This tool addresses common symptoms and symptom complexes. Imaging requests for patients with atypical symptoms or clinical presentations that are not specifically addressed will require physician review. Consultation with the referring physician, specialist and/or patient’s Primary Care Physician (PCP) may provide additional insight.

This version incorporates MSI accepted revisions prior to 7/22/11
# 2011 CHEST IMAGING GUIDELINES

## 2011 CHEST IMAGING GUIDELINE NUMBER and TITLE

<table>
<thead>
<tr>
<th>ABBREVIATIONS</th>
<th>4</th>
<th>BI-RADS™ Categories Chart</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH-1~GENERAL GUIDELINES</td>
<td>6</td>
<td>CH-2~LYMPHADENOPATHY</td>
<td>8</td>
</tr>
<tr>
<td>CH-3~CHRONIC COUGH</td>
<td>11</td>
<td>CH-4~NON-CARDIAC CHEST PAIN</td>
<td>11</td>
</tr>
<tr>
<td>CH-5~DYSPNEA/Shortness of Breath</td>
<td>12</td>
<td>CH-6~HEMOPTYSIS</td>
<td>13</td>
</tr>
</tbody>
</table>

## BRONCHIAL TREE

| CH-7~BRONCHIECTASIS | 14 | CH-8~BRONCHITIS | 14 |

## LUNG PARENCHYMA (Alphabetical Order)

| CH-9~ASBESTOS EXPOSURE | 15 |
| CH-10~CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) | 15 |
| CH-11~INTERSTITIAL DISEASE | 16 |
| CH-12~MULTIPLE PULMONARY NODULES | 16 |
| CH-13~PNEUMONIA | 17 | CH-14~POSITIVE PPD or TUBERCULOSIS (TB) | 17 |
| CH-15~SARCOID | 17 | CH-16~SOLITARY PULMONARY NODULE (SPN) | 18 |

## PLEURA (Alphabetical Order)

| CH-17~PLEURAL-BASED NODULES and OTHER ABNORMALITIES | 21 |
| CH-18~PLEURAL THICKENING | 21 |

## DISORDERS INVOLVING the PLEURAL SPACE (Alphabetical Order)

| CH-19~PLEURAL EFFUSION | 22 | CH-20~PNEUMOTHORAX-HEMOTHORAX | 22 |

## MEDIASTINUM

| CH-21~MEDIASTINAL LYMPHADENOPATHY | 24 | CH-22~MEDIASTINAL MASS | 24 |

## CHEST WALL and RIBS (Alphabetical Order)

| CH-23~CHEST TRAUMA | 24 | CH-24~COSTOCHONDritis | 25 |
| CH-25~CHEST WALL MASS | 26 | CH-26~PECTUS EXCAVATUM/CARINATUM | 26 |

## THORACIC VASCULAR DISORDERS (Alphabetical Order)

| CH-28~PULMONARY ARTERIOVENOUS FISTULA (AVM) | 36 |
| CH-29~PULMONARY EMBOLISM | 36 | CH-30~SUBCLAVIAN STEAL SYNDROME | 39 |
| CH-31~SUPERIOR VENA CAVA (SVC) SYNDROME | 39 |
| CH-32~THORACIC AORTA | 40 | CH-33~ELEVATED HEMIDIAPHRAGM | 44 |
| CH-34~THORACIC OUTLET SYNDROME | 45 |

## NEWER IMAGING TECHNIQUES

| CH-35~Virtual Bronchoscopy | 46 | CH-36~EM-Guided Peripheral Bronchoscopy | 46 |
| CH-37~Positron-Emission Mammography | 46 | CH-38~Breast MR Spectroscopy | 47 |

END—Chest Imaging Guidelines—For Evidence Based Clinical Support, See NEXT PAGE
## 2011 CHEST IMAGING GUIDELINES

### EVIDENCE BASED CLINICAL SUPPORT

<table>
<thead>
<tr>
<th>CH-3 ~ Chronic Cough</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH-9 ~ Asbestos Exposure</td>
<td>48</td>
</tr>
<tr>
<td>CH-15 ~ Sarcoid</td>
<td>49</td>
</tr>
<tr>
<td>CH-16 ~ Solitary Pulmonary Nodule (SPN)</td>
<td>49</td>
</tr>
<tr>
<td>CH-22 ~ Mediastinal Mass</td>
<td>50</td>
</tr>
<tr>
<td>CH-27 ~ Breast Abnormalities</td>
<td>50</td>
</tr>
<tr>
<td>CH-29 ~ Pulmonary Embolism (PE)</td>
<td>52</td>
</tr>
<tr>
<td>CH-31 ~ Superior Vena Cava (SVC) Syndrome</td>
<td>54</td>
</tr>
<tr>
<td>CH-32 ~ Thoracic Aortic Dissection or Aneurysm</td>
<td>55</td>
</tr>
</tbody>
</table>

### CHEST IMAGING GUIDELINE REFERENCES

56
### ABBREVIATIONS for CHEST GUIDELINES

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>abdominal aortic aneurysm</td>
</tr>
<tr>
<td>ACE</td>
<td>angiotensin-converting enzyme</td>
</tr>
<tr>
<td>AIDS</td>
<td>acquired immune deficiency syndrome</td>
</tr>
<tr>
<td>AVM</td>
<td>arteriovenous malformation</td>
</tr>
<tr>
<td>BI-RADS</td>
<td>Breast Imaging Reporting and Database System</td>
</tr>
<tr>
<td>BP</td>
<td>blood pressure</td>
</tr>
<tr>
<td>BRCA</td>
<td>tumor suppressor gene</td>
</tr>
<tr>
<td>CAD</td>
<td>computer-aided detection</td>
</tr>
<tr>
<td>CBC</td>
<td>Complete blood count</td>
</tr>
<tr>
<td>COPD</td>
<td>chronic obstructive pulmonary disease</td>
</tr>
<tr>
<td>CT</td>
<td>computed tomography</td>
</tr>
<tr>
<td>CTA</td>
<td>computed tomography angiography</td>
</tr>
<tr>
<td>CTV</td>
<td>computed tomography venography</td>
</tr>
<tr>
<td>DCIS</td>
<td>ductal carcinoma in situ</td>
</tr>
<tr>
<td>DVT</td>
<td>deep venous thrombosis</td>
</tr>
<tr>
<td>ECG</td>
<td>electrocardiogram</td>
</tr>
<tr>
<td>EM</td>
<td>electromagnetic</td>
</tr>
<tr>
<td>EMG</td>
<td>electromyogram</td>
</tr>
<tr>
<td>FDA</td>
<td>Food and Drug Administration</td>
</tr>
<tr>
<td>FDG</td>
<td>fluorodeoxyglucose</td>
</tr>
<tr>
<td>FNA</td>
<td>fine needle aspiration</td>
</tr>
<tr>
<td>GERD</td>
<td>gastroesophageal reflux disease</td>
</tr>
<tr>
<td>GI</td>
<td>gastrointestinal</td>
</tr>
<tr>
<td>HRCT</td>
<td>high resolution computed tomography</td>
</tr>
<tr>
<td>IPF</td>
<td>idiopathic pulmonary fibrosis</td>
</tr>
<tr>
<td>LCIS</td>
<td>lobular carcinoma in situ</td>
</tr>
<tr>
<td>LFTP</td>
<td>localized fibrous tumor of the pleura</td>
</tr>
<tr>
<td>MRA</td>
<td>magnetic resonance angiography</td>
</tr>
<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>MRV</td>
<td>magnetic resonance venography</td>
</tr>
<tr>
<td>NCV</td>
<td>nerve conduction velocity</td>
</tr>
<tr>
<td>PE</td>
<td>pulmonary embolus</td>
</tr>
<tr>
<td>PEM</td>
<td>positron-emission mammography</td>
</tr>
<tr>
<td>PET</td>
<td>positron emission tomography</td>
</tr>
<tr>
<td>PFT</td>
<td>pulmonary function tests</td>
</tr>
<tr>
<td>PPD</td>
<td>purified protein derivative of tuberculin</td>
</tr>
<tr>
<td>RODEO</td>
<td>Rotating Delivery of Excitation Off-resonance MRI</td>
</tr>
<tr>
<td>SPN</td>
<td>solitary pulmonary nodule</td>
</tr>
<tr>
<td>SVC</td>
<td>superior vena cava</td>
</tr>
</tbody>
</table>
# BI-RADS™ Categories Chart

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1: Negative</strong></td>
<td>There is nothing to comment on. The breasts are symmetrical and no masses, architectural disturbances or suspicious calcifications are present.</td>
</tr>
</tbody>
</table>

**Category 2: Benign Finding**

This is also a negative mammogram, but the interpreter may wish to describe a finding. Involuting, calcified fibroadenomas, multiple secretory calcifications, fat containing lesions such as oil cysts, lipomas, galactoceles, and mixed density hamartomas all have characteristic appearances, and may be labeled with confidence. The interpreter might wish to describe intramammary lymph nodes, implants, etc. while still concluding that there is no mammographic evidence of malignancy.

**Category 3: Probably Benign Finding – Short Interval Follow-up Suggested**

A finding placed in this category should have a very high probability of being benign. It is not expected to change over the follow-up interval, but the radiologist would prefer to establish its stability. Data is becoming available that sheds light on the efficacy of short interval follow-up. At the present time, most approaches are intuitive. These will likely undergo future modification as more data accrue as to the validity of an approach, the interval required, and the type of findings that should be followed.

**Category 4: Suspicious Abnormality – Biopsy Should Be Considered**

There are lesions that do not have the characteristic morphologies of breast cancer but have a definite probability of being malignant. The radiologist has sufficient concern to urge a biopsy. If possible, the relevant possibilities should be cited so that the patient and her physician can make the decision on the ultimate course of action.

**Category 5: Highly Suggestive of Malignancy-Appropriate Action Should Be Taken**

These lesions have a high probability of being cancer.

---

RETURN TO: CH-27~BREAST ABNORMALITIES
• A recent complete history and physical examination should be performed prior to considering advanced imaging of the chest.

**Chest X-ray**
- A recent chest x-ray (generally within the last 30 days) that has been overread by a radiologist should be performed prior to considering advanced imaging.

**Chest Ultrasound**
- Chest ultrasound (CPT®76604) includes transverse, longitudinal, and oblique images of the chest wall with measurements of chest wall thickness, and also includes imaging of the mediastinum.
- Chest x-ray should be performed prior to chest ultrasound
- **Indications for chest ultrasound (CPT®76604) include:**
  - Evaluate presence of fluid within the pleural spaces
  - Evaluate mediastinal masses
  - Measure the distance between the anterior surface to chest wall prior to radiation therapy
  - Evaluate other masses suspected within the chest or chest wall
- **Coding Notes**
  - Chest ultrasound--CPT®76604
  - Breast ultrasound--CPT®76645 (unilateral or bilateral)
  - Axillary ultrasound--CPT®76882 (unilateral)
    - If bilateral axillary ultrasounds are being performed, this should be coded as CPT®76882 x 2.

**Chest CT**
- Intrathoracic abnormalities found on chest x-ray, fluoroscopy, abdominal CT scan, or other imaging modalities can be further evaluated with chest CT with contrast (CPT®71260).
- Non-contrast chest CT (CPT®71250) can be used for the following:
  - Patient has contraindication to contrast
  - Follow-up of pulmonary nodule(s)
  - High Resolution CT (HRCT)
  - Noncontrast CT is specifically requested by pulmonary specialist
  - Other circumstances as specified in the guidelines
- Chest CT without and with contrast (CPT®71270) does not add significant diagnostic information above and beyond that provided by chest CT with contrast, unless a question regarding calcification needs to be resolved.
- **Coding notes:**
  - High resolution chest CT should be reported only with an appropriate CPT® code from the set 71250-71270. No additional CPT® codes should be used for the “high resolution” portion of the scan. The “high resolution” involves additional slices which are not separately billable.

**Chest CTA**
- Pre-op evaluation for minimally invasive or robotic surgery:
➢ There is insufficient data to support the routine use of CTA for the routine evaluation of peripheral arteries, iliac arteries, and/or aorta prior to minimally invasive or robotic surgery.

- **Chest MRI**
  o Chest CT is indicated in the majority of cases to evaluate pathology in the chest when advanced imaging is appropriate. Indications for chest MRI are much less common.
  o MRI chest is appropriate when there are concerns about CT contrast such as renal insufficiency or contrast allergy.
  o MRI chest may be appropriate in order to clarify equivocal findings on previous imaging studies. Appropriateness will need to be determined on a case by case basis.
### CH-2—LYMPHADENOPATHY

<table>
<thead>
<tr>
<th>CH-2</th>
<th>LYMPHADENOPATHY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Supraclavicular Region</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Axillary Lymphadenopathy</td>
<td>8</td>
</tr>
<tr>
<td>2.3</td>
<td>Mediastinal Lymphadenopathy</td>
<td>9</td>
</tr>
</tbody>
</table>

#### CH-2.1 Supraclavicular Region
- Also see **NECK-1 General Guidelines** in the Neck Imaging Guidelines
- A complete history and physical examination, including palpation of the supraclavicular region, should be performed initially in the evaluation of a suspected supraclavicular mass or abnormality.
  - The sensitivity of palpation, CT, and ultrasound for detecting supraclavicular metastases were 33%, 83%, and 100%, respectively.
  - In one study, lymph nodes had to have a diameter of 22.3 mm or greater to be palpated in 50% of cases.

- Given the high false positive and false negative results of palpation alone, ultrasound (CPT® 76536) should be performed in order to confirm the presence of enlarged lymph nodes or other mass prior to considering advanced imaging.
  - Ultrasound has the added advantage of allowing ultrasound-guided fine needle aspiration (FNA) (CPT® 76942) for histologic diagnosis of a suspicious lymph node or mass.*

  *Radiology* 2004;232:75-80
- If ultrasound is indeterminate, soft tissue neck CT with contrast (CPT® 70491) or chest CT with contrast (CPT® 71260) can be performed. Either study images the supraclavicular region equally well if done correctly.*

- Definitive diagnosis of a supraclavicular abnormality requires biopsy (FNA or open biopsy).

#### CH-2.2 Axillary Lymphadenopathy
- In the primary care setting, lymphadenopathy is usually due to benign infectious causes.
- Most patients can be diagnosed on the basis of a careful history and physical examination.
- Localized axillary lymphadenopathy should prompt a search for an adjacent precipitating lesion such as a hand or arm injury or infection, and an examination of other nodal areas to rule out generalized lymphadenopathy.
  - In individuals with localized axillary lymphadenopathy and a benign clinical picture, a 3 to 4 week period of observation is appropriate.
    - If the adenopathy persists, excisional biopsy of the most abnormal lymph node is indicated. Advanced imaging is generally not indicated.
  - In individuals with generalized lymphadenopathy, a more extensive
diagnostic work-up including serological tests to rule out systemic infectious diseases, and lymph node biopsy is indicated.

- **Reference:**

- **Axillary Lymphadenopathy from an Occult Primary Cancer**
  - Axillary lymph node metastasis, without identification of a primary cancer, is an uncommon finding. Adenocarcinoma is the most common histology, with breast cancer being the most common cancer (although non-palpable breast cancer presenting as axillary metastases accounts for less than 0.5% of all breast cancers).
    - Breast MRI (CPT®77059) can be performed if breast cancer is suspected and physical exam and mammography are negative.
  - Carcinomas of the lung, thyroid, stomach, colon, rectum, and pancreas have the potential to spread to axillary lymph nodes, but these metastases are rarely the first manifestations of disease.
    - Symptomatology, risk factors, and clinical suspicion should lead to imaging of these possible primary sites.
      - Also see [ONC-29 Metastatic Cancer and Carcinomas of Unknown Primary Site](...) in the Oncology and PET Imaging Guidelines
    - Immunohistochemical markers have proven useful for differentiating metastatic breast carcinoma from adenocarcinoma arising in other primary sites.
  - **References:**
    - *The Breast* 2006;15:259-262

- **CH-2.3 Mediastinal Lymphadenopathy**
  - Mediastinal abnormalities detected on chest x-ray (overread by a radiologist) can be further evaluated by chest CT with contrast (CPT®71260).
  - Mediastinal masses identified on screening chest CT scans should be approached conservatively.
    - In the I-ELCAP study which involved almost 30,000 individuals who received screening chest CT scans, 123 (1%) had a mediastinal lesion, but only 4 were cancers.*
      - [Imaging Economics 2005 Feb, p.37](...)  
  - If chest CT shows enlarged lymph nodes in the mediastinum with no other abnormalities in a patient at low risk for malignancy and with no clinical suspicion for malignancy, one follow-up chest CT (CPT®71260) at 4 to 8 weeks can be performed.
    - Requests for additional CT scans or for PET should be sent for Medical Director review.
    - Lymph node biopsy should be considered in cases of persistent lymphadenopathy in order to obtain a histologic diagnosis.
  - Lymphadenopathy from neoplasms as well as from benign sources of inflammation can result in a positive PET scan. Therefore, the use of PET may not be helpful prior to histologic diagnosis.
  - If biopsy can only be accomplished by mediastinoscopy or thoracoscopy/thoracotomy (i.e. percutaneous biopsy, transbronchial biopsy,
transbronchial biopsy using endobronchial ultrasound, and endoscopic ultrasound-guided FNA cannot be performed), and a negative PET scan will allow the patient to be observed, then PET can be considered to confirm the likelihood of yielding a pathologic diagnosis and to determine if a more favorable site for biopsy exists.

- PET may be helpful in characterizing anterior mediastinal abnormalities, especially since the thymus gland has a characteristic uptake pattern on most PET scans, and the study may differentiate normal or benign hypertrophic thymus tissue from pathologic mediastinal lesions.
CH-3~CHRONIC COUGH

- Chronic cough is defined as a cough that lasts at least eight weeks.
- Information provided for patients with chronic cough should include a complete list of current medications, smoking history, history of recent upper respiratory infection, and history of cancer.
- All patients must first be evaluated with a recent (within last 30 days) chest x-ray (overread by a radiologist).
- Current or past cigarette smokers with a history of chronic smoker's cough should be asked if the cough has changed. If no change in cough and chest x-ray is unremarkable, no further imaging is indicated.
- Chest CT with contrast (CPT®71260) is indicated in a current or past smoker with a change in cough (other than improvement) or a new onset cough lasting greater than 4 weeks.
- Patients taking medications known to cause coughing (e.g. ACE inhibitors) should have medication discontinued. If cough persists > 4 weeks, chest CT with contrast (CPT®71260) or without contrast (CPT®71250) is indicated.
- Patients with no history of smoking and clear chest x-ray should undergo the following algorithm:¹ ²
  - A 3 week trial of antihistamine and decongestant treatment should be performed initially.
  - If chronic cough persists after treatment of upper airway cough syndrome, asthma should be ruled out with bronchoprovocation challenge (e.g. methacholine challenge, exhaled nitric oxide test) and spirometry should be performed.
  - If bronchoprovocation challenge is not available, an empiric trial of corticosteroids should be performed.
  - If cough persists, treatment of gastroesophageal reflux disease should be started and referral to a cough specialist is helpful.
  - If cough persists, chest CT (either with contrast [CPT®71260] or without contrast [CPT®71250] can be performed.

  ¹Can Fam Physician 2002 Aug;48:1311-1316
  ²Chest 2006;129:1S-23S

CH-4~NON-CARDIAC CHEST PAIN

- Defined as recurrent episodes of unexplained retrosternal pain in patients lacking a cardiac abnormality after a reasonable evaluation.*
  *Chiropractic and Osteopathy 2005;13:18
- This guideline addresses all types of non-cardiac chest pain (chest wall pain, pleuritic pain, retrosternal pain, etc.).
- Chronic chest pain is generally defined as pain that persists for 6 months or more.
- More than half of patients with no organic cause for chest pain continue to experience chest pain one year after discharge from the hospital.*
  *European J of Emergency Medicine 1997;4:72-80
• **Etiology:**
  o Studies have found that the most common etiologies include idiopathic (60%), musculoskeletal chest pain (esp. costochondritis) (36%), and reflux disease (GERD) (13%).*
    
    *J Fam Pract 1994;38(4):345-352
  o Esophageal angina: Approximately 10%-20% of patients with GERD present with symptoms that are clinically indistinguishable from angina pectoris.
    ➢ Clinical features that may suggest the esophagus as the source of the atypical pain include: posturally aggravated symptoms, history of dysphagia, substernal pain limited to the midline and radiating to the interscapular area.
  ➢ **Reference:**
• 25%-50% of chest pain presentations in ambulatory settings may be musculoskeletal.
  o Musculoskeletal pain is a diagnosis of exclusion.
  o Some patients with Thoracic Outlet Syndrome can present with anterior chest wall or parascapular pain.*
  o Also see **CH-34 Thoracic Outlet Syndrome**
• Chest x-ray should be performed initially and overread by a radiologist.
• Abnormalities present on chest x-ray that were not present on previous imaging studies (if available) can be further evaluated with chest CT with contrast (CPT®71260).
• If chest x-ray is unremarkable, a thorough cardiac (ECG, echocardiogram, stress test), GI (trial of anti-reflux medication, possible upper endoscopy, pH probe, esophageal manometry), and pulmonary (PFT’s) evaluation should be performed at least once.
• If the above evaluations have not yielded an explanation for the chest pain, symptoms have not improved after a 6 to 8 week trial of rest, analgesics, and anti-inflammatory treatment under the direction of a physician, and a recent chest x-ray (within 2 to 4 weeks) has been performed, then chest CT with contrast (CPT®71260) can be performed.
• There is no evidence to support MRI for the evaluation of chest pain.
• Repeat advanced imaging of the chest in patients with unchanged or improving symptoms is not appropriate.

---

**CH-5~DYSPNEA/SHORTNESS OF BREATH**

- Dyspnea is the subjective experience of breathing discomfort
- Evaluation of dyspnea/shortness of breath is aimed at determining whether the cause is cardiac, pulmonary, mixture of cardiac and pulmonary, or noncardiac/nonpulmonary
  - Most cases are due to cardiac or pulmonary disease
• If pulmonary embolus (PE) is suspected, see **CH-29 Pulmonary Embolism**

• Prior to considering advanced imaging of the chest, work up should include the following:
  o Thorough history and physical examination
  o Recent (within past 30 days) chest x-ray that has been overread by a radiologist
  o ECG
  o Pulse oximetry
  o Pulmonary function studies (PFT’s)
  o Blood work including CBC and thyroid function tests
    ➢ Intrathoracic abnormalities found on chest x-ray that were not present on previous imaging studies and do not have benign features such as a benign calcification pattern typical of granuloma or hamartoma can be evaluated with chest CT without (CPT®71250) or with (CPT®71260) contrast.
    ➢ High resolution chest CT scan (HRCT) without contrast (CPT® 71250) can be performed if PFT’s are consistent with interstitial lung disease such as idiopathic pulmonary fibrosis.

• If chest x-ray, ECG, and PFT’s do not yield a diagnosis, then arterial blood gas measurement, echocardiography, and cardiac stress testing should be performed prior to considering advanced imaging of the chest.
  o See the following in the Cardiac Imaging Guidelines for the appropriate cardiac stress test:
    ➢ **CD-1.3 Stress Testing**
    ➢ **CD-2.4 Stress Echocardiography**
    ➢ **CD-3.2 Indications for MPI**
    ➢ **CD-6.3 Indications for Stress MRI**

• Chest CT without (CPT®72150) or with (CPT®71260) contrast can be performed if the above work up has been completed and dyspnea/shortness of breath that is not cardiac in origin persists for greater than 6 to 8 weeks.

---

**CH-6–HEMOPTYSIS**

• A careful history should help determine the amount of blood and differentiate between hemoptysis, pseudohemoptysis, and hematemesis.

• Most common etiologies for hemoptysis:
  o Adults: Bronchitis, bronchogenic carcinoma, pneumonia

• Work up:
  o Careful history and physical examination and chest x-ray.
  o Low risk patient with normal chest x-ray: treat on an outpatient basis with close monitoring and antibiotics if indicated.
  o Patients with risk factors for malignancy (e.g. male sex, age >40, smoking, duration of hemoptysis >1 week): chest CT with contrast (CPT®71260) should be performed even if chest x-ray is normal.

• **Reference:**
  o *Am Fam Physician* 2005;72(7):1253-1260

• In the non-trauma patient with a history of clinically documented hemoptysis, chest CT (either with contrast [CPT®71260] or without contrast [CPT®71250])
Bronchial Tree

CH-7~Bronchiectasis

- Bronchiectasis is defined as localized, irreversible dilatation of bronchi >2 mm in diameter. Patients have excessive mucus production.
- Bronchiectasis is associated with a wide range of disorders, including cystic fibrosis, AIDS, alpha1-antitrypsin deficiency, rheumatoid arthritis, obstruction of the bronchi, and necrotizing bacterial infections.
- Chest x-ray and PFT's should be performed initially in patients with known or suspected bronchiectasis, but may be normal.
- High resolution chest CT scan (HRCT) without contrast (CPT®71250) is the advanced imaging study of choice to confirm the diagnosis of bronchiectasis and/or evaluate patients with known bronchiectasis who have worsening symptoms or worsening PFT's.
- There is no published data to support performing routine follow-up advanced imaging of the chest in the absence of new or worsening symptoms or worsening lung function studies in patients with known bronchiectasis.
- MRI is not used to evaluate patients with bronchiectasis.
- Patients with bronchiectasis who present with hemoptysis should undergo chest CTA (CPT®71275) or chest MRA (CPT®71555).

Reference:

CH-8~Bronchitis

- Acute inflammation of trachea and/or large and small bronchi due to infection or other causes. The majority of cases of bronchitis are due to viral infections.
- Symptoms can include coughing, wheezing, shortness of breath, fever
  - Acute bronchitis usually improves within a few days but the cough may continue for weeks.
- Imaging Studies:
  - Chest x-ray to rule out pneumonia if symptoms do not improve after a trial of conservative therapy (rest, analgesics, fluids, humidifier, etc.)
LUNG PARENCHYMA (ALPHABETICAL ORDER)

CH-9~ASBESTOS EXPOSURE

- Chest x-ray must be performed initially in patients with suspected asbestos-related lung disease.
- In patients with stable calcified pleural plaques seen on chest x-ray, no advanced imaging of the chest is indicated.
- If a change is seen on chest x-ray, high resolution chest CT (HRCT) (CPT®71250) can be performed.
- Patients with progressive pleural and parenchymal changes are at particularly high risk of developing malignant mesothelioma and should have HRCT (CPT®71250) every 3 to 6 months.

CH-10~CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

- COPD includes a spectrum of diseases: asthmatic bronchitis, chronic bronchitis, and emphysema.
- Typical presenting symptoms include cough, excess mucus, dyspnea on exertion, and/or wheezing.
- Diagnosis is best made by performing spirometry (PFT’s).\(^1\)
  - In addition, chest x-ray and arterial blood gas measurement should be performed.\(^1\)


  - Chest CT without contrast (CPT®71250), high resolution chest CT without contrast (CPT®71250), or chest CT with contrast (CPT®71260) can be performed if emphysema is suspected and the above initial studies are indeterminate.
  - Chest MRI is generally not indicated in the evaluation of COPD.
  - Patients with a family history of emphysema or chronic bronchitis should have a spirometry test as part of their initial evaluation.*


- An exacerbation of COPD is characterized by a change in baseline dyspnea, cough, and/or sputum that is acute in onset and beyond normal day-to-day variations.
  - Advanced imaging of the chest is not typically indicated in the evaluation of COPD exacerbation.
  - Evaluation of COPD exacerbation should include arterial blood gas measurement, chest x-ray, ECG, sputum culture, and blood work to measure electrolytes and complete blood count.*

There is no published data to support performing routine follow-up advanced imaging of the chest in patients with COPD.

**Lung Volume Reduction Surgery**
- Chest CT either without contrast (CPT®71250) or with contrast (CPT®71260) can be performed for preoperative evaluation in patients who are being considered for lung volume reduction surgery.*
  *Radiology 1999;212:1-3
- There is insufficient data to support obtaining routine follow-up advanced imaging of the chest in patients who have had lung volume reduction surgery.
- New or worsening signs/symptoms in patients who have had lung volume reduction surgery should be evaluated with chest x-ray prior to considering advanced imaging of the chest.

**CH-11~INTERSTITIAL DISEASE**

- High resolution chest CT scan (HRCT) without contrast (CPT®71250) is the diagnostic modality of choice to evaluate for interstitial changes in patients with pulmonary symptoms and abnormal pulmonary function studies (PFT’S). Chest x-ray may be normal in some cases of interstitial lung disease and PFT’s are the best indicator of the need for HRCT.
- Evaluation by a Pulmonologist is helpful in determining the need for advanced imaging.
- HRCT can be performed in patients with known interstitial pneumonia, idiopathic pulmonary fibrosis, or other interstitial lung disease if there are new or worsening pulmonary symptoms or worsening PFT’s.
- HRCT can be performed once a year in patients with known idiopathic pulmonary fibrosis (IPF) who are asymptomatic or have stable symptoms and stable PFT’s, if imaging results showing progression or regression of disease will change patient management.*

**CH-12~MULTIPLE PULMONARY NODULES**

- More than 6 nodules usually indicates inflammatory lung disease, and this has been confirmed after years of follow-up.*
  *Chest 2004;125:1522-1529
- Clustering of multiple nodules in a single location in the lung tends to favor an infectious process, although a dominant nodule with adjacent small satellite nodules can be seen in primary lung cancer.*
  *Radiology 2005;237:395-400
- In patients with multiple pulmonary nodules, the largest nodule should be imaged based on **CH-16 Solitary Pulmonary Nodule** Imaging Guidelines.
- If infection is highly suspected in a patient with multiple pulmonary nodules, the first follow-up chest CT (CPT®71250 or 71260) can be performed sooner than 3 months.
**CH-13~PNEUMONIA**

- Chest x-ray (overread by a radiologist) must be performed initially in all patients with suspected pneumonia prior to considering advanced imaging.
- Chest CT with contrast (CPT®71260) may be helpful in evaluating a patient with pneumonia that has shown no improvement by chest x-ray after two weeks or has not cleared by chest x-ray after four weeks.
- Chest CT with contrast (CPT®71260) is indicated when chest x-ray shows a possible complication of pneumonia (e.g. abscess, effusion) or possible lung mass associated with the infiltrate.

**CH-14~POSITIVE PPD or TUBERCULOSIS (TB)**

- Chest CT with contrast (CPT®71260) can be performed in patients with positive PPD skin test or other positive tuberculin skin tests and normal chest x-ray who have not had a previous normal chest CT.
- Chest CT can show evidence of tuberculosis (e.g. primary complexes, mediastinal or hilar lymphadenopathy) in up to 20% of patients with unremarkable chest x-rays.*
  * AJR 1997 Apr;168(4):1005-1009
  * Eur J Radiol 2003 Dec;48(3):258-262
  - Evidence of tuberculosis on chest CT will alter clinical management and result in full multi-drug treatment for these patients rather than single drug treatment for positive PPD.
- If chest CT is unremarkable, there is insufficient data to support performing subsequent chest CT scans unless symptoms develop or chest x-ray shows a new abnormality.
- Follow-up chest CT with contrast (CPT®71260) can be used to re-evaluate patients undergoing active treatment for tuberculosis who had abnormalities seen only on chest CT.
  - The frequency of the follow-up chest CT scans should be at the discretion of the pulmonary specialist following the patient, as there are no published guidelines or evidence-based data addressing this issue.
- Patients with suspected complications or progression of tuberculosis (e.g. pleural tuberculosis, empyema, mediastinitis) can be evaluated with chest CT with contrast (CPT®71260).

**CH-15~SARCOID**

- Also see **ONC-30.5 Sarcoidosis** in the Oncology Imaging Guidelines and **HD-32.3 Sarcoidosis** in the Head Imaging Guidelines.
- CT of the chest either with contrast (CPT®71260) or without contrast (CPT®71250) is superior to chest x-ray in establishing the diagnosis of sarcoid. CT scan helps differentiate sarcoid from other granulomatous disorders, especially tuberculosis, and allows follow-up for the detection of complications, especially fibrosis.*
• Patients with suspected sarcoid should have chest CT either with contrast (CPT®71260) or without contrast (CPT® 71250) to establish or rule out the diagnosis.
• Bronchoscopy with biopsy is indicated to make a definitive diagnosis; if positive for sarcoidosis, no further imaging is necessary.
• PET can also be useful in making the diagnosis of sarcoid, as sarcoid has a distinctive appearance on PET. However, definitive diagnosis can only be made by biopsy.
  o There is currently no evidence-based data to support performing serial PET scans to monitor disease activity while tapering steroid therapy.
• Cardiac PET (CPT®78459) is useful for identifying and monitoring response to therapy for cardiac sarcoid. The diagnosis should be established or strongly suspected prior to imaging.*
• Chest CT (either with or without contrast) is indicated in patients with worsening symptoms, new symptoms after a period of being asymptomatic, or if a treatment change is being considered.

CH-16~SOLITARY PULMONARY NODULE (SPN)

• A nodule is any pulmonary or pleural lesion represented in a radiograph by a sharply defined, discrete, nearly circular opacity 2-30 mm in diameter which is surrounded by normal lung tissue.
  o A linear or essentially two-dimensional opacity that does not have an approximately spherical component is not a nodule.
  o Purely linear or sheet like lung opacities are unlikely to represent neoplasms and do not require follow-up, even when the maximum dimension exceeds 8 mm (0.8 cm).*
    *Radiology 2005;237:395-400
  o Nodular opacities and/or thickening that are typical of scarring do not require follow-up advanced imaging and do not require imaging with contrast for further delineation.*
    *Radiology 2005;237:395-400
  o Malignant features can include spiculation, abnormal calcification, size greater than 7-10 mm, ground glass opacity, interval growth, history of a cancer that tends to metastasize to the lung or mediastinum, and/or smoking history.
  o Benign features can include benign calcification (granuloma, hamartoma), multiple areas of calcification, small size, multiple nodules, linear/streaking/sheet-like opacities, negative PET, and stability of size over 2 years.
• A pulmonary nodule seen on an imaging study other than a dedicated chest CT (e.g. nodule seen on abdominal CT, spine MRI, chest or coronary artery CTA, etc.) can be further evaluated with one chest CT without contrast (CPT®71250) or with contrast (CPT®71260).
• Follow-up imaging should proceed based upon the Modified Fleischner Society Criteria (next page) and other guidelines below. A solitary pulmonary nodule (SPN) can be imaged by chest CT without contrast (CPT®71250) or with contrast
(CPT®71260) (depending on physician preference) if there has been an increase in size on chest x-ray, if there are no old films for comparison, or if the lesion does not have classically benign characteristics by chest x-ray or previous CT (e.g. benign calcification pattern typical for a granuloma or hamartoma).

- If the SPN was identified on a prior CT or there has been a negative PET scan, then CT without contrast (CPT®71250) or with contrast (CPT®71260) (with thin cuts through the nodule) can be performed as follows:

\[1,2\]

\[\text{Radiology 2005;};237:395-400\]
\[\text{Radiology 2004;};231:164-168\]

**Modified Fleischner Society Criteria**

<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 months; if unchanged, no further follow-up¥</td>
</tr>
<tr>
<td>&gt; 4 – 6</td>
<td>Follow-up CT at 12 months; if unchanged, no further follow-up¥</td>
<td>One follow-up CT at 6-12 months then repeat CT at 18 months and 24 months±</td>
</tr>
<tr>
<td>&gt; 6 – 7</td>
<td>One follow-up CT at 6-12 months then repeat CT at 18 months and 24 months</td>
<td>One follow-up CT at 3-6 months, one CT at 9-12 months, and one CT at 24 months</td>
</tr>
<tr>
<td>&gt; 7</td>
<td>Follow-up CT at 3, 9, and 24 months</td>
<td>Same as for low-risk patient</td>
</tr>
</tbody>
</table>

*Note – Newly detected indeterminate nodule in persons 35 years of age or old.*

+ Average of length and width

+ Minimal or absent history of smoking and of other known risk factors.

± History of smoking or of other known risk factors.

§ The risk of malignancy in this category (<1%) is substantially less than that in a baseline CT scan of an asymptomatic smoker.

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

- “High risk patients” include those with smoking history, significant second hand smoke exposure, asbestos exposure, or history of cancer other than ordinary skin cancer.

- No further imaging is necessary if a nodule has been stable for 2 years.

- **Exceptions:**
  - Lesions that have a ground glass opacity component may require longer follow-up time than 2 years to exclude indolent adenocarcinoma\(^1\) and ground glass lesions greater than 2 cm should be resected.\(^2\) These cases should be sent for Medical Director review.
  - Although most cancerous nodules are solid, partly solid nodules are most likely to be malignant (usually bronchioalveolar cancer).\(^3\)
  - Likelihood of malignancy is 63% for partly solid nodule, 18% for nonsolid nodule, and 7% for solid nodule.\(^4\)

\[1\] \text{Radiology 2005;};237:395-400
\[2\] Siegelman SS. Hot Topics in Chest CT. Presented at: 24th Annual Computed Body Tomography: The Cutting Edge, February 14-17, 2008, Orlando, FL.
\[3\] \text{Radiology 2006;};239:34-49
\[4\] AJR 2002 May;178(5):1053-1057

- Patients with a personal history of malignancy that would reasonably metastasize
to the lungs or mediastinum who are found to have pulmonary nodules of any size can have repeat chest imaging at 3, 6, 12, and 24 months.

- A nodule that grows at a rate consistent with cancer (doubling time 30 to 360 days) should be sampled for biopsy or resected.*
  *Chest 2004;125:1522-1529

- PET scan (CPT®78812 or CPT®78815) is appropriate for the characterization of an SPN if the lesion is a distinct parenchymal lung nodule (not an infiltrate, ground glass opacity, or hilar enlargement) measuring greater than or equal to 7 mm (0.7 cm) on chest CT scan.
  o **NOTE:** Certain payers consider PET scan investigational for evaluating pulmonary nodules ≤1 cm or lung masses >4 cm. Their coverage policies will take precedence over MedSolutions’ guidelines.
  o **Reference:**

- If PET scan is negative, chest CT should be performed at 3, 9, and 24 months.*

- Serial PET scans to evaluate lung nodules are not appropriate: if the original PET is positive, biopsy should be performed. If the original PET is negative but subsequent chest CT shows increase in size of the nodule, biopsy should be performed. *
  *Radiology 2006; 239:34-49

- MRI of the chest is the least preferred modality for evaluation of lung nodules*
  *ACR Appropriateness Criteria, Solitary pulmonary nodule, 2008
PLEURA (ALPHABETICAL ORDER)

CH-17~PLEURAL-BASED NODULES
and OTHER ABNORMALITIES

- An indeterminate pleural-based nodule or lesion seen on an imaging study other than a dedicated chest CT (e.g. nodule or lesion seen on chest x-ray overread by a radiologist, abdominal CT, spine MRI, chest or coronary artery CTA, etc.) can be further evaluated with one chest CT without contrast (CPT®71250) or with contrast (CPT®71260).
  - If CT scan shows findings consistent with a benign process (round atelectasis, scarring, apical thickening, etc.), no follow-up advanced imaging is indicated.
    - “Round atelectasis”: twisting or folding of the lung which becomes adherent to the adjacent pleura.
  - If the abnormality cannot be read as benign, repeat chest CT (CPT®71250 or CPT®71260) can be performed using the Modified Fleischner Society Criteria and other guidelines in CH-16 Solitary Pulmonary Nodule (SPN)
- Nodular opacities and/or thickening that are typical of scarring do not require follow-up advanced imaging and do not require imaging with contrast for further delineation.*
  *Radiology 2005;237:395-400
- There is no evidence-based data to support performing PET scan in patients with pleural-based nodules or lesions.

CH-18~PLEURAL THICKENING

- Pleural thickening may be the residual effect of inflammatory processes, including pneumonia with parapneumonic effusion, empyema, hemothorax, asbestos exposure, talc exposure, rheumatoid lung disease, radiation therapy, and drugs.
- May occur due to infiltration of the pleura by malignant tumors such as mesothelioma or metastatic adenocarcinoma.
- May occur due to localized fibrous tumor of the pleura (LFTP)
  - LFTP’s exist in benign and malignant forms with the benign form occurring seven times more frequently than the malignant form.
  - Etiology of LFTP’s is unknown.
  - If LFTP is suspected due to a chest x-ray abnormality, chest CT with contrast (CPT®71260) or chest MRI without and with contrast (CPT®71552) can be performed.
  - Histologic examination is needed for a definitive diagnosis.
  - Treatment is resection.
- Localized pleural thickening often occurs at the lung apices with increasing age, forming a pleural cap. Unless the patient is at high risk for malignancy or tuberculosis, no advanced imaging is indicated.
• Patients with suspected pleural thickening seen on chest x-ray (overread by a radiologist) can have chest CT with contrast (CPT®71260) or high resolution chest CT without contrast (CPT®71250) for further evaluation.
  o If the chest CT shows pleural plaques or findings consistent with asbestosis, follow-up imaging guidelines described in CH-9 Asbestos Exposure should be followed.
  o If CT scan shows findings consistent with a benign process (round atelectasis, scarring, apical thickening, etc.), no follow-up advanced imaging is indicated.
  o If there is concern for malignancy or a definitive diagnosis is desired, then pleural biopsy should be performed by thoracoscopy or open biopsy.
  o Serial advanced imaging of pleural thickening is not indicated unless patients have a known diagnosis such as asbestos-related disease, silicosis, or tuberculosis that is causing progressive pleural changes.

DISORDERS INVOLVING THE PLEURAL SPACE
(ALPHABETICAL ORDER)

CH-19~PLEURAL EFFUSION

• Chest x-ray (including lateral decubitus films) should be performed initially in patients with suspected pleural effusion.
• Chest ultrasound (CPT®76604) can be used to evaluate for the presence of fluid within the pleural spaces.
• In patients with large pleural effusions, thoracentesis and analysis of the pleural effusion (cytology, culture, cell count, biochemical studies) to distinguish transudative vs exudative should be performed prior to considering advanced imaging.
• The most common causes of pleural effusions in the United States are congestive heart failure, bacterial pneumonia, malignancy (esp. lung cancer, breast cancer, and lymphoma), and pulmonary emboli.
• If the pleural effusion is transudative and the etiology has been established (e.g. congestive heart failure, cirrhosis, nephrotic syndrome, peritoneal dialysis), advanced imaging of the chest is rarely indicated.
• If the pleural effusion is exudative, chest CT with contrast (CPT®71260) can be performed after as much fluid as possible has been removed by thoracentesis.
  o There is little utility to obtaining chest CT in a patient with a large effusion prior to thoracentesis, since the fluid will obscure the underlying lung parenchyma.
  o Pleural biopsy is indicated for unexplained exudative effusions, most of which are found to result from malignancy or tuberculosis.

References:
- Advanced imaging of the chest is rarely indicated in the diagnosis or management of pneumothorax.
- If the diagnosis of a small pneumothorax is in doubt, and the presence of a pneumothorax will affect patient treatment decisions, then noncontrast chest CT (CPT®71250) can be performed.
- There is no data supporting the use of serial chest CT scans to follow patients with known pneumothorax who are asymptomatic or have stable symptoms.
- Patients with trauma significant enough to raise suspicion for hemothorax should be evaluated in the Emergency Department.
- Chest CT with contrast (CPT®71260) can be performed as a preoperative study in patients in whom pleurodesis or other invasive procedure for pneumothorax is being considered.
- There is no data supporting the use of serial chest CT scans to follow patients with known hemothorax who are asymptomatic or have stable symptoms.
- Chest CT with contrast (CPT®71260) can be performed in patients with suspected complications from hemothorax (e.g. empyema).
- Chest CT with contrast (CPT®71260) can be performed as a preoperative study in patients undergoing surgical evacuation for hemothorax.
**MEDIASTINUM**

**CH-21~MEDIASTINAL LYMPHADENOPATHY**

- See [CH-2.3 Mediastinal Lymphadenopathy](#)

**CH-22~MEDIASTINAL MASS**

- Chest ultrasound (CPT®76604) can be used to evaluate a mediastinal mass if requested. However, chest CT with contrast (CPT®71260) is the imaging study of choice to evaluate mediastinal abnormalities.
- Chest CT with contrast (CPT®71260) is indicated to evaluate a widened mediastinum on a chest x-ray (overread by a radiologist).
- Chest CT (either with contrast [CPT®71260] or without contrast [CPT®71250]) is indicated in patients diagnosed with myasthenia gravis in order to rule out a thymoma. **Note:** iodinated contrast has been reported to provoke myasthenia crisis.
  - Also see [PN-6.1 Neuromuscular Disease](#) in the Peripheral Nerve Disorders Imaging Guidelines and Thymoma in [ONC-11 Other Thoracic Tumors](#) in the Oncology Imaging Guidelines
- Patients with a suspected substernal goiter should have a neck ultrasound (CPT®76536) or radionuclide study first to confirm extension of the thyroid to the sternum.
- In patients who present with dysphagia and no history of prior malignancy, barium swallow should be performed initially (see [NECK-3 Dysphagia](#) in the Neck Imaging Guidelines).

**CHEST WALL AND RIBS (ALPHABETICAL ORDER)**

**CH-23~CHEST TRAUMA**

- **Rib Fracture**
  - A complete history and physical examination, including palpation of the chest, should be performed initially in patients with chest trauma and suspected rib fracture.
  - A recent chest x-ray, including erect posteroanterior (PA) and oblique views should be performed prior to considering advanced imaging.
  - Suspicion of an occult rib fracture is not an indication for chest CT.
  - If the patient remains symptomatic, repeat plain x-rays of the ribs should be obtained. These may show signs of early healing of a rib fracture.
  - If the diagnosis is still uncertain, bone scan is indicated. A delay of several days should be allowed after an acute trauma to increase the sensitivity of bone scan to detect rib fracture(s).
  - Patients with multiple new rib fractures can undergo chest CT without contrast (CPT®71250) or with contrast (CPT®71260) to rule out any associated intrathoracic pathology.
  - Routine follow-up advanced imaging of rib fractures is not indicated.
- **Fracture of the Sternum**
  - Injury to the sternum or suspected fracture of the sternum should be
evaluated initially with lateral and oblique x-rays centered on the sternum.

- If the diagnosis is still uncertain, chest CT without (CPT®71250) or with contrast (CPT®71260) can be performed.
- If a new sternal fracture is found, cardiac evaluation with ECG, cardiac enzymes, and rhythm monitoring should be performed to rule out significant arrhythmia due to blunt cardiac trauma.
- Routine follow-up advanced imaging of sternal fractures is not indicated.

**References:**


**Imaging of the Abdomen and Pelvis in Patients with Chest Trauma**

- If there was no significant trauma involving the abdomen or pelvis, and a careful physical examination, laboratory studies, and urinalysis do not raise suspicion for abdominal or pelvic pathology, no advanced imaging of the abdomen or pelvis is indicated.

### CH-24–COSTOCHONDRITIS

- Inflammatory process of the costochondral or costosternal joints that causes localized pain and tenderness. More than one site is affected in 90% of cases.
- The 2nd to 5th costochondral junctions are most commonly involved.
- Pain is usually described as follows:
  - Worse with movement of the trunk, deep breath, and/or exertion
  - Decreases with change of position
  - Sharp, nagging, aching, or pressure-like
  - Usually localized but may radiate extensively
  - May wax and wane

- Physical examination with palpation of the chest should be performed initially.
  - Pain with palpation of the affected costochondral joints is a constant finding in costochondritis.
  - The diagnosis should be reconsidered if there is absence of local tenderness to palpation.

- Chest x-ray should be the initial imaging study to rule out other pathology.
- Bone scan is sometimes performed to confirm the diagnosis of costochondritis or if infection of the costochondral joint is suspected.
- If signs, symptoms, and physical examination are consistent with costochondritis, advanced imaging is not indicated.
- If pain persists despite treatment with rest and anti-inflammatory medication, work-up should proceed as described in: CH-4 Non-Cardiac Chest Pain.

**Reference:**

CH-25~CHEST WALL MASS

- Chest ultrasound (CPT® 76604) can be used to evaluate a chest wall mass if requested.
- Chest x-ray should be performed initially to rule out intrathoracic pathology, evaluate the presence of calcification in the mass and rule out bony destruction of the chest wall.
- If chest x-ray shows a suspicious intrathoracic abnormality, chest CT with contrast (CPT® 71260) can be performed.
- If chest x-ray does not show a suspicious intrathoracic abnormality, but there is a palpable chest lesion that is not clinically consistent with a lipoma or simple skin lesion, then chest MRI without and with contrast (CPT® 71552) is the advanced imaging modality of choice. Chest CT with contrast (CPT® 71260) is acceptable if MRI cannot be performed.
- If lipoma or simple skin lesion is high on the differential diagnosis list, then evaluation by a surgeon or dermatologist is helpful in determining the need for advanced imaging.
  - Lipomas are one of the most common chest wall lesions.
  - The preferred imaging technique for evaluating lipomas depends on the clinical question.
    - If the study is being performed to diagnose a mass as a lipoma, noncontrast chest CT (CPT® 71250) is sufficient and enables specific recognition of fat and is faster than MRI.
    - If surgical removal of the lesion is planned and the lesion is large, infiltrating, or near important neurovascular structures, chest MRI (contrast as requested) can be performed.
  - Reference:

CH-26~PECTUS EXCAVATUM and PECTUS CARINATUM

- See also PACCH-12 Pectus Excavatum and Pectus Carinatum in the Pediatric Chest Imaging Guidelines
- Initial evaluation of patients with suspected or known pectus excavatum (ribs and sternum grow abnormally producing a concave or caved-in appearance in the anterior chest wall), pectus carinatum (anterior protrusion of the chest wall), or other deformities of the chest wall or sternum should include a complete history and physical examination and plain chest x-rays.
- Chest CT without contrast (CPT® 71250) can be performed in selected cases of asymmetric pectus excavatum if significant cardiac displacement and rotation is suspected, or for preoperative planning.
- ECG and echocardiography should be performed initially in patients with cardiac symptoms or evidence of abnormalities of cardiac function.
- Chest x-ray and PFT’s should be performed initially in patients with known pectus who present with increasing shortness of breath.
- Reference:
BREAST

CH-27 BREAST ABNORMALITIES

<table>
<thead>
<tr>
<th>27.1</th>
<th>Breast Ultrasound</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.2</td>
<td>Breast Reconstruction</td>
<td>27</td>
</tr>
<tr>
<td>27.3</td>
<td>Computer-Aided Detection (CAD) for Breast MRI</td>
<td>28</td>
</tr>
<tr>
<td>27.4</td>
<td>Indications for MRI of the Breast</td>
<td>28</td>
</tr>
<tr>
<td>27.5</td>
<td>Breast MRI Not Indicated</td>
<td>31</td>
</tr>
<tr>
<td>27.6</td>
<td>Nipple Discharge/Galactorrhea</td>
<td>33</td>
</tr>
<tr>
<td>27.7</td>
<td>Breast Pain (Mastodynia)</td>
<td>34</td>
</tr>
<tr>
<td>27.8</td>
<td>Newer Breast Imaging Techniques</td>
<td>35</td>
</tr>
</tbody>
</table>

CH-27~BREAST ABNORMALITIES

- See [BI-RADS™ Categories Chart](#) for full description of BI-RADS™ categories.
- **CH-27.1 Breast Ultrasound**
  - CPT®76645—Ultrasound breast(s) (unilateral or bilateral)
  - CPT®76882—Ultrasound of the axilla
    - If bilateral axillary ultrasounds are being performed, this should be coded as CPT®76882 x 2.
  - Mammography should be used to screen for breast cancer in the general population. It is inappropriate to use only breast ultrasound (CPT®76645) for cancer screening instead of mammography.
  - Breast ultrasound (CPT®76645) is typically performed to further evaluate abnormalities found on mammography.
    - Routine performance of breast ultrasound with diagnostic mammography is inappropriate.
    - Sagittal, transverse, and oblique images are generally obtained when performing breast ultrasound (CPT®76645).
  - Breast ultrasound (CPT®76645) should be used to differentiate cysts from solid lesions.
  - Breast ultrasound (CPT®76645) without mammogram can be the initial imaging study to evaluate a palpable breast mass in women younger than age 30.
- **CH-27.2 Breast Reconstruction**
  - In individuals under consideration for DIEP or other free tissue transfer flaps for breast reconstruction, CTA or MRA of the body part from which the tissue transfer is being taken can be performed for preoperative planning.
    - For example, for DIEP flap, CTA (CPT®74175 and CPT®72191) or MRA (CPT®74185 and CPT®72198) of the abdomen and pelvis can be performed for preoperative planning.
There is currently insufficient evidence-based data to support the need for routine advanced imaging for TRAM flaps or other flaps performed on a vascular pedicle.

- **CH-27.3 Computer-Aided Detection (CAD) for Breast MRI**
  - Certain payers consider computer-aided detection (CAD) for breast MRI investigational, and their coverage policies will take precedence over MedSolutions' guidelines.
  - There have been no large, prospective studies showing that CAD definitively improves the sensitivity, specificity, and recall rates of breast MRI.
  - Therefore, the use of CAD with breast MRI should be considered investigational at this time.
  - It is not appropriate to report 3D rendering (CPT®76376 or CPT®76377) when requesting breast MRI with CAD, since 3D rendering is included in the Category III code for CAD (CPT®0159T).
    - A dictated report of either the breast MRI study for which 3D rendering is being requested (if the 3D rendering request is a retro request), or a previous breast MRI report if one was done, should be sent to MSI prior to approving a 3D rendering request for breast MRI.

- **CH-27.4 Indications for MRI of the Breast**
  - **Breast MRI**: either unilateral [CPT®77058] or bilateral [CPT®77059] per physician request.
  - Mammography, ultrasound (CPT®76645), and percutaneous biopsy should be used to screen for breast cancer in the general population.
  - Breast ultrasound (CPT®76645), should be used to differentiate cysts from solid lesions.
  - **Indications for Breast MRI**:
    - **Breast Augmentation, Breast Implants (saline or silicone), Breast Reconstruction, Free Injection, Capsular Contracture**
      - Breast MRI can be performed if mammography or ultrasound (CPT®76645) is uninterpretable
        - Findings on the mammogram or ultrasound report should be obtained or documented prior to starting breast MRI surveillance studies.
      - Evaluate or confirm breast implant rupture
        - Patients with silicone breast implants can have a surveillance breast MRI three years after implantation and every two years thereafter to screen for rupture per the current FDA recommendations.
        - If leakage is detected on MRI, the implant(s) should be removed.
        - Once the implant(s) have been removed, no further surveillance MRI of the affected breast(s) is indicated.
        - **NOTE:** Certain payers do not include breast implants in their coverage policies if the breast implants were placed as part of purely cosmetic surgery. Thus, surveillance MRI scans in these patients would also not be included in the coverage policy. Their coverage policies will take precedence over MedSolutions' guidelines.
- **Annual Screening Breast MRI Study for High Risk Patients:**
  - Starting at age 25 for patients with BRCA 1 or BRCA 2 mutation.
  - Patients with a first degree relative with BRCA mutation (if patient has not been tested).
    - Screening studies for the patient should start 10 years before the relative with BRCA was diagnosed with cancer.
    - If the relative with BRCA was not diagnosed with cancer, then screening studies for the patient should start at age 25.
  - **Starting at Age 25 for High Risk Patients, Defined as 20%-25% or Greater Lifetime Risk of Developing Breast Cancer as Determined By:**
    - Clinical lifetime risk estimated at greater than 20% using clinical risk estimator such as the Gail, Claus, Tyrer-Cuzick or BRCAPRO models
    - Two or more first degree relatives (parent, sibling, child) with breast or ovarian cancer
    - One first degree relative with breast cancer or ovarian cancer diagnosed before age 50
    - One first degree relative with bilateral breast cancer or both breast and ovarian cancer
    - History of breast cancer in a male relative (not a distant relative)
    - Ashkenazi Jewish women from families with onset of breast cancer before age 40
    - Li-Fraumeni Syndrome and first degree relatives
    - Cowdan and Bannayan-Riley-Ruvalcaba Syndromes and first degree relatives
    - Women with history of radiation to the chest between ages 10 and 30. (If history of Hodgkin’s Disease, breast screening should start 8 to 10 years post-therapy, or at age 40, whichever comes first)
    - The American Cancer Society, the Society of Breast Imaging, and the National Comprehensive Cancer Network (NCCN) Clinical Guidelines in Oncology recommend that breast MRI be performed in facilities that have the capability to perform MRI-guided breast biopsies.
  - **References:**
    - *CA Cancer J Clin* 2007;57:75-89

- **Equivocal or Occult Findings**
  - Patients in whom mammography, ultrasound, and clinical findings are inconclusive or conflicting.*

    - “MRI should not be used to determine biopsy recommendations for indeterminate lesions that can be readily biopsied, such as palpable masses and microcalcifications.”**
    - *AJR 2009;193:986-993
  - Although breast MRI has superior sensitivity in identifying new
unknown malignancies, it carries a significant false positive risk when compared to mammogram and ultrasound. Incidental lesions are seen on 15% of breast MRI's. The percentage of incidental lesions that turn out to be malignant varies from 3% to 20% depending on the patient population. Cancer is identified by breast MRI in only 0.7% of those with “inconclusive mammographic lesions.”*

*AJR 2009;193:986-993

- Evaluate patients who present with axillary metastases suspicious for primary breast cancer with negative physical exam and negative mammogram (MRI detects breast cancer in 90%-100% of cases if tumor is indeed present)
- Guide biopsy of lesions seen only on MRI
  - If diagnostic breast MRI has previously been performed, and the currently requested breast MRI is being performed solely to guide a breast biopsy, then the breast MRI portion of the procedure is included in the CPT code for the MRI-guided procedure (CPT®77021) and requests for CPT®77058 or CPT®77059 are inappropriate.
  - Exception: If the previous diagnostic breast MRI was of poor quality or an unanswered clinical question remains, a repeat diagnostic breast MRI (CPT®77058 or CPT®77059) can be performed prior to MRI guided breast biopsy, especially if the biopsy is being performed at a different facility than the original breast MRI.

Newly Diagnosed Breast Cancer
- Breast MRI (including contralateral breast) can be performed to evaluate patients with newly-diagnosed, biopsy-proven breast cancer
- A recent study found that breast MRI detected cancers in the contralateral breast that were not detected by clinical exam or mammogram in 30 of 969 women*

Tumor Response
- Assess response to neoadjuvant chemotherapy for locally advanced breast cancer
  - NOTE: If no pre-chemotherapy breast MRI was performed, then a post-chemotherapy MRI should not be performed, as the findings will be too confusing.*
  *Huff JG. Clinical Applications of Breast MRI: Current Indications and Examples. Presented at: Identification and Management of Breast Cancer, October 6, 2007; Nashville,TN

Residual or Recurrent Malignancy
- Assessment of residual tumor load in patients who have undergone lumpectomy and have close or positive margins, when the findings may indicate a significant change in surgical management.
- Evaluate clinical suspicion of recurrence, following evaluations with mammography and/or ultrasound, if those evaluations are inconclusive
or conflict with physical examination or other clinical indicators. This applies to intact breasts, reconstructed breasts, and possible chest wall recurrences following mastectomy.

- **NOTE:**
  - Breast MRI in the first 12 months after surgery has poor sensitivity and specificity due to post surgical edema, hemorrhage, inflammation, scarring, and fat necrosis.*
  - It is advisable to wait 6 to 12 months after radiation before performing breast MRI. MRI prior to this time may give misleading results due to edema, architectural distortion, and cancers may exhibit benign appearing kinetics.*

  *Huff JG. *Clinical Applications of Breast MRI: Current Indications and Examples. Presented at: *Identification and Management of Breast Cancer, October 6, 2007; Nashville, TN*

- **Reference:**

- **CH-27.5 Breast MRI Not Indicated**
  - See [BI-RADS™ Categories Chart](#) for full description of BI-RADS™ categories.
  - **Routine Surveillance:**
    - Breast MRI should not be used for routine surveillance in patients with a history of breast cancer (including DCIS, premenopausal women with a history of breast cancer, and women with a history of breast cancer that was only found on MRI), unless the patient meets criteria for [Annual Screening Breast MRI Study for High Risk Patients](#) in CH-27.4 Indications for MRI of the Breast.
    - NCCN guidelines state that “a diagnosis of LCIS is associated with estimated risks of 10%-20% for the subsequent development of cancer in either breast over the next 15 years…the panel also recommends consideration of MRI annually for women with LCIS.”**
    - Therefore, LCIS by itself does not confer a 20%-25% lifetime risk of breast cancer and the patient must still have additional risk factors that meet criteria for [Annual Screening Breast MRI Study for High Risk Patients](#) in CH-27.4 Indications for MRI of the Breast.

- **Dense Breasts**
  - Evidence-based data does not support routine breast MRI screening for patients with dense breasts by mammogram (density 4 or 5). The patient must still have additional risk factors that meet criteria for [Annual Screening Breast MRI Study for High Risk Patients](#) in CH-27.4 Indications for MRI of the Breast. There are currently no data to show reduction in mortality from breast cancer from any screening technique other than mammography.*
  - The findings on the most recent mammogram should be obtained or documented. If the mammogram has been given a BI-RADS™ designation of BI-RADS™ 1, 2, 3, 4, or 5, then the radiologist has been able to interpret the mammogram and breast MRI is not indicated even if the mammogram report states the presence of dense breasts.
  - If the mammogram has been given a BI-RADS™ 0 then further
imaging is needed and MRI can be considered.  
*AJR 2009;192:390-399

- Currently, there is insufficient data to support the use of breast MRI for breast cancer screening in women with atypical hyperplasia or mutations other than BRCA unless the patient satisfies the criteria for annual screening with breast MRI outlined under Annual Screening Breast MRI Study for High Risk Patients in CH-27.2 Indications for MRI of the Breast.*

- References:
  - CA Cancer J Clin 2007;57:75-89

- Low Risk, Probably Benign (BI-RADS™3) Solid Lesion on Mammogram and/or Ultrasound
  - A solid lesion found on mammogram/ultrasound (CPT®76645), can be observed and followed with repeat mammogram/ultrasound in 6 months if the lesion is a low-risk, probably benign lesion (includes the following: <15 mm, three or fewer lobulations, more than 50% of the lesion margin appears well-circumscribed in any view).
  - Lesions not fitting all of the above criteria should be considered indeterminate and the patient should be referred for surgical evaluation for biopsy.*
  - If a probably benign lesion is clearly seen on mammogram and/or ultrasound (CPT®76645), then repeat mammography and/or ultrasound should be performed at 6 months. Follow-up breast MRI is not indicated.*
  - In the evaluation of BI-RADS™ category 3 lesions, MRI did not provide additional information (low positive predictive value [33%]) and was similar to that of short interval (6 month) mammography follow-up.*
    - *Eur J Radiol 2006 Mar;57(3):436-444

- Suspicious (BI-RADS™4 or 5) Solid Lesion on Mammogram and/or Ultrasound
  - Bilateral total breast ultrasound (CPT®76645), and bilateral axillary ultrasound (CPT®76882) are recommended for patients who have BI-RADS™ 4 or 5 abnormalities. If additional suspicious breast lesions or more extensive malignant breast disease is detected by ultrasound, the extent of disease can be mapped with ultrasound-guided biopsies (CPT®76942).*
A breast mass categorized as BI-RADS 4 or 5 should be biopsied.*

*ACR Appropriateness Criteria, Nonpalpable mammographic findings (excluding calcifications), Updated 2010

Biopsy of microcalcifications seen on mammogram in order to rule out malignancy (including DCIS) should be performed rather than breast MRI.

- The sensitivity of MRI in evaluating mammographically detected suspicious microcalcifications was only 87% with specificity 68%. The sensitivity of MRI for DCIS was 79%.* Therefore, biopsy of these lesions is warranted rather than MRI.
- Some DCIS is only seen on MRI; therefore MRI-guided biopsy (CPT®77021) is appropriate in these cases.
  *AJR 2006 Jun;186(6):1723-1732

**Serial Follow-up on Breast MRI Scans**

- There is insufficient data to support using serial breast MRI studies to follow patients with mammographic abnormalities or abnormalities seen on other imaging studies.
- Breast MRI should be able to characterize a lesion as benign, probably benign, or as suspicious.
- If breast MRI was obtained because a mammogram or ultrasound was unclear, then a probably benign lesion on MRI (MRI BI-RADS 3) should undergo repeat mammography and one repeat breast MRI in 6 months.
- A report from The Agency for Healthcare Research and Quality (AHRQ) Effective Health Care Program concluded that none of the four commonly used noninvasive tests for breast abnormalities (MRI, ultrasound, PET, scintimammography) is sufficiently accurate to preclude breast biopsy in average risk women with nonpalpable breast lesions. The data were insufficient to estimate the accuracy of these tests in women with only palpable lesions.*

- Also see ONC-12 Breast Cancer in the Oncology guidelines

- **CH-27.6 Nipple Discharge/Galactorrhea**
  - Mammogram should be obtained. Ultrasound (CPT®76645), may be helpful to locate a duct papilloma, an intraductal nodule, or dilated duct.
  - The appearance of the fluid generally correlates with the etiology:
    - Yellow, brown, green, or gray fluid is associated with fibrocystic change in most patients.
    - Purulent discharge can result from duct ectasia or partial duct obstruction.
    - Pathologic discharges are usually bloody, blood-containing, or sometimes watery and usually are unilateral and involve a single duct.
      - Patients with bloody or unilateral discharge or palpable abnormality should have a mammogram, with or without an ultrasound (CPT®76645) and referral to a surgeon for open biopsy is recommended.*
Physiologic discharges are usually bilateral, involve multiple ducts, are multicolored or milky, sticky, and are stimulated rather than occurring spontaneously.

- Prolactin and TSH levels should be obtained. A prolactinoma typically causes a milky or clear discharge bilaterally.
- Imaging of the pituitary is not necessary in patients with galactorrhea and normal prolactin levels.
- See **HD-27.1 Prolactinomas** in the Head Imaging Guidelines

- Bloody or, less commonly, watery discharge raises the possibility of cancer (cancer accounts for 8%-15% of bloody nipple discharges), although most hemoccult-positive discharges are due to a benign etiology such as intraductal papilloma (45%), duct ectasia (36%), and infection and other causes (5%-10%).
- Ductogram and duct excision can be considered. A papilloma should be resected by lumpectomy or vacuum-assisted lumpectomy.
- Breast MRI is not indicated* 


- If mammography and endocrine studies are normal, observation and clinical re-evaluation should be performed. If clinical evaluation at the time of follow-up does not reveal any palpable or visible abnormalities, the patient should return to routine screening interval studies with mammogram or clinical exam.

- Reference:

### CH-27.7 Breast Pain (Mastodynia)

- Three classifications:
  - Cyclic mastalgia: occurs in premenopausal women and is clearly related to the menstrual cycle.
  - Non-cyclic mastalgia: intermittent or continuous pain that is not related to the menstrual cycle. Usually occurs in older women.
  - Non-mammary pain: may present with the symptom of breast pain. History and physical exam should help differentiate breast pain from pain radiating from the chest wall or another site.

- Evaluation of breast pain:
  - Careful history and physical exam
  - Pregnancy test is generally the only laboratory study that is needed
  - Mammogram/ultrasound (CPT® 76645)

- Advanced imaging is not routinely indicated in patients with breast pain and negative evaluation as outlined above.
  - The risk of malignancy following a negative examination has been estimated to be only 0.5%.

- Reference:
  - Institute for Clinical Systems Improvement (ICSI), *Diagnosis of Breast Disease*. Jan 2010.
CH-27.8 Newer Breast Imaging Techniques
  - RODEO MRI: Rotating Delivery of Excitation Off-Resonance MRI
    - High resolution 1.5T MRI system designed specifically for the breast. This system utilizes a unique fat suppression technology which provides greater detail about a lesion including distance, length/width, area, surface area, and volume without the distraction of fat tissue in the image. This reduces signal from normal ductal tissue and avoids false positive enhancement from benign lesions and dense fibroglandular tissue.
    - RODEO MRI is a particular software sequence for breast MRI. With current MRI techniques on a non-RODEO MRI, multiple MRI sequences give similar results to those obtained on a RODEO MRI.
    - There is no unique CPT® code or different reimbursement for breast MRI scans performed using the RODEO system, and the indications for breast MRI are no different (see CH-27.2 Indications for MRI of the Breast).
  - Positron-Emission Mammography (PEM) or Naviscan: See CH-37
  - Breast MR Spectroscopy: See CH-38
  - Breast Tomosynthesis:
    - Uses conventional mammographic x-ray tubes, but the x-ray source is movable and swings over the breast in a 50-degree arc, creating 11 discrete images that can be combined or analyzed in many different ways to provide a three-dimensional data set or to create cross-sectional images.
    - There is insufficient data currently to generate appropriateness criteria for the use of breast tomosynthesis, and this procedure should be considered investigational at this time.
  - Scintimammography
    - Nuclear medicine study that uses a radioisotope such as Tc-99 tetrofosmin to image the breast. Breast cancer typically shows increased uptake of the radioisotope compared to benign lesions.
    - Acts as a “poor man’s MRI”.
    - Scintimammography does not require preauthorization by MedSolutions at this time.
THORACIC VASCULAR DISORDERS (ALPHABETICAL ORDER)

CH-28~PULMONARY ARTERIOVENOUS FISTULA (AVM)

- **Definition**: abnormal connection between pulmonary arteries and veins.
- **Etiology**:
  - Acquired: penetrating or blunt trauma to the chest; bronchiectasis
  - Pulmonary AVM's are most commonly found in the lower lobes.
  - Chest x-rays are abnormal in approximately 98% of patients with pulmonary AVM.
    - Chest x-ray usually shows a peripheral, circumscribed, non-calcified lesion connected by blood vessels to the hilum of the lung.
  - Chest CT (contrast as requested) and chest MRA (CPT®71555) or chest CTA (CPT®71275) can be obtained for evaluation of possible pulmonary AVM.
  - First degree relatives of a patient with a pulmonary AVM (not due to trauma or bronchiectasis) can undergo screening with chest CT (CPT®71260).
- **Treatment of pulmonary AVM** is by surgery (usually lobectomy) or embolization of the feeding artery using platinum coils or detachable balloons.

**References**:
- Australasian Radiology 2005;49:242-245

CH-29~PULMONARY EMBOLISM (PE)

- Patients who present with severe findings and dyspnea (including heart rate >100 beats/minute along with systolic BP<90, syncope, new onset right heart failure) should be referred to the Emergency Department for immediate evaluation and treatment.
- The clinical probability of PE is important in making an accurate diagnosis. An often cited point system (**Wells criteria**) includes the following:*  
  *Thromb Haemost 2000;83:416-420*  
  - Clinical signs/symptoms of DVT (at minimum: leg swelling and pain with palpation of the deep veins) (3 points)
  - No alternate diagnosis likely or more likely than pulmonary emboli (3 points)
  - Heart rate >100 beats/minute (1.5 points)
  - Immobilization (>3 days) or surgery in last 4 weeks (1.5 points)
  - Previous history of DVT or PE (1.5 points)
  - Hemoptysis (1 point)
  - Cancer actively treated in last 6 months or receiving palliative treatment (1 point)
  - Low probability <2 points; moderate 2 to 6 points; high>6 points
  - Using the above criteria, only 3% of patients with a low pretest probability had PE versus 63% of those with a high pretest probability.
- **Signs/Symptoms of PE** include (in decreasing order):
  - Dyspnea (73%)
  - Pleuritic chest pain (70%)
  - PE is found in 5%-20% of patients who present to the Emergency Department with pleuritic pain.*  
  *Am Fam Physician 2007 May;75(9):1357-1364*
- Tachypnea (70%)
- Leg swelling or pain (54%)
- Cough (37%)
- Tachycardia (30%)
- Hemoptysis (13%)
- Palpitations (10%)
- **Reference:**
  - Chest 1991;100(3):598-603

**Other risk factors for deep venous thrombosis (DVT)/PE not listed above:**
- Recent history of a long airplane flight
- Use of birth control pills
- Trauma
- Advanced age
- Congestive heart failure

Evaluation of outpatients with suspected pulmonary embolism should include a consideration for clinical probability of PE using the Wells criteria point chart above as well as the urgent nature of the request, and results of a quantitative D-dimer study.

**CT or CTA is not indicated for the following:**
- Wells criteria score is ≤4 and D-dimer is negative*  
  - *JAMA 2006; 295:172-179  
  - Negative D-dimer in combination with low or moderate PE risk classification do not require CTA since the negative predictive value approaches 100%
- **Chest CT with contrast (CPT®71260) or chest CTA (CPT®71275) is indicated for the following:**
  - Abnormal D-dimer test
    - **NOTE:** recent surgery, injury, malignancy, sepsis, diabetes, pregnancy, or other conditions where fibrin products are likely to be present can give a false positive D-dimer result.
  - Wells criteria score higher than 4 points*  
    - *JAMA 2006; 295:172-179
  - High clinical probability of PE
    - In general, this includes individuals with one or more risk factors for PE who present with recent onset (within past two weeks) of shortness of breath (dyspnea) and one other sign or symptom that cannot readily be attributed to a cardiac etiology (ischemia, congestive heart failure, valve problem, etc.) or primary pulmonary etiology (pneumonia, pleural effusion, pneumothorax, etc.).
      - In non-urgent cases, chest x-ray should be obtained prior to considering advanced imaging of the chest.

**Pregnant patients with suspected PE** should have D-dimer performed.
- If there is low clinical pre-test probability for PE and D-dimer is negative, no further work-up is needed.
- If D-dimer is positive (D-dimer is normally increased in pregnancy and the levels tend to increase as pregnancy goes to term), or if clinical pre-test probability is intermediate or high, lower extremity Doppler study should be performed.
  - If Doppler study is positive, the patient should be treated for PE.
If Doppler study is negative, ventilation/perfusion (V/Q) scan is preferred due to the much lower dose of radiation absorbed by the maternal breast than with CTA.

- Chest CTA (CPT®71275) or chest MRA (CPT®71555) can be performed if V/Q scan is not available.

- If CTA is performed, neonates need to have thyroid functions tested in the first week of life to rule out contrast-induced hypothyroidism.

**Reference:**
- Radiology 2007 Jan;242(1):15-21

**CTA combined with CTV**
- Although the use of CTA combined with venous phase imaging (CTA-CTV) for diagnosing PE was found to have a higher sensitivity (90%) than CTA alone (sensitivity 83%),* there is insufficient data at this time to justify routinely performing CTA-CTV in patients with suspected PE.

- If routine diagnostic testing (including CTA) is inconclusive, and clinical suspicion remains high, then CTA-CTV can be considered.


**Follow-up Imaging in Patients with Known PE:**
- The duration of treatment with anticoagulation in patients with known PE is based upon the patient’s history and risk factors and is NOT based upon advanced imaging studies (see CH-29 Pulmonary Embolism Evidence Based Clinical Support section).

- D-dimer levels can help guide continued treatment decisions since persistent elevation of the D-dimer is associated with increased recurrence.

- There is insufficient evidence-based data to support routine follow-up advanced imaging in asymptomatic patients or patients with stable symptoms who have known PE, including advanced imaging prior to discontinuing anticoagulation therapy.

- **PE and persistent pulmonary hypertension**
  - Pulmonary hypertension occurs when more than 40% of the pulmonary vasculature is obstructed due to either recurrent thromboembolism or in situ pulmonary artery thrombosis.
  
  - More than 50% of patients will have repeat CTA evidence of pulmonary thromboembolism at 6 months after diagnosis and undergoing anticoagulation treatment.
    - Some patients will have complete resolution while others will have evidence of chronic embolism. Pulmonary hypertension develops in 8% of patients, primarily from the persistent thromboembolism group.
    
  - Chest CTA is not able to distinguish between intravascular chronic and recurrent thromboembolism and pulmonary hypertension has a limited correlation with repeat CTA findings.
    - Therefore, transthoracic echo (CPT®93306) is a better screening test for pulmonary hypertension in patients treated for PE. Right heart catheterization is the best study to evaluate suspected pulmonary hypertension.

**References:**
- Am Fam Physician 2004 June;69(12):2841-2848
PULMONARY HYPERTENSION—See PVD-5~Pulmonary Artery Hypertension in the Peripheral Vascular Disease Imaging Guidelines

CH-30~SUBCLAVIAN STEAL SYNDROME

- **Definition:** reversal of flow in the ipsilateral vertebral artery distal to a stenosis or occlusion of the proximal subclavian or innominate artery. Blood flows up the contralateral vertebral artery to the basilar artery and retrograde down the ipsilateral vertebral artery to supply collateral circulation to the arm on the side of the subclavian lesion.
- Symptoms include vertebral basilar artery insufficiency, vertigo, limb paresis, and paresthesias. Bilateral cortical visual disturbances, ataxia, syncope, and dysarthria occur less frequently.
  - Also see HD-30.1 Vertebrobasilar Ischemia in the Head Imaging Guidelines.
- Patients have a difference in the brachial systolic blood pressure of at least 30 mmHg between the two arms associated with a bruit in the supraclavicular area on the affected side.
- Symptoms of cerebral ischemia may be produced by exercise of the affected arm.
- Carotid duplex study (CPT®93882) should be the initial imaging study in patients with suspected Subclavian Steal Syndrome.
  - Duplex study will show reversal of flow in the ipsilateral vertebral artery.
  - If there are no symptoms of vertebrobasilar ischemia, then no further imaging is generally needed.
- Neck and chest MRA (CPT®70548 and CPT®71555) or CTA (CPT®70498 and 71275) can be performed for diagnosis in patients with symptoms of vertebrobasilar ischemia if the clinical exam and duplex study are indeterminate, or as preoperative studies if they will substitute for invasive angiography.
- Upper extremity MRA (CPT®73225) or CTA (CPT®73206) can be performed in symptomatic patients if needed to exclude pathology distal to the subclavian artery and if they will substitute for invasive angiography.
- Treatment options include ligation of the ipsilateral vertebral artery, aorta-subclavian artery bypass graft, or subclavian endarterectomy.
  - **Reference:**

CH-31~SUPERIOR VENA CAVA (SVC) SYNDROME

- Chest x-ray and CT of the chest with contrast (CPT®71260) are the initial imaging studies of choice for the evaluation of suspected SVC syndrome.
- MRV (CPT®71555) or CTV (CPT®71275) of the chest may be indicated when stenting of the SVC is being considered.
THORACIC AORTA

32.1 Aortic Dissection 40
32.2 Thoracic Aortic Aneurysm (TAA) 41
32.3 Imaging the Thoracic Aorta in Individuals with Bicuspid Aortic Valve 42
32.4 Screening Guidelines for familial Syndromes and Genetic Disorders 43

- See also AB-22.1 Abdominal Aortic Aneurysm in the Abdomen Imaging Guidelines

- Pre-op evaluation for minimally invasive or robotic surgery
  - There is insufficient data to support the routine use of CTA for the routine evaluation of peripheral arteries, iliac arteries, and/or aorta prior to minimally invasive or robotic surgery.

- Type A Aortic Intramural Hematoma
  - A variant form of aortic dissection in which there is no intimal tear and no false lumen
  - May lead to aortic dissection or actually be a precursor of aortic dissection
  - Evaluation should follow that of aortic dissection (See CH-32.1 Aortic Dissection)

- References:
  - Circulation 2009;120:2029-2032
  - Circulation 2009;120;2046-2052

- CH-32.1 Aortic Dissection
  - Suspicion of acute dissection should be handled as a medical emergency. Patients typically present with sharp, severe retrosternal or interscapular chest pain with subsequent migration down the back (ripping or tearing sensation). This occurs in 90% of patients with aortic dissections and usually causes patients to seek medical attention within minutes or hours of onset.
  - In patients with aortic dissection, CTA or MRA of the entire aorta (including arch branches) and extending through the femoral arteries is indicated.
  - Patients with Type A dissection (involving the ascending aorta) require urgent surgical intervention with placement of an aortic graft or endovascular stent graft.

  - Follow-up imaging after repair of Type A dissection:
    - In the small number of patients with pure, truly isolated ascending aortic dissection that has been completely repaired, there is no evidence-based data to support routine follow-up imaging.
    - Many patients with Type A dissection also have an aortic arch and descending aortic component to the dissection. In these patients, follow-up imaging should proceed as in patients with Type B dissection.
  - Patients with Type B dissection (involves the descending aorta; usually originates distal to the origin of the left subclavian artery) can usually be treated medically with careful blood pressure control. Surgery is reserved for
distal dissections that are leaking, ruptured, or compromising blood flow to a vital organ, or if there is inability to control the blood pressure

- **Follow-up imaging in patients with Type B dissection who are being treated medically:**
  - If false lumen is <4.5 cm, routine imaging can be performed every 12 months
  - If false lumen is ≥4.5 cm, routine imaging can be performed every 6 months

- **Follow-up imaging in patients with Type B dissection who underwent surgical procedure:**
  - Routine imaging can be performed at 1 month, 3 months, 6 months, 12 months, and then every 12 months for patients who have had stent grafts placed or other types of surgical procedures for dissection

- Imaging can be one of the following:
  - CT of chest, abdomen and pelvis (contrast as requested), or
  - MRI of chest, abdomen and pelvis (contrast as requested), or
  - CTA of chest, abdomen and pelvis (CPT®71275, CPT®74175, and CPT®72191), or
  - MRA of chest, abdomen and pelvis (CPT®71555, CPT®74185, and CPT®72198)

- The purpose of routine follow-up imaging is due to the fact that 30%-40% of chronic dissections will become aneurysmal in 5 years and will require intervention. Patency of the false lumen is an independent risk-factor for secondary dilatation of the aorta.*


- **CH-32.2 Thoracic Aortic Aneurysm (TAA)**
  - The normal size of the aortic arch and descending thoracic aorta is 3 cm. The aortic root is normally 3.5 cm.
  - **Suspicion for TAA**
    - Chest x-ray that has been overread by a radiologist should be performed initially, especially in patients with low clinical risk of TAA.
    - Widened mediastinum or other abnormalities on chest x-ray (overread by a radiologist) that raise the suspicion for TAA can be further evaluated with chest CT with contrast (CPT®71260)
    - Suspicion for TAA based on other previous imaging studies such as fluoroscopy, spine MRI, abdominal CT, etc. can be further evaluated with chest CT (contrast as requested), chest MRA (CPT®71555), or chest CTA (CPT®71275).
  - **Follow-up imaging of known TAA**
    - Thoracic aortic aneurysms (TAA) measuring greater than 3 cm can be followed every year by chest CT (contrast as requested), chest MRI (contrast as requested), chest MRA (CPT®71555), or chest CTA (CPT®71275).*
      *Circulation 2009;119:880-890
    - Consultation with a thoracic surgeon is helpful in determining the frequency of imaging.
  - Patients with TAA should be screened for AAA using the Abdominal Guidelines (see **AB-22.1 Abdominal Aortic Aneurysm**).
There is insufficient evidence-based data to support using advanced imaging to screen for thoracic aortic aneurysm (TAA) in patients with known abdominal aortic aneurysm.

- Patients with known TAA who present with chest pain or back pain should have chest CT (contrast as requested), chest MRI (contrast as requested), chest MRA (CPT®71555), or chest CTA (CPT®71275).
- **Preoperative imaging if endovascular or open repair of TAA is being considered:**
  - CT chest, abdomen, pelvis (contrast as requested) or CTA (CPT®71275, CPT®74175, and CPT®72191) or MRA (CPT®71555, CPT®74185, and CPT®72198).
- **Follow-up imaging in patients who have had open repair or endovascular stent graft repair of TAA:**
  - If open repair was performed, routine chest imaging can be performed every 3 to 5 years.
  - If endovascular graft was placed, routine chest imaging can be performed at 1 month, 3 months, 6 months, 12 months, and then every 12 months.
  - Chest imaging can be chest CT (contrast as requested), chest MRI (contrast as requested), chest MRA (CPT®71555), or chest CTA (CPT®71275).

**CH-32.3 Imaging the Thoracic Aorta in Individuals with Bicuspid Aortic Valve**

- Since 20% of individuals who underwent bicuspid aortic valve surgery had concurrent ascending aortic aneurysms that needed repair1,2, all patients with bicuspid aortic valve should have both the aortic root and ascending thoracic aorta evaluated for evidence of aortic dilatation3
  - Evaluation of the aortic root and ascending thoracic aorta can be by **one** of the following (based on the preference of the requesting provider):
    - Echocardiogram (CPT®93306, CPT®93307, or CPT®93308), or
    - Chest CT (CPT®71250 or CPT®71260), or
    - Chest CTA (CPT®71275), or
    - Chest MRI (CPT®71550 or CPT®71551), or
    - Chest MRA (CPT®71555)
  - Additional imaging such as cardiac MRI, cardiac CT, or CCTA is not generally indicated.
  - If dilatation of the aortic root and/or ascending thoracic aorta is found on the initial imaging study, follow-up imaging (echo, chest CT, chest CTA, chest MRI, or chest MRA) can be performed yearly.
  - If **no** dilatation of the aortic root or ascending thoracic aorta is found on the initial imaging study, there is no evidence-based data to support continued surveillance imaging.
  - There is no evidence-based data to support imaging of the aortic root and ascending thoracic aorta for screening purposes in relatives of patients with bicuspid aortic valve.

**References:**

**CH-32.4 Screening Guidelines for Familial Syndromes and Genetic Syndromes**

- **Familial Thoracic Aortic Aneurysm:**
  - In one study of 520 patients with TAA, an inherited pattern for TAA was present in 21.5% of non-Marfan syndrome patients. The predominant inheritance pattern was autosomal dominant (76.9%) with varying degrees of penetrance and expressivity. Familial TAA’s have a relatively early age of onset. Aortic growth rate was highest for the familial group (0.21 cm/year).¹
  - First-degree relatives (parents, siblings, children) of patients with thoracic aortic aneurysm and/or dissection should have a screening study.²
    - Screening studies should include echocardiogram and chest x-ray initially. If these studies are equivocal or do not visualize the ascending aorta adequately, chest CT with contrast (CPT®71260) can be performed.
  - If one or more first-degree relatives of a patient with known thoracic aortic aneurysm and/or dissection is found to have thoracic aortic dilatation, aneurysm, or dissection, then screening studies of second-degree relatives can be performed.²
    - ²*J Am Coll Cardiol* 2010;55:e27-e129

- **Marfan Syndrome**
  - Echocardiogram (CPT®93306, 93307, or 93308) should be performed at the time of diagnosis of Marfan syndrome.
  - Annual echocardiogram (CPT®93306, 93307, or 93308), chest CT (contrast as requested), or chest MRI (contrast as requested) can be performed if aortic diameter is stable.
  - If maximal aortic diameter is 4.5 cm or greater, or if there is significant growth of the aorta, more frequent imaging can be considered at the discretion of the specialist following the patient.
  - **Reference:**
    - ²*J Am Coll Cardiol* 2010;55:e27-e129

- **Ehlers-Danlos Syndrome, Vascular form or Type IV**
  - Imaging as per Marfan Syndrome
• The right hemidiaphragm usually sits 1-2.5 cm higher than the left.
• The most common cause of a significant discrepancy between the two hemidiaphragms is focal or diffuse eventration of the higher diaphragm, which occurs more commonly on the left.
• Eventration occurs when the muscular sheet of the diaphragm is replaced by a thin membranous sheet causing elevation of the diaphragm due to upward pressure from the adjacent abdominal viscera.
• **Work-up of an elevated hemidiaphragm includes the following:**
  o Comparison with previous chest x-rays should be performed initially.
    ➢ If the elevation is an old finding, further evaluation is not indicated.
    ➢ If the elevation is a new finding, work-up to rule out phrenic nerve pathology is indicated.
  o **Work-up to rule out phrenic nerve pathology:**
    ➢ Interruption of the phrenic nerve anywhere between the neck and the diaphragm results in paralysis of the ipsilateral hemidiaphragm.
    ➢ Fluoroscopic examination (“sniff test”) should be performed initially to evaluate whether there is true diaphragmatic paralysis versus diaphragmatic weakness.
    ➢ Common causes of diaphragmatic paralysis include:
      ▪ Phrenic nerve injury
      ▪ Malignancy involving the phrenic nerve such as lung carcinoma (usually involving the mediastinum or mediastinal lymph nodes) or other mediastinal tumors such as thymoma, lymphoma, or germ cell tumors.
    ➢ Other thoracic causes of elevated hemidiaphragm include lobar pneumonia, tuberculosis, empyema, substernal thyroid, pulmonary infarction, rib fracture, atelectasis, aortic aneurysm, and radiation treatment
    ➢ Elevated hemidiaphragm can also be idiopathic
    ➢ Chest CT with contrast (CPT®71260) and neck CT with contrast (CPT®7049) (if requested) can be performed in patients with new diaphragmatic paralysis
    ➢ If chest CT does not reveal the etiology of the elevated hemidiaphragm, CT abdomen with contrast (CPT®74160) can be performed to rule out liver pathology, subphrenic abscess, or intraabdominal mass
    ➢ Repeat advanced imaging studies in the absence of new signs or symptoms are not indicated.
• **Reference:**
CH-34~THORACIC OUTLET SYNDROME (TOS)

- Refers to compression of the subclavian vessels and/or brachial plexus at the thoracic outlet of the chest (the area bounded by the two scalene muscles and the first rib).

- Three types of TOS:
  - **Neurogenic TOS** (80% of TOS):
    - Etiologies include an injury causing tearing and spasm in the scalene muscles which then irritate the adjacent nerves.
    - Symptoms include pain and paresthesias (95% of patients) as well as motor weakness and sometimes atrophy of the hypothenar and interosseous muscles (10% of patients).
    - Generally occurs in patients < age 45.
    - Almost never occurs bilaterally.
    - EMG/NCV studies should be performed initially in the evaluation of patients with suspected neurogenic TOS in order to exclude carpal tunnel syndrome.
    - Also see PN-4 Brachial Plexus in the Peripheral Nerve Disorders guideline.
  - **Arterial TOS** (5% of TOS cases):
    - Symptoms include coldness, weakness, easy fatigability of the arm and hand.
    - Emboli from thrombosis in the proximal subclavian artery may travel to the hand, causing distal ischemia.
    - Generally occurs in patients < age 25.
  - **Venous TOS** (also called “effort thrombosis”) (15% of TOS cases):
    - Due to compression of the subclavian vein between the rib and clavicle.
    - Symptoms include arm edema, discoloration of the arm, distention of the superficial veins of the limb and shoulder, and arm pain.
    - Competitive athletes and individuals who repeatedly use their arms overhead are susceptible.
    - Generally occurs in patients < age 25.

- Neck and chest MRA (CPT®70548 and CPT®71555) or CTA (CPT®70498 and CPT®71275) can be performed to evaluate for arterial or venous TOS.

- Since true TOS is a rare entity and diagnosis is difficult, specialist evaluation by a vascular surgeon or thoracic surgeon is helpful in determining the appropriate imaging pathway.

- **Reference:**
NEWER IMAGING TECHNIQUES

CH-35~VIRTUAL BRONCHOSCOPY

- Virtual bronchoscopy uses multidetector CT with 3D rendering (CPT®71260 and CPT®76377) to generate an image of the tracheobronchial tree down to the level of the sixth- to seventh-generation bronchi, and can visualize areas inaccessible to the flexible bronchoscope.
- There is insufficient data currently to generate appropriateness criteria for the use of virtual bronchoscopy, and this procedure should be considered investigational at this time.

CH-36~EM-GUIDED PERIPHERAL BRONCHOSCOPY

- Peripheral bronchoscopy using electromagnetic (EM) guidance on a CT road map is a technology for performing biopsies of peripheral lesions of the lungs. A 3D image of the lungs is generated using CT and transferred to the peripheral bronchoscopy system. The target nodule position is marked by the physician. The next day, the patient is placed on a location board in the procedure room. The location board detects an EM sensor inserted through the working channel of the bronchoscope. When the bronchoscope reaches the target, the working channel is locked in place and the location sensors removed, allowing the physician to biopsy the suspect tissue using the system’s steerable flexible catheter.
- EM-guided bronchoscopy enables biopsies to be performed on regions of the lungs that were formerly very difficult or dangerous to reach.
- Clinical trials are currently underway to evaluate this technique for mediastinal lymph node biopsies.
- Currently this procedure should fall under the classification of CT Guidance (CPT®77012).

CH-37~POSITRON-EMISSION MAMMOGRAPHY (PEM) OR NAVISCAN

- High-resolution positron-emission mammography (PEM) by Naviscan PET Systems, also referred to as Naviscan or PET mammography, performs high-resolution metabolic imaging of breast cancer using FDG tracer. The PEM detectors are integrated into a conventional mammography system, allowing acquisition of the emission images immediately after the mammogram.
- Requesting providers often code requests for PEM as CPT®78811 or “PET scan of the breast.”
- The spatial resolution of this technique is at the individual duct level (1.5 mm) and allows visualization of intraductal as well as invasive breast cancers. This technique is especially adept at detecting ductal carcinoma in situ.
- Early clinical trials have shown high clinical accuracy in characterizing lesions identified as suspicious on conventional imaging or physical examination, as well as detecting incidental breast cancers not seen on other imaging modalities.
- A prospective multi-center clinical trial for women with newly diagnosed breast cancer anticipating breast-conservation surgery was performed. These women
underwent both high-resolution PEM imaging and breast MRI. Results showed that PEM and MRI had comparable breast-level sensitivity, although MRI had greater lesion-level sensitivity and more accurately depicted the need for mastectomy. PEM had greater specificity at the breast and lesion levels. 3.6% of the women had tumors seen only at PEM. 


• The radiation exposure from a PEM study is 23 times higher than for digital mammography.* 


• There is currently insufficient data to generate appropriateness criteria for this modality, and this procedure should be considered investigational at this time.

• References:

CH-38~BREAST MR SPECTROSCOPY

• Breast MR Spectroscopy identifies the presence of choline, which is a strong indicator of malignancy.

• Preliminary studies show that breast MR Spectroscopy can help reduce breast MRI false positives.

• A clinical study from Memorial Sloan-Kettering Cancer Center in New York showed that imaging suspicious breast lesions with both MRI and MR spectroscopy reduced the need for biopsy by 58% without missing any of the resultant cancers. However, only 56 patients were included in the study.* 
  
  *Radiology 2006 June;239(3):686-692

• There is currently insufficient data to generate appropriateness criteria for breast MR Spectroscopy, and this procedure should be considered investigational at this time.
Evidence Based Clinical Support

CH-3~CHRONIC COUGH

- The American College of Chest Physicians has updated their evidence-based guidelines on cough*
  *Chest 2006;129:1-25
- Chronic cough is defined as a cough that lasts at least eight weeks. One percent of the population is affected by chronic cough, and it is the fifth most common reason for consultation with a primary care physician.
- The most common cause of chronic cough is upper airway cough syndrome which usually follows a viral infection of the upper respiratory tract and usually resolves by 8 weeks.
- In 95% of immunocompetent persons, chronic cough is caused by one of the following: cough variant asthma, upper airway cough syndrome, eosinophilic bronchitis, reflux disease, chronic bronchitis from cigarette smoking, bronchiectasis, or medication side effect (especially ACE inhibitors).
- In the remaining 5%, cough is caused by lung cancer, carcinomatosis, sarcoidosis, left ventricular failure, or aspiration.
- A normal chest x-ray in an immunocompetent patient rules out carcinoma, tuberculosis, sarcoidosis, or bronchiectasis in the majority of patients.
- The cause of chronic cough can be determined in 88%-100% of cases with treatment for specific causes yielding a success rate from 84%-98%.*
  *New Eng J Med 2000 Dec;343(23):1715-1721
- Cough variant asthma occurs in almost 50% of all asthma cases, and chronic cough is the only symptom. Methacholine challenge test has a positive predictive value of 88% and negative predictive value of 100%. Cough resolves in 6 to 8 weeks after treatment with beta agonists and steroids.
- Resolution of cough after smoking cessation or stopping medications with cough as a known side effect may take 4 weeks.
- The character of the cough (productive vs dry), timing (night, with meals, etc.) has not been shown to be diagnostically useful.

Evidence Based Clinical Support

CH-9~ASBESTOS EXPOSURE

- Asbestos-related benign and neoplastic diseases of the lung and pleura include pleural effusion, pleural plaques, lung cancer, and malignant mesothelioma.
- Asbestosis is a well-recognized risk factor for developing lung cancer.
- The risk of developing pleural disease (mesothelioma) increases with increasing intensity and duration of exposure.
- Rales and low diffusion capacity on PFT’s support the diagnosis of asbestosis.
- The sensitivity and specificity of chest x-ray and high resolution chest CT (HRCT) in detecting pleural lesions are 64.9% and 98.5%, respectively.* However, out of 2,080 patients exposed to asbestos without chest x-ray signs of asbestosis or pleural changes, 13 (0.6%) developed malignant mesothelioma.*
Sarcoidosis is a systemic disease of unknown etiology that commonly affects young and middle aged patients with a higher prevalence in women, African Americans, Swedes and Danes. Symptoms commonly include dyspnea and dry cough. Half of patients are asymptomatic. Clinical signs include fatigue, weight loss, general malaise, and fever. Treatment can include steroids, Methotrexate, and/or cyclophosphamide. Ninety percent of patients with sarcoidosis have pulmonary involvement (usually asymptomatic mediastinal lymphadenopathy). 50% of patients present with lymphadenopathy only. Bilateral hilar lymphadenopathy is the most common radiologic finding and there is frequently an associated pulmonary infiltrate. Mediastinal adenopathy without hilar involvement is rare and sometimes seen in older patients. Lung involvement occurs in 20% of patients and can include multiple small perivascular nodules, miliary nodules, bronchial wall thickening, or ground glass attenuation. Sarcoidosis can have spontaneous resolution or progress to fibrosis of lung or other organs. Sarcoid can involve the heart, eyes (uveitis or lacrimal glands), parotid glands, liver, spleen, kidney and paraaortic lymph nodes (rare).

A solitary pulmonary nodule (SPN) is a lesion less than 3 cm in diameter that is completely surrounded by pulmonary parenchyma. Lesions larger than 3 cm are called lung masses and are often malignant. An estimated 150,000 SPN’s are identified on chest imaging each year. The malignancy rate in nodules 1 cm or smaller in the Early Lung Cancer Action Project study was 8%. This study did not include patients with known primary malignancies.*

*Lancet 1999;354:99-105

In a Mayo Clinic study, three year follow-up detected lung cancer in 1.4% of all lung nodules found. In nodules less than 7 mm in size, less than 1% were malignant.*

*Radiology 2005;235:259-265

In ELCAP II which screened 2,897 subjects, there were zero cancers among 378 subjects whose largest detected nodule was <5mm at baseline. There were 14 cancers among 238 subjects (5.9%) whose largest nodule was 5 mm to 9 mm.*

*Radiology 2004;231:164-168
Patients with known primary malignancies have a higher rate of malignancy of SPN’s (between 12% and 58% depending on the study).

- New nodules discovered on a 1 year repeat CT more frequently contain cancer and at smaller size than on the baseline CT scan.
- Infectious granulomas constitute about 80% of the benign lesions, and hamartomas 10%.
- A lung nodule that doubles in volume in less than 1 month is uncharacteristic of lung cancer.
- Nodules are considered benign if they resolve, decrease in size, or demonstrate no perceptible growth over 2 years. However, only biopsy with pathological diagnosis can give a definitive diagnosis.
- If a nodule does not grow in volume in 6 months, the risk of malignancy is <10%.
  *Chest 2004;125:1522-1529

- Malignant nodules have a doubling time of 40 to 360 days. Therefore, CT scan will detect nodule growth in virtually all patients with malignant lesions within 12 months.
  *Radiology 2003;226:489-493

- The National Lung Screening Trial is an ongoing trial to determine whether there is a mortality benefit from x-ray or CT lung screening.
  - Protocol: If lung nodule <4 mm, annual screening; Lung nodules 4-10 mm, follow up scan at 6, 12, 24 months.
  - A false-negative PET scan occurred in 27% of cancers that were 1cm or smaller, in 10% of cancers between 1 to 2 cm, and in 12% of cancers >2cm.
  *AJR 2005;185:126-131
  - Current PET technology is likely inaccurate in discriminating nodules smaller than 7 mm.
  *AJR 2005;185:126-131

---

### Evidence Based Clinical Support

#### CH-22~MEDIASTINAL MASS

- The most common primary mediastinal tumors are lymphoma, thymus gland neoplasia, thymus cysts/hyperplasia, and endocrine tumors (mainly goiters).
- Other tumors include germ cell tumors such as mature teratomas, seminomas, and nonseminomatous germ cell tumors. Overall, 43% of mediastinal tumors are malignant and 57% benign.

#### CH-27~BREAST ABNORMALITIES

- MRI has an 80%-100% sensitivity for detecting breast cancers, but positive predictive value is only 26%-75%. Therefore, MRI has a high false-positive rate (i.e. low specificity).
- This makes MRI a poor screening device for the general population.
- Dense breasts lower the sensitivity of mammography to detect breast cancer because the cancers are obscured. There is also an independent increased risk (1.8 to 6 times higher) of malignancy in dense breasts.
- In a study of 11,130 women undergoing 27,825 screening exams for breast cancer, mammography was shown to have 98% sensitivity in detecting breast cancer in patients with fatty breasts. The sensitivity decreased to 48% in grade 4 breasts (defined as having tissue that can obscure cancer in >75% of the breast).*

*Radiology 2002;224:165-175

- In the same study cited above, the sensitivity of ultrasound in detecting breast cancer was 75% in patients with dense breasts. The combined sensitivity of mammography and ultrasound in patients with minimally (grade 2) to extremely dense breasts (grade 4) was 97%. (grade 2: having at least one area of tissue that could obscure cancer; grade 3: having tissue that can obscure cancer in 50% to 75% of the breast).

- In several studies, MRI showed no additional lesions in patients with fatty breasts, but showed additional true positive lesions in 28% of grade 2, 57% of grade 3, and 14% of grade 4 breasts.

- Numerous studies have shown the usefulness of breast MRI in the preoperative staging of breast cancer:
  - MRI detects intraductal spread more accurately than mammography or ultrasound. Intraductal spread is a principal risk factor for local recurrence.
  - In women with biopsy-proven unilateral breast cancer who were considered candidates for breast conservation surgery and had MRI of the ipsilateral breast preoperatively, MRI identified mammographically and clinically occult cancer other than the index lesion in 27% of women.*

*AJR 2003 April;180(4):901-910

- Screening MRI of both breasts in patients with newly diagnosed breast cancer demonstrated that 15 out of 182 patients (8.2%) had suspicious lesions in the contralateral breast. 7 patients (3.8%) had malignant results on biopsy (7 true positives, 8 false positives).*

*Radiology 2003 March;226(3):773-778

- Another study found that breast MRI detected cancers in the contralateral breast that were not detected by clinical exam or mammogram in 30 of 969 women with newly diagnosed breast cancer.*


- In 26%-30% of cases, preoperative breast MRI resulted in a change from the planned surgical procedure (e.g. re-excision of the lumpectomy site or planned conservation therapy) to mastectomy, neoadjuvant chemotherapy, biopsy of an additional lesion in the ipsilateral breast or contralateral breast.*

*AJR 2004 Feb;182:473-480
*Cancer 2003 Aug;98(3):468-473

- MRI is especially useful in predicting the extent of disease in patients with invasive lobular cancer (ILC) which accounts for 15% of all breast cancers and is more likely to occur in multiple sites and in both breasts.

- MRI is more sensitive in detecting residual cancer in patients who have undergone lumpectomy. Sensitivity 61.2%, specificity 69.7%, positive predictive value 75%, negative predictive value 54.8%.*

*AJR 2004 Feb;182:473-480

- Tumor recurrence in the lumpectomy site occurs at a rate of 1%-2% per year. In one study, MRI had 100% sensitivity and 88.8% specificity in detecting recurrent
breast cancer in patients who had undergone breast conservation surgery and had completed at least one year of radiation therapy. Dynamic MRI is accurate in differentiating post-treatment changes from recurrent carcinoma.*

*J Am Coll Surg 2004 Feb;198(2):190-197

• MRI can assess the response to neoadjuvant chemotherapy better than physical exam and mammography.
• The American Society of Breast Disease statement June 2004 (found at http://www.guideline.gov): "At this time there are no data on the use of MRI for breast cancer screening of women at high risk based on personal history of breast cancer, previous chest irradiation, lobular carcinoma in situ, atypical hyperplasia, or mutations other than BRCA". However, the latest recommendations from the American Cancer Society do recommend screening breast MRI in women who have had chest radiation between the ages of 10 and 30 years old.*

*CA Cancer J Clin 2007;57:75-89

Evidence Based Clinical Support
CH-29~PULMONARY EMBOLISM (PE)

• It is estimated that 600,000 episodes of pulmonary embolism (PE) occur each year in the U.S. resulting in 100,000 to 200,000 deaths.
• The most common signs/symptoms of PE include unexplained dyspnea (>80% of patients with PE), unexplained tachycardia, and pleuritic chest pain either with or without dyspnea. Also, SaO2 <95% in a nonsmoker with no asthma or COPD.
• 25%-65% of patients with suspected PE have a low clinical probability of embolism.
• In patients with a low pretest probability and a negative D-dimer study, the 3 month follow-up rate of PE was 0%.*
  *Arch Intern Med 2002;162:1631-1635
• D-dimer level has a high sensitivity and low specificity for diagnosing PE.
• A number of conditions in which fibrin products are likely to be present often lead to false positive D-dimer exams including: patients with recent surgery or trauma, malignancy, sepsis, diabetes, GI problems, certain liver and blood disorders, pregnancy, and Alzheimer care givers. The exam specificity in these situations is approx. 50%.
• Highly sensitive D-dimer assays based on ELISA safely rule out PE in outpatients presenting with low clinical probability. However, low sensitivity assays based on latex agglutination or whole blood agglutination cannot be used in isolation to rule out PE. There is a lack of standardization among assays, which makes them less useful. However, newer automated ELISA assays and quantitative latex-agglutination assays compare favorably with the manual ELISA. The whole blood agglutination assay is a qualitative study.
• 90% of CT angiograms obtained in one hospital were negative for PE. A study was then performed with 419 patients evaluated by both quantitative D-dimer and pulmonary CTA.

Conclusion: If the D-dimer was <1.0 micrograms/ml, no CTA should be performed unless there is a high clinical suspicion. A 3 month follow up of all patients with D-dimer <1.0 micrograms/ml showed that none of the 247 patients
had a subsequent acute PE. Therefore, if a D-dimer <1.0 micrograms/ml had been used, 60% of the CTA’s could have been avoided. If a positive D-dimer threshold is defined as ≥1.0 micrograms/ml, the sensitivity and negative predictive value are 100%, specificity is 62% and positive predictive value is 17%.*

*AJR 2004;182:1377-1381

- CT pulmonary angiography (which is largely equivalent to contrasted chest CT scan with PE protocol—120cc of I.V. contrast and slice thicknesses of 1.25 mm) has a sensitivity of 60%-100% and specificity of 78%-100% in diagnosing PE.*
  *AJR 2004;182:499-504

- CT scan also showed additional potentially significant findings in 30%-78% of patients that provided alternative diagnoses to PE. 47% of these findings were not suspected on chest x-ray.*
  *AJR 2004;182:499-504

- Most clinical studies predict patients with a high probability of PE based on physical exam, chest x-ray, EKG, and ABG. However, these studies are not readily available in physicians’ offices.

- The most cost-effective strategies for PE diagnosis are D-dimer level (provided there are no risk factors for a false positive exam) followed by spiral CT if the D-dimer is positive, or leg ultrasound followed by spiral CT if the ultrasound is negative.* However, this study estimated that as the sensitivity of CT scan approached 100% and the specificity approached 96%, the most cost-effective strategy became the spiral CT alone. With the advent of multidetector CT scanners, these high sensitivity and specificity levels are being realized.
  *Chest 2001;119:1791-1800

- Although V/Q scan is an accurate study in patients in whom there is a clinical suspicion for PE, a normal chest x-ray, and no known chronic pulmonary disease, this study is difficult to obtain quickly, does not provide a substantial cost savings, and does not diagnose other pulmonary pathology if the diagnosis of PE is negative. Thus, many of the patients with low probability V/Q scan would potentially go on to have a chest CT to rule out other pathology.

- The Prospective Investigation of Pulmonary Embolism Diagnosis II trial (PIOPED II) was a prospective, multicenter investigation of the accuracy of CTA alone combined with venous-phase imaging (CTA-CTV) for the diagnosis of acute PE.
  - Results: Among 824 patients, sensitivity of CTA was 83%, specificity was 96%. Positive predictive values were 96% with a concordantly high or low probability on clinical assessment, and 92% with an intermediate probability on clinical assessment. Sensitivity of CTA-CTV for PE was 90%, specificity 95%. Both CTA and CTA-CTV were nondiagnostic with a discordant clinical probability.*
American College of Chest Physicians Recommendations for Long-Term Anticoagulation in Patients with DVT or PE:

**TABLE 5**

<table>
<thead>
<tr>
<th>Thromboembolism</th>
<th>Duration of anticoagulation</th>
<th>Strength of recommendation*</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>First event with a reversible or time-limited risk factor for venous disease (e.g. trauma, surgery)</td>
<td>At least 3 months</td>
<td>A</td>
<td>4</td>
</tr>
<tr>
<td>First episode of idiopathic venous thromboembolic disease</td>
<td>At least 6 months</td>
<td>A</td>
<td>4</td>
</tr>
<tr>
<td>Recurrent idiopathic venous thromboembolic disease or continuing risk factor (e.g. thrombophilia)</td>
<td>At least 12 months</td>
<td>B</td>
<td>4</td>
</tr>
<tr>
<td>Symptomatic isolated calf-vein thrombosis</td>
<td>6-12 weeks †</td>
<td>A</td>
<td>17</td>
</tr>
</tbody>
</table>

ACCP= American College of Chest Physicians; DVT = deep venous thrombosis; PE = pulmonary embolism; INR = International Normalized Ratio.

*ACCP ratings have been converted to American Family Physician’s strength-of-recommendation taxonomy.

†-Serial noninvasive studies of the lower extremities to assess for extension are an option.


---

**Evidence Based Clinical Support**

**CH-31~SUPERIOR VENA CAVA (SVC) SYNDROME**

- SVC syndrome is caused by intrinsic or extrinsic obstruction of the SVC and can be acute or subacute.
- Symptoms of SVC syndrome include head fullness, dyspnea/orthopnea, headache, and dizziness.
- Signs include head swelling, enlarged collateral vessels on the chest wall, facial cyanosis, and arm swelling.
- Malignancies are the etiology in 80%-85% of cases, and lung cancer is the most common cause.
- 15%-20% of cases are due to nonmalignant causes such as mediastinal fibrosis, sclerosing mediastinitis, indwelling central venous catheter, or transvenous pacemaker electrodes.
For confirming or ruling out thoracic aortic dissection, transesophageal echo (TEE), CT, and MRI have equally reliable diagnostic values.*

*Arch Intern Med 2006;166(13):1350-1356

Thoracic aortic aneurysms (TAA) occur in the ascending aorta (25%), aortic arch (25%) or descending aorta (50%).

Risk factors include connective tissue disorders (e.g. Marfan’s or Ehlers-Danlos), atherosclerosis, previous aortic dissection, prolonged hypertension, and trauma.

Mean age is 65 years old.

Most patients are asymptomatic until the aneurysm begins to leak or expand. Chest or back pain may indicate acute expansion or leakage.

25% of patients with TAA also have AAA.

The normal diameter of the aorta is 2.5 cm to 3 cm.

The normal diameter of the aortic root is 3.5 cm.

The usual size of a TAA is 4 to 5 cm.

Risk of rupture at 5 years is 0% for TAA less than 4 cm, 16% for diameter 4-5.9 cm, and 31% for aneurysms greater than 6 cm.

The critical point for rupture or dissection of an ascending TAA is 6 cm (31% risk) and for a descending TAA, 7 cm (43% risk).

Surgery is usually recommended if the aneurysm is 5.5 cm in the ascending aorta or 6.5 cm in the descending aorta. Ann Thorac Surg 2002;74:S1877-S1880

Surgery is recommended earlier (when aneurysm is 5 cm) in Marfan’s patients.

The median size of an ascending aortic or arch aneurysm at rupture or dissection is 5.9 cm.

All symptomatic TAA’s require surgery or intervention regardless of size.
2011 CHEST IMAGING GUIDELINE REFERENCES

CHEST GUIDELINE REFERENCES

CH-2~Lymphadenopathy

CH-3~Chronic Cough

CH-4~Non-Cardiac Chest Pain

CH-6~Hemoptysis

CH-7~Bronchiectasis

CH-10~Chronic Obstructive Pulmonary Disease

CH-11~Interstitial Disease

CH-12~Multiple Pulmonary Nodules

CH-14~Positive PPD or Tuberculosis (TB)

CH-15~Sarcoid

CH-16~Solitary Pulmonary Nodule (SPN)

CH-17~Pleural-Based Nodules and Other Abnormalities

**CH-18~Pleural Thickening**

**CH-19~Pleural Effusion**

**CH-20~Mediastinal Lymphadenopathy**

**CH-21~Mediastinal Lymphadenopathy**

**CH-22~Costochondritis**

**CH-23~Chest Wall Mass**

**CH-24~Pectus Excavatum and Pectus Carinatum**

**CH-25~Breast Abnormalities**
- Huff JG. *Clinical Applications of Breast MRI: Current Indications and Examples*. Presented at: Identification and Management of Breast Cancer, October 6, 2007; Nashville, TN.


ACR Appropriateness Criteria, Nonpalpable mammographic findings (excluding calcifications), Updated 2010.


Lawson LL. State of the Art Diagnosis of Breast Abnormalities: From Clinical Exam to MRI. Presented at: Identification and Management of Breast Cancer, October 6, 2007; Nashville, TN.

CH-28—Pulmonary Arteriovenous Fistula (AVM)


CH-29—Pulmonary Embolism (PE)


CH-30~Subclavian Steal Syndrome

CH-32~Thoracic Aortic Dissection or Aneurysm

CH-33~Elevated Hemidiaphragm

CH-34~Thoracic Outlet Syndrome (TOS)

CH-37~Positron-Emission Mammography (PEM) or Naviscan


**CH-38~Breast MR Spectroscopy**


**Chest Evidence Based Clinical Support References**

**CH-3~Chronic Cough-Evidence Based Clinical Support**


**CH-9~Asbestos Exposure-Evidence Based Clinical Support**


**CH-16~Solitary Pulmonary Nodule-Evidence Based Clinical Support**


**CH-27~Breast Abnormalities-Evidence Based Clinical Support**

- Lehman CD, Gatsonis C, Kuhl CK, et al. MRI evaluation of the contralateral breast in


**CH-29~Pulmonary Embolism-Evidence Based Clinical Support**

- Abcarian PW, Sweet JD, Watabe JT, Yoon HC. Role of a quantitative D-dimer assay in determining the need for CT angiography of acute pulmonary embolism. *AJR* 2004;182:1377-1381.

**CH-32 ~Thoracic Aortic Dissection or Aneurysm-Evidence Based Clinical Support**