Selected Topics

- Hemoptysis
- Bronchiectasis and bronchiolitis
- Solitary pulmonary nodule

Hemoptysis: Case Example

- 56 year-old man presents for evaluation of a lingering chest cold.
- He had the onset of cough and chest congestion 8 weeks ago. He expectorated discolored phlegm with blood streaks for several days. His cough persists, productive of small amounts of blood mixed with white phlegm.

Hemoptysis: Case Example (cont.)

- He smokes one pack of cigarettes per day and takes one aspirin daily.
- His chest exam reveals a few scattered rhonchi
- His chest X-ray is normal.

Hemoptysis: Initial Work-Up

- Chest radiograph
- Sputum analysis

In massive hemoptysis
- Adequacy of oxygenation/ventilation
- Coagulation studies
- Hemoglobin/hematocrit
Case Histories

Chest X-rays in Hemoptysis:

Case 1: Four weeks of cough with discolored phlegm intermittently mixed with blood; fevers, night sweats, and significant weight loss.

Case 2: Several days of hemoptysis with progressive shortness of breath; dark-colored urine and creatinine of 2.5 mg%.

Case 3: Expectoration of blood-streaked sputum preceded by chronic a.m. cough in a heavy cigarette smoker. Exam is notable for clubbing and obvious weight loss.

Case 4: Hemoptysis and pleuritic chest pain on the third post-operative day.

Case 1: Further Work-Up/Treatment

Dx: Isolation room; Sputum for AFB smear and culture

Rx: Anti-tuberculosis therapy with 3 – 4 drugs

Case 2. Further Work-Up/Treatment

Dx: Serologies (ANCA, anti-GBM antibody, ANA) Biopsy of kidney or lung

Rx: High-dose systemic corticosteroids + immunosuppressives Plasmapheresis
Case 3. Further Work-Up/Treatment

Dx: Sputum cytology
   Fiberoptic bronchoscopy

Rx: Radiation therapy, chemotherapy
   (Possible brachytherapy or endobronchial laser therapy)

Case 4. Further Work-Up/Treatment

Dx: Chest CT angiogram
   Ventilation-perfusion lung scan
   (Conventional pulmonary angiogram)

Rx: Anticoagulation

Which of the Following Is the Most Common Cause of Recurrent/Persistent Hemoptysis in a Cigarette Smoker with a Normal CXR?

A. Lung cancer
B. Chronic bronchitis
C. Tuberculosis
D. Aspiration
E. Pulmonary embolism
### Hemoptysis with a Negative Chest X-ray: Incidence of Lung Cancer

<table>
<thead>
<tr>
<th>Authors</th>
<th>No. of Pts</th>
<th>No. (%) with Lung Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rath et al.</td>
<td>17</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Zavala</td>
<td>55</td>
<td>9 (16)</td>
</tr>
<tr>
<td>Weaver et al.</td>
<td>15</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Kalenbach et al.</td>
<td>32</td>
<td>7 (22)</td>
</tr>
<tr>
<td>Gong et al.</td>
<td>42</td>
<td>3 (7)</td>
</tr>
<tr>
<td>Dreisin et al.</td>
<td>19</td>
<td>2 (11)</td>
</tr>
<tr>
<td>Donlan et al.</td>
<td>72</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Poe et al.</td>
<td>196</td>
<td>12 (6)</td>
</tr>
<tr>
<td>Lederle et al.</td>
<td>106</td>
<td>6 (6)</td>
</tr>
<tr>
<td>O’Neil et al.</td>
<td>119</td>
<td>6 (5)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>699</strong></td>
<td><strong>46 (7)</strong></td>
</tr>
</tbody>
</table>

### Hemoptysis With a Normal CXR: Risk Factors for Lung Cancer

- Past or present cigarette smoker
- Age > 40 years
- Hemoptysis that continues beyond 1 week

### Hemoptysis with a Normal CXR: Pursuing Further Evaluation

- Chest CT scan
- Fiberoptic bronchoscopy
- (Serial chest radiographs)

### Hemoptysis with a Normal Chest X-ray: Complementary Roles of Bronchoscopy and Chest CT Scanning

Among 50 patients with hemoptysis and a normal or non-localizing chest X-ray, a definitive diagnosis was established in 17 (34%) patients:

- CT made Dx in 15 (30%)
- FB made diagnosis in 5 (10%)


### Massive Hemoptysis

Definition: 600 ml of blood/24 hr

- Cancer of the lung
- Tuberculosis (active and inactive)
- Bronchiectasis
- Lung abscess
- Mycetoma
- Pulmonary vasculitis
Non-Specific Treatments of Massive Hemoptysis

- Provide adequate oxygenation and ventilation
- Position with bleeding lung dependent
- Balloon-tipped catheter placed for bronchial tamponade
- Bronchial artery embolization
  - Potential complication: spinal artery infarction with paraplegia
- Surgical resection

Obstructive Lung Diseases

- Asthma
- Chronic Bronchitis and Emphysema
- Bronchiectasis (including cystic fibrosis)
- Bronchiolitis
- Upper airway obstruction

Case History

- 66 year-old woman was referred for evaluation of her “asthma.”
- She had a 10-year history of intermittent wheeze, cough and exertional dyspnea, made worse by respiratory tract infections, cold air and exercise. Her medications were theophylline and inhaled albuterol.

Case History (cont.)

- Chest exam was notable for inspiratory rhonchi at the right base. Spirometry revealed a mild restrictive pattern.
- Sputum culture on several occasions grew H. influenzae.
Clinical Presentations of Bronchiectasis:

**Historical Features**

- Chronic productive cough
- Recurrent hemoptysis
- Persistent/recurrent pneumonia
- Associations: sinusitis, infertility

**Physical Examination**

- Focal inspiratory crackles
- Low-pitched wheezing ("rhonchi")
- Clubbing

**Microbiology of Bronchiectasis**

- Bacterial
  - *Staphylococcus*
  - *Hemophilus*
  - *Pseudomonas*
- Mycobacterial (MAI)
- Fungal (*Aspergillus*)
**Chest CT Appearance in Bronchiectasis**

- Lack of bronchial tapering
- Bronchial dilatation (internal diameter > 1.5 x diameter of accompany vessel)
- Visualization of bronchi in lung periphery (within 1 cm of pleura)
- Bronchial wall thickening may be present

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**Etiologies of Bronchiectasis**

- Localized
  - Residuum of pneumonia
  - Distal to a focal airway obstruction
- Widespread
  - Cystic fibrosis
  - Immotile cilia syndrome
  - Hypogammaglobulinemia
  - Alpha-1 antitrypsin deficiency

**Etiologies of Bronchiectasis: Other Observations**

- AIDS
- Rheumatoid arthritis
- Bronchiolitis

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**Therapeutic Options in Bronchiectasis**

- Antibiotics
- Mucolytics
- Clearance of secretions
- Bronchodilators
- Other: (corticosteroids)

**Randomized Trial of Suppressive Antibiotics (in Cystic Fibrosis)**

- 520 patients with cystic fibrosis randomized to inhaled tobramycin 300 mg BID vs. placebo every other month for 6 months.

**Outcomes:**

- Lung function (FEV₁)
- Density of Ps. aeruginosa in sputum
- Need for hospitalization/intravenous antibiotics

Randomized Trial of Nebulized Tobramycin (in Cystic Fibrosis)

Change in Lung Function


Other Therapeutic Options in Bronchiectasis

• Bronchodilators
• Clearance of secretions
  • Chest physiotherapy and postural drainage
  • Vibratory PEP device
  • External electric vibrator
  • Pneumatic vest
  • Exercise

Flutter

Acapella

Complications of Bronchiectasis

• Hemoptysis
• Infection with resistant organisms
• Respiratory failure
• Other: weight loss, mycetoma

Bronchiolitis: Definition

Acute or chronic cellular inflammation of the bronchiolar walls.

Acute: Viral (e.g., RSV), mycoplasma
Chronic: Follicular bronchiolitis
Mineral dust bronchiolitis
Cigarette smoke respiratory bronchiolitis
Diffuse panbronchiolitis (Japan)
Bronchiolitis obliterans
Bronchiolitis: Etiologies

- Toxic fume inhalation (e.g., nitrogen oxides in silo filler’s lung disease; diacetyl in workers exposed to artificial butter flavoring for popcorn)
- Post-infectious (e.g., viral, mycoplasma)
- Immune-mediated
  - Rheumatoid arthritis (+ penicillamine)
  - Ulcerative colitis
  - S/P transplantation (e.g., bone marrow, lung)

Bronchiolitis: Clinical Features

- Hx: dyspnea, non-productive cough
- P.E.: inspiratory crackles; mid-inspiratory squeak; expiratory wheezes
- CXR: hyperinflation; ± small patchy parenchymal infiltrates
- CT: areas of relative oligemia (“mosaic oligemia”); “tree-in-bud” appearance
Bronchiolitis: Treatment

- Corticosteroids (systemic/inhaled)
- Bronchodilators
- Supplemental oxygen as needed

Bronchiolitis obliterans is often refractory to therapy.

Evaluation of SPN

In a 50 year-old cigarette smoker, the next step in the evaluation of this pulmonary nodule should be percutaneous needle biopsy:

A. True
B. False

Solitary Pulmonary Nodule: Etiologies

- Benign
- Malignant

Solitary Pulmonary Nodule: Aphorism

“When in doubt, cut it out.”

Solitary Pulmonary Nodule: Radiographic Features Definitive for Benign Disease

- Calcification (exception: small eccentric focus of calcium within nodule)
- Absence of increase in size over 2 years
### Solitary Pulmonary Nodule: Clinical Features Favoring Benign Disease

- Age ≤ 40 yrs
- Non-smoker
- Residence in area endemic for fungal infections

### Solitary Pulmonary Nodule: Radiographic Features Favoring Benign Disease

- Smooth margin
- Round edge
- Presence of satellite lesions
- Small size (≤ 1 cm)

### Solitary Pulmonary Nodule: Use of Biopsy Techniques to Identify Benign Disease

- Percutaneous needle aspiration is the preferred technique, but yield for a specific benign etiology is ≤ 5%, and a non-specific benign result is unreliable in excluding malignancy (false negatives ≥ 20%).

### Video-Assisted Thoracoscopic Surgery (VATS)

- Three one-inch chest incisions, plus chest tube drainage
- Average length of hospital stay: 2-3 days
- Pre-resection mediastinoscopy is routine at many centers

### Solitary Pulmonary Nodule: Novel Techniques to Identify Benign Disease

- Positron emission tomography (PET) scanning with fluorodeoxyglucose
- Contrast-enhanced CT scan
- Radiolabeled peptide analogs of somatostatin (depreotide)

### PET Scanning for Solitary Pulmonary Nodules

**Rationale:**
- Malignant tumors have increased metabolic activity
- $^{18}$F-2-fluoro-2-deoxyglucose (FDG) is a radiotracer taken up by malignant tumors but not by metabolically inactive tissue.
- Intensity of FDG uptake in a lung nodule is qualitatively compared with background activity.
**PET Scanning**
**For Solitary Pulmonary Nodules**

**Results:**
for nodules ≥ 8 mm in diameter
- Sensitivity: ~95%
- Specificity: ~85%
- Negative predictive value: ~95%
  - False negatives: Bronchoalveolar carcinoma

**Prospective Monitoring of Solitary Pulmonary Nodule in Low-Risk Patients**

- Serial chest X-rays or CT scans
- Surgical resection of enlarging nodule
- Compulsive follow-up!

**Pre-Operative Assessment**

- Exclude distant metastases
  - Brain, bone, liver, adrenals
- Exclude extrathoracic primary malignancy
  - Breast, thyroid, and rectal exams; urinalysis
- Assess adequacy of cardiopulmonary reserve
  - PFTs; possible ABGs; ETT if indicated
PET Scanning
For Assessing Distant Metastases

Comparison of conventional staging work-up vs. conventional work-up plus PET-CT scan in NSCLC:
- Significant reduction in futile thoracotomies;
- No difference in justifiable thoracotomies;
- No difference in mortality.


Screening for Lung Cancer:
Early Lung Cancer Action Project (ELCAP)

- 1000 cigarette smokers (≥ 10 pack-years), ≥ age 60, and fit to undergo thoracic surgery
- Screened with helical low-dose chest CT scans
- 233 persons (23%) had noncalcified nodule(s) detected on CT scan (vs. 68 persons [7%] on CXR)

_Henschke CI et al., Lancet 1999; 354:99-105._

Screening for Lung Cancer:
National Lung Screening Trial

- 50,000 current and former smokers enrolled between 9/02 and 2/04.
- Randomized to low-dose screening chest CT scans vs. routine CXRs annually for 3 years.
- Annual follow-up through 2009.
- Primary outcome: Is there a ≥ 20% decrease in lung cancer mortality with CT screening?

_www.nci.nih.gov/nlst_

**NLST: Preliminary Results**

<table>
<thead>
<tr>
<th>Arm</th>
<th>Person years (py)</th>
<th>Lung cancer deaths</th>
<th>Lung cancer mortality per 100,000 py</th>
<th>Reduction in lung cancer mortality (%)</th>
<th>Value of test statistic</th>
<th>Efficacy boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>144,097.6</td>
<td>354</td>
<td>245.7</td>
<td>20.3</td>
<td>-3.21</td>
<td>-2.02</td>
</tr>
<tr>
<td>CXR</td>
<td>143,363.5</td>
<td>442</td>
<td>308.3</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Deficit of lung cancer deaths in CT arm exceeds that expected by chance

_National Lung Screening Trial Research Team._

_NEJM 2011; 10.1056/NEJMoa1102873_
NLST: Results

National Lung Screening Trial Research Team. 

Screening for Lung Cancer: Early Lung Cancer Action Project (ELCAP)

Recommendations for management of detected nodules:

- Baseline high-resolution chest CT scan (HRCT) in all pts, and
  - ≤5 mm: follow-up HRCTs at 3, 6, 12, and 24 months to observe for growth
  - 6-10 mm: individualized decision between biopsy (needle aspiration or VATS) or follow-up HRCT
  - >11 mm: biopsy by needle aspiration or VATS


Radiographic Follow-Up of SPN: Recommendations from the Fleischner Society

<table>
<thead>
<tr>
<th>Nodule Size (mm)</th>
<th>Low-Risk Patient</th>
<th>High-Risk Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤4</td>
<td>No follow-up needed</td>
<td>Follow-up CT at 12 mo. If unchanged, no further follow-up</td>
</tr>
<tr>
<td>&gt;4-6</td>
<td>Follow-up CT at 12 mo. If unchanged, no further follow-up/ Initial follow-up CT at 6-12 mo then at 18-24 mo if no change</td>
<td></td>
</tr>
<tr>
<td>&gt;6-8</td>
<td>Initial follow-up CT at 6-12 mo then at 18-24 mo if no change</td>
<td>Initial follow-up CT at 3-6 mo then at 9-12 and 24 mo if no change</td>
</tr>
<tr>
<td>&gt;8</td>
<td>Follow-up CT at around 1, 9, and 24 mo, dynamic contrast-enhanced CT, PET, and/or biopsy</td>
<td>Same as for low-risk patient</td>
</tr>
</tbody>
</table>

Nonsolid (ground-glass) or partly solid nodules may require longer follow-up to exclude indolent adenocarcinoma.


Summary Recommendations

Conclusions:

“In general, all SPNs should be considered malignant until proven otherwise. Resection is the treatment of choice for all patients who are surgical candidates after appropriate preoperative evaluation, including those with indeterminate nodules.”

ACCP Evidence-Based Guidelines: Diagnosis and Management of Lung Cancer. Chest 2003; 123 (suppl):1S-337S.

References

Hemoptysis:

Bronchiectasis:

Bronchiolitis:

Solitary Pulmonary Nodule: