THORACIC NODULES AND MASSES

Heber MacMahon MB, BCh
Department of Radiology
The University of Chicago
Disclosures

- Consultant for Riverain Medical
- Minor stockholder in Hologic, Inc.
- Consultant for GE Healthcare
- Research Support from Philips Healthcare
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Thoracic Nodules and Masses

- Classification of Lung Cancer
- Lung Cancer Screening
- Other Thoracic Masses
- Mimics and Pitfalls
Cancer Deaths by Site

- Prostate
- Breast
- Colorectal
- Other Cancers
- Lung & Bronchus
- Lung Cancer
Advanced Stage Lung Cancer
Lung Cancer: Major cell types

- Adenocarcinoma (50%)
- Squamous cell (30%)
- Small cell Undifferentiated (15%)
- Large cell Undifferentiated (5%)
Lung Cancer: Major cell types

- Adenocarcinoma (50%)
  - Bronchioloalveolar (5%)
Lung Adenocarcinoma Classification 2011

- AAH : Atypical Adenomatous Hyperplasia
- AIS : Adenoca in Situ
- MIA : Minimally Invasive Adenoca
- LPA : (Invasive) Lepidic Predominant Adenoca

International Association for the Study of Lung Cancer/American Thoracic Society/European Respiratory Society International Multidisciplinary Classification of Lung Adenocarcinoma.
WD Travis et al. Journal of Thoracic Oncology • Volume 6, Number 2, February 2011
Lung Adenocarcinoma Classification 2011

• AAH : Atypical Adenomatous Hyperplasia
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Non-Mucinous  Mucinuous

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Adenocarcinoma

• Up to 50% of lung cancers
• 55% present as peripheral nodule
• May grow very slowly
Adenocarcinoma
Invasive adenocarcinoma

Cyst with thickened wall
Adenocarcinoma
Mucinous Adenocarcinoma
Mucinous Adenocarcinoma
Squamous Cell Carcinoma

- 75% arise from segmental or larger bronchi
- 20% show central necrosis & cavitation
- 17% present with atelectasis
Small-Cell Carcinoma

- 15-20% of lung cancers
- Early metastases, lymphadenopathy
- Strongly associated with smoking
- Ectopic ACTH, inappropriate ADH
Large Cell Undifferentiated Carcinoma

- 2-5% of lung cancers
- 50% have large peripheral mass
- May have very rapid growth
- Poor prognosis
Missed Lung Cancer
6mm metastasis
Percentage of Lung Cancers Detected by CXR According to Size

Adapted from: Henschke et al. Lancet 1999;354:99-105
### Percentage of Lung Cancers Detected by CXR According to Size

<table>
<thead>
<tr>
<th>Size Interval</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>2-5mm</td>
<td>X</td>
</tr>
<tr>
<td>6-10mm</td>
<td></td>
</tr>
<tr>
<td>11-20mm</td>
<td></td>
</tr>
<tr>
<td>21-45mm</td>
<td>100%</td>
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</tbody>
</table>

Adapted from: Henschke et al. Lancet 1999;354 99-105
CXR for Lung Cancer Screening

- 1978-1983 Hopkins, Mayo, MSK:
  31,360 Male smokers 45 + y/o. CXR vs CXR plus sputum cytology or CXR vs Standard of Care.
  - Improved 5 yr survival
  - Failed to show significant long term reduction in mortality.
Isotropic Voxels
Mucinous Adenocarcinoma
CT for Lung Cancer Screening

ELCAP (Early Lung Cancer Action Program)

- 1000 smokers with 10+ pack/yrs.
- LDCT screening (10mm slice thickness).
- No control group.
- Showed shift to early stage cancers (80% stage 1A).
- Unable to show reduction in lung cancer mortality.
CT for Lung Cancer Screening

Mayo Clinic Experience 1999-2002

- 1520 pts > 50 y/o with 20+ pk/ys
- 3 annual LDCT scans (3mm slice thickness)
- Historical controls only
CT for Lung Cancer Screening

Mayo Clinic Experience 1999-2002

- Approximately half of all older smokers have at least one lung nodule at the time of an initial screening scan.
- Approximately 10% of screening subjects develop a new nodule over a one year period

Issues in Cancer screening: Lead Time Bias

Patient A
- Cancer onset
- Cancer detected through screening
- Lead time
- Perceived survival time
- Death

Patient B
- Cancer onset
- Cancer detected from symptoms
- Perceived survival time
- Death
Issues in Cancer screening: Length Time Bias

**Cancer Discovered Through Screening**
- Cancer onset
- Death from Cancer
- Survive Cancer

**Truly Had Cancer**
- Cancer onset
- Die from Cancer
- Survive Cancer

<table>
<thead>
<tr>
<th></th>
<th>Death from Cancer</th>
<th>Survive Cancer</th>
<th>% Surviving Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer Discovered Through Screening</td>
<td>1</td>
<td>4</td>
<td>80%</td>
</tr>
<tr>
<td>Truly Had Cancer</td>
<td>7</td>
<td>5</td>
<td>41.7%</td>
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</table>
CT for Lung Cancer Screening

NLST (National Lung Cancer Screening Trial)

- 53,454 subjects randomized to CT or CXR from 2002-2004
- 55 – 74 yrs old
- ≥ 30 pack years, current or quit within 15 yrs
- Follow up through 2009
NLST Trial Results

- Lung cancer death rate 20% lower in CT group (p= 0.004)
- All cause mortality 6.7% lower in CT group
- Needed to screen 320 to prevent one lung ca death
• Recommended annual screening for lung cancer with LDCT in persons at high risk for lung cancer based on age and smoking history
• Current or former smokers 55-79 years old with 30 pack year or more, until 15 years after smoking cessation
• Other groups (NCCN and AATS) include 50+ years olds and 20+ pack year smokers if additional risk factors present.
Lung Cancer Screening

- Qualified patients are offered screening
- Counseling with smoking cessation guidance
- Low dose non contrast CT technique
- Reported using ACR LungRADS format
<table>
<thead>
<tr>
<th>Category Descriptor</th>
<th>Category Descriptor</th>
<th>Primary Category</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete</td>
<td>-</td>
<td>0</td>
<td>Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed</td>
</tr>
<tr>
<td>Negative</td>
<td>No nodules and definitely benign nodules</td>
<td>1</td>
<td>Continue annual screening with LDCT in 12 months</td>
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<tr>
<td>Benign Appearance or Behavior</td>
<td>Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Probably benign</td>
<td>Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer</td>
<td>3</td>
<td>6 month LDCT</td>
</tr>
<tr>
<td>Suspicious</td>
<td>Findings for which additional diagnostic testing and/or tissue sampling is recommended</td>
<td>4A</td>
<td>8 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4B</td>
<td>chest CT with or without contrast, PET/CT and/or tissue sampling depending on the probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm solid component</td>
</tr>
<tr>
<td>Significant - other</td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Prior Lung Cancer</td>
<td></td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>
62 y/o man with severe dyspnea and wheezing
Severe Dyspnea with Normal CXR

- Pulmonary Embolism
- Severe bronchospasm
- Panic attack
Severe Dyspnea with Normal CXR

- PE
- Severe bronchospasm
- Panic attack
- Central airway obstruction
Squamous Cell Carcinoma
Tumors of Trachea

- **Benign**
  Hemangioma, papilloma, hamartoma, etc

- **Primary Malignant**
  Squamous cell (45%)
  Adenoid cystic (35%)
  Mucoepidermoid Ca
  Adenoca, Carcinoid, Lymphoma

- **Secondary malignant**
  Metastases (renal, melanoma, breast)
  Direct invasion (Esophageal, Lung Ca)
Adenoid Cystic Carcinoma
Mucoepidermoid Tracheal Tumor
Tracheal Chondrosarcoma
59 y/o man with cough and wheezing
Endobronchial Lipoma
Extrinsic Invasion by Lung Carcinoma Metastasis
Beef Rib Fragment in Bronchus Intermedius
Aspirated Dental Tool
38 y/o man with cough for six months
Adult presenting with lobar atelectasis

- Endobronchial tumor
- Mucous plug
- Aspirated food/foreign body
- Chronic infection (RML syndrome)
Lung Cancer Incidence by Age, UK 2006-2008
Carcinoid Tumor
Carcinoid Tumor

- Neuroendocrine tumors; carcinoid syndrome rare (1-3%)
- Majority (80%) in main or segmental bronchi; present with atelectasis/obstructive pneumonia
- Calcification in 30%
- “Atypical carcinoids”: 10%
- Mets in 70% of atypicals vs. 5% typicals
Carcinoid
Carcinoid Tumorlets

- Otherwise typical carcinoid tumors ≤ 5 mm
- 90% females
- Present in about 10% of carcinoids
- 1/3 have dominant carcinoid tumor or emphysema
- Diffuse idiopathic pulmonary neuroendocrine cell hyperplasia (DIPNECH) – airway centered proliferation of neuroendocrine cells with peribronchiolar fibrosis & ± air trapping, org pna
- Excellent prognosis
CXR obtained for occasional cough
Another example of the same entity

29 y/o woman with chest discomfort; told she had PE at outside hospital
Congenital Bronchial Atresia

- Usually seen in asymptomatic young adults
- Typically LUL posterior-apical segment
- Mass due to bronchocele (80%)
- Air trapping (90%)
31 year-old male with asthma and recurrent pneumonia.
31 year-old male with asthma and recurrent pneumonia.
Allergic Bronchopulmonary Aspergillosis (ABPA)
Allergic Bronchopulmonary Aspergillosis (ABPA)

- Asthma (84%)
- Eosinophilia
- Elevated serum IgE
- Central bronchiectasis
- Immediate skin reaction to Aspergillus
Allergic Bronchopulmonary Aspergillosis (ABPA)

- Caused by hypersensitivity reaction
- Usually Asp. Fumigatus
- Majority have asthma
- Also occurs in CF
Aspergillus Infection

- Aspergilloma
- ABPA
- Chronic Semi-Invasive Aspergillosis
- Invasive Aspergillosis – Angioinvasive
- Invasive Aspergillosis – Acute Airway
Hamartoma
Hamartoma

- Most commonly resected benign tumor
- Peak incidence in sixth decade
- Endobronchial in 5%
- Fat and/or calcium on CT in 50%+
- Well-defined, slow growing
? Hamartoma
How to measure HU values?
ROI : HU=81
ROI : HU=+ 81

1mm lung section

ROI : HU= - 41

0.9mm source image
1mm lung section

0.9mm source image

Inaccurate: Lung or bone filter with sharpening algorithm

Accurate: Unsharpened soft tissue series
Pleural/Extrapleural Tumors

• Solitary Fibrous tumors
• Lipomas, liposarcomas
• Neurogenic tumors
• Mesothelioma
• Metastases
Incidental Chest Mass
Solitary Fibrous Tumor of Pleura (SFT)
85 y/o woman with chest pain
85 y/o woman with chest pain

Solitary Fibrous Tumor of Pleura (SFT)
Local Fibrous Tumor of Pleura
(Localized/Benign Mesothelioma)

- Peak incidence > 50 years
- Asymptomatic + pain, dyspnea
- HPO (35%), hypoglycemia (5%)
Local Fibrous Tumor of Pleura (Localized/Benign Mesothelioma)

- Peak incidence > 50 years
- Asymptomatic ± pain, dyspnea
- HPO (35%), hypoglycemia (5%)
- 40% malignant (fibrosarcoma)
- No association with asbestos exposure
Localized Fibrous Tumor of Pleura

CT Features

- Sharply defined margins
- Contrast enhancement (100%)
- Pedunculation (40%)
- Tumor calcification (5%)
- Pleural effusion (10%)
Pleural Lipoma
Pleural Lipoma
44 y/o woman with mild chest discomfort
44 y/o woman with mild chest discomfort
Benign Schwannoma
Neurogenic Thoracic Tumors

- Nerve Sheath Tumors
  - Schwannoma
  - Neurofibroma
  - Malignant nerve sheath tumors
Neurogenic Thoracic Tumors

• Nerve Sheath Tumors
  ▪ Schwannoma
  ▪ Neurofibroma
  ▪ Malignant nerve sheath tumors

• Ganglion Cell Tumors
  ▪ Ganglioneuroma
  ▪ Ganglioneuroblastoma
  ▪ Neuroblastoma
Neurogenic Thoracic Tumors

• Nerve Sheath Tumors
  ▪ Schwannoma
  ▪ Neurofibroma
  ▪ Malignant nerve sheath tumors

• Ganglion Cell Tumors
  ▪ Ganglioneuroma
  ▪ Ganglioneuroblastoma
  ▪ Neuroblastoma

• Paraganglioneuromas
  ▪ Chemodectoma
  ▪ Phaeochromocytoma
Schwannoma (Neurilemmoma)

- Typically posterior paravertebral
- Rib erosion in 50%
- Low density areas, peripheral enhancement
- Calcification 5-10%
Pleural/Extrapleural Tumors

- Solitary Fibrous tumors
- Lipomas, liposarcomas
- Neurogenic tumors
- Mesothelioma
- Metastases
Malignant Mesothelioma Epidemiology

- 80% asbestos related
- 35 yr. Latent period
- 10% lifetime risk for asbestos workers
- Greater risk with crocidolite and amosite
Malignant Mesothelioma
Malignant Mesothelioma
CT Findings

- Pleural Thickening (90%)
- Thickened fissures (85%)
- Pleural effusion (75%)
- Mediastinal adenopathy (50%)
- Volume Loss (40%)
- Pleural calcification (20%)
- Chest wall invasion (20%)
Mesothelioma with chest wall invasion
Pleural/Extrapleural Tumors

- Solitary Fibrous tumors
- Lipomas, liposarcomas
- Neurogenic tumors
- Mesothelioma
- Metastases
Metastatic Melanoma
Pleural metastases presenting with effusion
Cancers commonly causing Pleural Effusions

- Lung Ca
- Breast Ca
- Lymphoma
- Ovarian Ca
- Gastric Ca
Take Home Points

• Be alert for atypical lung cancer morphology, including cyst wall thickening, and mucinous adenocarcinoma
• Recognize unusual “Aunt Minnies” such as congenital bronchial atresia
• Measure HU on soft tissue (mediastinal) series images
• Always use IV contrast when evaluating pleural effusions