- Collagen vascular disease (lupus, scleroderma-related)
- Many of the diffuse parenchymal lung diseases (DPLDs) and pneumoconioses
Differential for Basal Subpleural Fibrosis

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Asbestosis: Basics

- A kind of interstitial fibrosis with a relatively better prognosis than other DPLDs
- Latency period of 15-20 years
Asbestosis: Tissues Affected

- Occurs when asbestos fibers accumulate to 10 million per gram of tissue
- Begins in subpleural portions of the lung around bronchioles, and then progresses to alveolar walls causing thickened interlobular septa and honeycombing
Let’s turn now to another companion patient with more advanced asbestosis...
Companion Patient #2: “Shaggy Heart Border” Sign

“Shaggy heart border” sign

PA Chest X-Ray

Shaggy Heart Border Sign

When fibrosis progresses to the point of obscuring the heart border, this is called the “shaggy heart border” sign.
Here are some other complications of asbestos exposure...
Diffuse Pleural Thickening

- Inflammation and fibrosis of the visceral pleura lymphatics
- 15 year latency
- Not specific to asbestosis
- Causes fusion of visceral and parietal pleura (native pleurodesis)
Bronchogenic Carcinoma

- Bronchogenic carcinoma develops in 20-25% of heavily exposed workers
- Latency of 25-35 years
- Smoking raises relative risk from 5 to 90
- No correlation between severity of asbestosis and development of lung cancer
Mesothelioma: Basics

- A primary malignancy of the pleura
- 1.0-1.1 in 100,000 people present annually
- Latency period of 35-40 years
Mesothelioma: Prognosis

- Death generally occurs within 18 months of symptom onset
- There is no dose-dependent relationship between asbestos exposure and the likelihood of incidence
Let’s turn now to a third companion patient to look at the radiographic features of mesothelioma...
Companion Patient #3: Mesothelioma

Axial CT Scan: Soft Tissue Window

Enveloping mass in the pleura
Let’s return to our patient to determine treatment and follow-up…
Our Patient: Assessment

- He is asymptomatic and has minimal $O_2$ desaturation with exercise—no need for supplemental oxygen
- Full pulmonary function tests yearly
Our Patient: Plan

- No need for repeat CT scan unless patient becomes symptomatic.
- If mesothelioma develops, patient wishes not to receive surgical intervention.
References

- National Center for Health Statistics. Asbestosis: Death rates (per million population) by race and sex, U.S. residents age 15 and over, 1995–2004
References

Acknowledgements

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