CLINICAL GUIDELINES

Chest Imaging Guidelines

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VERSION 1.1.2025

EviCore By EVERNORTH

EviCore healthcare Clinical Decision Support Tool Diagnostic Strategies: This tool addresses common symptoms and symptom complexes. Imaging requests for individuals with atypical symptoms or clinical presentations that are not specifically addressed will require physician review. Consultation with the referring physician, specialist, and/or individual's Primary Care Physician (PCP) may provide additional insight.

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General Guidelines (CH-1)

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Abbreviations for Chest Guidelines

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Abbreviations for Chest Guidelines	
AAA	abdominal aortic aneurysm
ACE	angiotensin-converting enzyme
AVM	arteriovenous malformation
BP	blood pressure
CAD	computer-aided detection
CBC	complete blood count
COPD	chronic obstructive pulmonary disease
CT	computed tomography
CTA	computed tomography angiography
CTV	computed tomography venography
DVT	deep venous thrombosis
ECG	electrocardiogram
EM	electromagnetic
EMG	electromyogram
FDA	Food and Drug Administration
FDG	fluorodeoxyglucose
FNA	fine needle aspiration
GERD	gastroesophageal reflux disease

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Abbreviations for Chest Guidelines	
GI	gastrointestinal
HRCT	high resolution computed tomography
IPF	idiopathic pulmonary fibrosis
LFTP	localized fibrous tumor of the pleura
MRA	magnetic resonance angiography
MRI	magnetic resonance imaging
MRV	magnetic resonance venography
NCV	nerve conduction velocity
PE	pulmonary embolus
PET	positron emission tomography
PFT	pulmonary function tests
PPD	purified protein derivative of tuberculin
RODEO	Rotating Delivery of Excitation Off-resonance MRI
SPN	solitary pulmonary nodule
SVC	superior vena cava

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General Guidelines (CH-1.0)

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- A pertinent clinical evaluation since the onset or change in symptoms is required prior to considering advanced imaging.
  - A pertinent clinical evaluation should include the following:
    - a detailed history and physical examination
    - appropriate laboratory studies and basic imaging, such as plain radiography or ultrasound
      - A recent chest x-ray since the onset or change in symptoms that has been over read by a radiologist would be performed in many of these cases prior to considering advanced imaging.[1,2]
        - Identify and compare with previous chest films to determine presence and stability.
  - For an established individual a meaningful technological contact (telehealth visit, telephone call, electronic mail or messaging) since the onset or change in symptoms can serve as a pertinent clinical evaluation.

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General Guidelines – Chest X-Ray (CH-1.1)

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- Chest x-ray can help identify previously unidentified disease and direct proper advanced imaging for such conditions as:
  - pneumothorax (See **Pneumothorax/Hemothorax (CH-19.1)**)
  - pneumomediastinum (See **Pneumothorax/Hemothorax (CH-19.1)**
  - fractured ribs (See **Chest Trauma (CH-21.1)**)
  - chest wall mass (See **Chest Wall Mass (CH-22.1)**)
  - acute and chronic infections (See **Pneumonia and Coronavirus Disease 2019 (COVID-19) (CH-13)** and **Other Chest Infections (CH-14)**)
  - malignancies
- Exceptions to preliminary chest x-ray include such conditions as:
  - supraclavicular lymphadenopathy (See **Supraclavicular Region (CH-2.1)**)
  - known bronchiectasis (See **Bronchiectasis (CH-7.1)**)
  - suspected interstitial lung disease (See **Interstitial Lung Disease (ILD)/Diffuse Lung Disease (DLD) (CH-11.1)**)
  - positive PPD or tuberculosis (See **Other Chest Infections (CH-14)**)
  - suspected pulmonary AVM (See **Pulmonary Hypertension (CH-26.1)**)

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General Guidelines – Chest Ultrasound (CH-1.2)

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- 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 ultrasound:
    - CPT® 76604
  - Breast ultrasound:
    - CPT® 76641: unilateral, complete
    - CPT® 76642: unilateral, limited
    - CPT® 76641 and CPT® 76642 be reported only once per breast, per imaging session
  - Axillary ultrasound:
    - CPT® 76882 (unilateral); if bilateral, can be reported as CPT® 76882 x 2

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General Guidelines – CT Chest (CH-1.3)

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- Intrathoracic abnormalities found on chest x-ray, fluoroscopy, CT Abdomen, or other imaging modalities can be further evaluated with CT Chest with contrast (CPT® 71260).
- CT Chest without contrast (CPT® 71250) can be used for the following:
  - individual has contraindication to contrast
  - follow-up of pulmonary nodule(s)
  - High Resolution CT (HRCT)
- Low-dose CT Chest (CPT® 71271) See **Lung Cancer Screening (CH-33)**
- CT Chest without and with contrast (CPT® 71270) does not add significant diagnostic information above and beyond that provided by CT Chest with contrast, unless a question regarding calcification, most often within a lung nodule, needs to be resolved.[1]

CT Chest Coding Notes:

- High resolution CT Chest should be reported only with an appropriate code from the set CPT® 71250-CPT® 71270.
  - No additional CPT® codes should be reported for the “high resolution” portion of the scan. The “high resolution” involves additional slices which are not separately billable.

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General Guidelines – CTA Chest (CPT® 71275) (CH-1.4)

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- CTA Chest (CPT® 71275) can be considered for suspected Pulmonary Embolism and Thoracic Aortic disease.
  - CTA prior to minimally invasive or robotic surgery (See **Transcatheter Aortic Valve Replacement (TAVR) (CD-4.8)** in the Cardiac Imaging Guidelines).

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General Guidelines – MRI Chest without and with Contrast (CPT® 71552) (CH-1.5)

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- Indications for MRI Chest are infrequent and may relate to concerns about CT contrast such as renal insufficiency or contrast allergy. MRI may be indicated:
  - Clarification of some equivocal findings on previous imaging studies, which are often in the thymic mediastinal region or determining margin (vascular/soft tissue) involvement with tumor and determined on a case-by-case basis.
    - Certain conditions include:
      - chest wall mass (See **Chest Wall Mass (CH-22.1)**
      - chest muscle tendon injuries (See **Muscle/Tendon Unit Injuries/Diseases (MS-11.1)** in the Musculoskeletal Imaging Guidelines)
      - pectoralis tendon rupture (See **Shoulder (MS-19)**)
      - brachial plexopathy (See **Brachial Plexus (PN-4.1)** in the Peripheral Nerve Disorders Imaging Guidelines)
      - thymoma (See **Thymoma and Thymic Carcinoma - Suspected/Diagnosis (ONC-10.5)** in the Oncology Imaging Guidelines)

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General Guidelines – Nuclear Medicine (CH-1.6)

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CPT	Description
78580	Pulmonary perfusion imaging (eg, particulate)
78582	Pulmonary ventilation (eg, aerosol or gas) and perfusion imaging
78597	Quantitative differential pulmonary perfusion, including imaging when performed
78598	Quantitative differential pulmonary perfusion and ventilation (e.g., aerosol or gas), including imaging when performed

- Pulmonary perfusion imaging (eg, particulate) (CPT® 78580) and pulmonary ventilation (eg, aerosol or gas) and perfusion imaging (CPT® 78582) See **Pulmonary Embolism (CH-25.1)**
- Quantitative differential pulmonary perfusion, including imaging when performed (CPT® 78597) and quantitative differential pulmonary perfusion and ventilation (e.g., aerosol or gas), including imaging when performed (CPT® 78598) See **Pre-Operative Assessment (CH-5.2)**

Navigational Bronchoscopy (CH-1.7)

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- CPT® 76497 (Unlisted CT procedure) if:
  - A CT Chest has been performed within the last 6 weeks and study is needed for navigational bronchoscopy.
- CT Chest without contrast (CPT® 71250) if:
  - Previous diagnostic scan was ≥6 weeks ago and study is needed for navigational bronchoscopy
- Bronchoscopy with computer-assisted, image-guided navigation, includes three-dimensional reconstruction. Do not report in conjunction with 3-D rendering CPT codes (CPT® 76376) or (CPT® 76377).

Background and Supporting Information

- Navigational bronchoscopy: This is a form of guided bronchoscopy. A special sensor inside a bronchoscopy is used to navigate to the desired location within the lung. Computer software generates a virtual bronchial tree which provides a road map to the target lesion. A thin-cut CT Chest with optimized reconstruction parameters is required to generate the virtual map of the lungs. A previous CT Chest may not be usable for navigation if it was not formatted correctly, even if done just a few days prior.
- Names for navigational bronchoscopy systems can include:
  - superDimension or super-D
  - Spin Thoracic Navigation System
  - Archimedes
  - Monarch Platform - robotic
  - Ion - endoluminal robotic bronchoscopy platform
- Cone-Beam CT, (CBCT) is a newer technique that helps locate the nodule in real time. Recent studies have shown comparable results and diagnostic yields to other guided bronchoscopy strategies. CBCT, however, can expose the patient to additional radiation. Another study concluded that, "Additional studies are warranted to confirm the safety and efficacy of this technique". Efforts are required to improve diagnostic accuracy and standardized practices before CBCT can be considered mainstream.

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Lymphadenopathy (CH-2)

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Supraclavicular Region (CH-2.1)

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- Ultrasound (CPT® 76536) is the initial study for palpable or suspected lymphadenopathy.
  - Allows simultaneous ultrasound-guided core needle biopsy (CPT® 76942)
  - CT Neck with contrast (CPT® 70491) or CT Chest with contrast (CPT® 71260) if ultrasound is indeterminate
    - See **General Guidelines (Neck-1.0)** in the Neck Imaging Guidelines

Evidence Discussion

For suspected or palpable supraclavicular lymphadenopathy, ultrasound (US) has an excellent sensitivity rate, up to 100% for the detection of metastases. CT Neck had a lower sensitivity rate of 83% for the same lesion. (van Overhagen,2004) Ultrasound avoids the ionizing radiation exposure of CT, is readily available and allows for the use of US-guided fine-needle aspiration cytologyfor diagnosis.

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Axillary Lymphadenopathy (and Mass) (CH-2.2)

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- There is no evidence-based support for advanced imaging of clinically evidenced axillary lymphadenopathy prior to a biopsy.[2,3] If axillary node biopsy reveals benign findings, advanced imaging is not indicated. If axillary node biopsy reveals findings concerning for malignancy, pathology results will determine the need for further advanced imaging. See **Carcinoma of Unknown Primary Site (ONC-31.7)** in the Oncology imaging Guidelines for imaging recommendations for carcinoma found in an axillary lymph node.
- Localized axillary lymphadenopathy:
  - Axillary US (CPT® 76882)
    - Initial evaluation of any axillary mass or enlarged node
  - Search for adjacent hand or arm injury or infection, and
  - 3-4 week observation if benign clinical picture (for ipsilateral COVID vaccination-related adenopathy, observation for 12 or more weeks is recommended)[4]. Follow-up imaging with ultrasound can be obtained if there is a significant risk of metastatic adenopathy (e.g., breast, head and neck, upper extremity/trunk melanoma or lymphoma[5])
    - If axillary adenopathy is unchanged, then consider additional follow up 6 months after initial presentation[4]
  - Ultrasound directed core needle biopsy or surgical excisional biopsy of the most abnormal lymph node if condition persists, or malignancy is suspected, or surgical excisional biopsy if core needle biopsy results are non-diagnostic.
  - No advanced imaging indicated.
- Generalized axillary lymphadenopathy:
  - Axillary US (CPT® 76882)
    - Initial evaluation of any axillary mass or enlarged node
  - Ultrasound directed core needle biopsy or surgical excisional biopsy of the most abnormal lymph node if condition persists, if malignancy is suspected, or surgical excisional biopsy if core needle biopsy results are non-diagnostic.
  - Diagnostic work-up, including serological tests, for systemic diseases
  - See **Non-Hodgkin Lymphomas (ONC-27)** in the Oncology Imaging Guidelines.
- Occult primary cancer in axillary lymph node(s):
  - See **Metastatic Cancer, Carcinoma of Unknown Primary Site, and Other Types of Cancer (ONC-31)** in the Oncology Imaging Guidelines.

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Evidence Discussion

Initial evaluation of an axillary mass or axillary lymphadenopathy (LAN) should be ultrasound (US). US allows for real-time evaluation and immediate image-directed biopsy.(Sun,2020) CT Chest is usually not appropriate in the evaluation of axillary LAN, especially in the female population with concern for breast cancer.(Expert Panel on Breast Imaging,2022)

Ultrasound is a very important initial imaging modality which is easy to obtain, universally available and portable, exposes patients to no radiation, and is cost effective. It is also excellent in helping to determine next best advanced imaging study including appropriate protocol and contrast level. US not only provides excellent soft tissue resolution, but also provides characterization of cystic lesions (Bosniak classification) whether complex or simple to help guide follow up imaging interval or biopsy.

Background and Supporting Information

- Adenocarcinoma is the most common histology, with breast cancer seen most often; non-palpable breast cancer and axillary metastases accounts for less than 0.5% of all breast cancers. 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.
- COVID-19 vaccine-related unilateral axillary adenopathy has been well documented to occur in 12% of recipients after the first dose and up to 16% after the second dose.[1] In some series the incidence has been as high as 53%.[2] Adenopathy usually develops within the first few days after vaccination and lasts a mean of 10 days. However, 29% had lymphadenopathy which persisted >6 weeks.[3] PET-CT can provide false positive results of unilateral axillary adenopathy up to 7-10 weeks post vaccination. Due to these concerns, in individuals with cancer history it is recommended that the vaccination be provided in the contralateral arm, especially in case of unilateral breast cancer.
- The Society for Breast Imaging (SBI) recommends that for unilateral axillary adenopathy on screening exams who received a recent COVID-19 vaccination in the ipsilateral upper extremity, a follow up interval of 12 or more weeks is recommended. If axillary adenopathy persists after short term follow up, then consider lymph node sampling to exclude breast and non-breast malignancy.[4] Imaging for urgent cancer related clinical indication should not be delayed in relationship to COVID vaccine timing. For routine surveillance, screening and similar non-urgent indications, postponement of imaging for at least 6 weeks after vaccinations should be considered.[5] However, the SBI no longer recommends delaying screening mammograms around COVID-19 vaccinations.[4,5]

Mediastinal Lymphadenopathy (CH-2.3)

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- CT Chest with contrast (CPT® 71260) if mediastinal abnormalities are detected on a chest x-ray (over read by a radiologist), other non-dedicated advanced chest imaging, or clarification of mediastinal abnormalities on a non-contrast CT Chest.
  - Follow-up CT Chest (CPT® 71260) after 3-6 months if:
    - enlarged lymph nodes, ≥15 mm, are in the mediastinum with no other thoracic abnormalities; and
    - thereafter, stability or decreasing size, does not require further advanced imaging.
  - Further evaluations:
    - Lymph node biopsy (see methods below) should be considered for:
      - persistent or increasing lymphadenopathy on follow-up CT Chest; or
      - suspected malignancy.
      - See **Non-Hodgkin Lymphomas (ONC-27)** and/or **Hodgkin Lymphoma (ONC-28)** in the Oncology Imaging Guidelines for suspicion of Lymphoma.
- PET/CT (CPT® 78815) can be considered for enlarged lymph nodes, ≥15 mm with no explainable disease or increasing lymph node size on follow-up CT Chest

Evidence Discussion

- CT Chest indicated for mediastinal abnormalities detected on chest x-ray or other non-dedicated advanced imaging. CT allows for further tissue characterization and can distinguish between calcium, macroscopic fat and water attenuation fluid [(1)]. CT has higher contrast resolution than plain chest radiography. CT does carry with it the risk of both iodinated contrast exposure and ionizing radiation exposure.
- Asymptomatic, incidental mediastinal lymph nodes less than 15 mm (in the short axis) do not require follow up. Evison et al found that size was the greatest predictor of lymph node etiology with those less than 15 mm always found to be reactive (Munden, 2018).
- For mediastinal lymph nodes greater than or equal to 15 mm follow-up should be directed by suspected etiology. For those with low or no clinical suspicion for malignancy and no other thoracic abnormalities, follow up CT chest in 3-6 months is reasonable (Munden, 2018). If the lymph nodes have increased in size on follow-up imaging, PET/CT or tissue biopsy should be considered (Munden, 2018).
- For those with no explainable disease and mediastinal lymph nodes greater than or equal to 15 mm, PET/CT may be considered. However, PET/CT has well-documented false positive results in this setting given the overlap of increased FDG

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uptake in both oncologic and infection or inflammatory disease processes (Munden, 2018).

Background and Supporting Information

- Incidentally detected lymph nodes <15 mm (in short axis) in individuals with no other findings do not require further evaluation.
- Most benign nodes have smooth and well-defined borders, show uniform and homogeneous attenuation, and demonstrate a central fatty hilum
- Explainable disease such as emphysema, interstitial lung disease, sarcoidosis, cardiac disease.
- Unexplained causes, consider lymphoma, undiagnosed metastatic disease, including testicular carcinoma in young male, and infection.
- 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.
- Less invasive methods of mediastinal biopsies are CT or ultrasound directed percutaneous biopsy, transbronchial biopsy, transbronchial biopsy using endobronchial ultrasound, and endoscopic ultrasound-guided FNA.
- More invasive and traditional methods are mediastinoscopy or thoracoscopy/ thoracotomy.

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Cough (CH-3)

Guideline Page

Cough (CH-3.1)

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- Initial evaluation should include a recent chest x-ray after the current episode of cough started or changed.[1,2]
  - In addition all medications known to cause coughing (e.g. ACE inhibitors, Sitagliptin) should be discontinued.[1,2,3]
- CT Chest (either with contrast [CPT® 71260] or without contrast [CPT® 71250]), if the initial chest x-ray is without abnormalities and all medications known to cause coughing have been discontinued, for the following:
  - Non-smoker cough after the following sequence for a total 3-week trial and investigation after ALL of the following:[4]
    - Antihistamine and decongestant or intranasal glucocorticoid treatment.[1,2,7]
    - Spirometry and/or pulmonary function tests (PFT's).[1,4,8]
    - Empiric trial of corticosteroids (oral or inhaled) and/or leukotriene receptor antagonist (e.g. Montelukast).[1,2,4,8,9]
    - Treatment of gastroesophageal reflux disease (GERD).[1,2,4,8,9]
      - See **Sinus and Facial Imaging (HD-29.1)** in the Head Imaging Guidelines.
  - Current or past cigarette smokers with either[4]:
    - new cough lasting greater than 2 weeks
    - changed chronic cough in worsening frequency or character
      - See **Hemoptysis (CH-6.1)**
  - For any abnormalities present on the initial chest x-ray, advanced chest imaging can be performed according to the relevant Chest Imaging Guidelines section.[1]
- CT Maxillofacial without contrast (CPT® 70486) or CT Sinus, limited without contrast (CPT® 76380) is indicated in those with suspicion of Upper Airway Cough Syndrome (UACS) in the following:[4,5,6]
  - Clinical criteria for chronic rhinosinusitis (CRS) or acute/recurrent rhinosinusitis are met, as per **Sinus and Facial Imaging (HD 29.1)**; **OR** ALL of the following:
    - at least a one week trial of daily antihistamine/decongestant
    - initial evaluation with a chest x-ray and/or CT Chest after the current episode of cough started or changed
    - all medications known to cause cough have been discontinued

Evidence Discussion

CT chest is not recommended routinely in people with a chronic cough, normal chest x-ray, and normal physical exam. There is concern regarding potential cancer risk from CT radiation exposure, especially in women and children.(Morice,2020) For patients

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with cough of unknown etiology or a chronic cough refractory to therapy, a CT chest may identify changes not seen on chest x-ray, such as interstitial lung disease or bronchiectasis.(Morice,2020;Kuzniewski,2021)

Current or former smokers with a new cough or change in chronic cough do not need a trial of therapy for UACS, asthma or GERD prior to a chest CT if an initial chest x-ray is abnormal or non-diagnostic. (Irwin,2018)

CT maxillofacial may be considered for suspected chronic rhinosinusitis (CRS) as the cause of chronic cough after clinical examination and chest x-ray if there is no response to empiric therapy or if the history and nasal endoscopy findings are concerning for CRS.(Irwin,2018;Kuzniewski,2021;Donaldson,2023)

Background and Supporting Information

- The resolution of cough usually will occur at a median time of 26 days of stopping use of the angiotensin-converting enzyme (ACE) inhibitor drug.[2] Smoking cessation is “almost always effective” in resolving cough in smoker.[2]
- Cough after URI (Upper Respiratory Infection) can typically last beyond 2-3 weeks.[3]
- Objective evidence of classic asthmatic cough conventionally requires some evidence of variable airflow obstruction such as peak flow variability, or reversibility to bronchodilator of >12%-15%.[8]
- In adult patients with chronic cough suspected to be due to reflux-cough syndrome, it is recommended that treatment include (1) diet modification to promote weight loss in overweight or obese patients; (2) head of bed elevation and avoiding meals within 3 hours of bedtime; and (3) in patients who report heartburn or regurgitation, PPI's, H-2 receptor antagonists, alginate or antacid therapy sufficient to control these symptoms.[9]

References (CH-3)

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Non-Cardiac Chest Pain (CH-4)

Guideline Page

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Non-Cardiac Chest Pain (CH-4.0)

CH.CP.0004.0.A
v1.1.2025

- See the following guidelines:
  - **Pulmonary Embolism (PE) (CH-25.1)**
  - **General Guidelines (CD-1)**
- Evidence is not conclusive whether Triple-rule-out CT (CAD, PE, and AD) will improve efficiency of patient management with acute chest pain.[1]

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Non-Cardiac Chest Pain – Imaging (CH-4.1)

CH.CP.0004.1.A
v1.1.2025

- Initial evaluation should include a chest x-ray.
  - CT Chest with contrast (CPT® 71260) or CTA Chest (CPT® 71275) if x-ray is abnormal. See **Pneumonia (CH-13.1)**
- Sub-Sternal Non-Cardiac Chest Pain:
  - If x-ray is normal and the chest pain is substernal, the individual should undergo evaluation of other possible causes of pain prior to advanced imaging (CT Chest with contrast or CTA Chest) including:[1,2,3]
    - Cardiac evaluation[1,2] (See *General Guidelines (CD-1)* in the Cardiac Imaging Guidelines)
    - GI treatment with any ONE of the following:
      - Trial of anti-reflux medication, or pH probe, or esophageal manometry[1] or
      - Barium swallow or endoscopy
    - Pulmonary Function Test (PFT's) in those with known or suspected respiratory disease
  - CT Chest with contrast (CPT® 71260) if persistent:
    - The initial chest x-ray reveals no abnormalities with known Sickle cell disease[2]
- Non-Cardiac Chest Pain, other than Sub-Sternal:
  - If x-ray is normal and the chest pain is in a location other than substernal:
    - CT Chest with (CPT® 71260) or without (CPT® 71250) contrast and/or bone scan for:
      - known or suspected malignancy, including individuals with chest pain associated with cough and weight loss
    - CT Chest with (CPT® 71260) or without (CPT® 71250) contrast for:
      - suspected infectious or inflammatory condition
      - history of prior chest intervention (surgery, Radiation Therapy)
    - MRI Chest without and with contrast (CPT® 71552) for:
      - necrotizing fasciitis
      - surgical planning prior to debridement procedure
  - For suspected migration of implantable contraceptive devices, see Implantable Contraceptive Devices (PV-10.3)

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Evidence Discussion

It is important to rule out potentially life-threatening causes of acute chest pain, such as an acute coronary syndrome, aortic dissection, and pulmonary embolus. These topics are discussed in other guideline summaries (CD 1.0, CD 1.4, PVD 6.2 and PVD 6.3, CH 25.1). A specialized imaging protocol called the "triple rule-out" is sometimes used to evaluate the pulmonary arteries, aorta and coronary arteries. However, it is associated with higher non-diagnostic imaging quality, radiation and contrast doses. (Burris 2015). The population for which it may be useful is unknown. It is yet to be proven useful in large clinical trials, and its appropriate use needs to be further defined. (Burris, 2015;Hollander,2015;Expert Panel on Cardiac Imaging,2022).

An evaluation for the cause of non-cardiac "angina-like" chest pain should be done if it persists or recurs despite a negative stress test or anatomic cardiac evaluation, or a low risk designation by a clinical decision pathway.(Gulati,2021) The differential diagnosis of non-cardiac chest pain is broad. The most common causes in a primary care setting are chest wall pain, reflux esophagitis and costochondritis.(McConaghy,2020) Respiratory causes include pneumonia, pleuritis and pneumothorax. People with COPD or acute asthma exacerbations may experience chest pain.(Edmonsdstone,2000;Lee,2015) A thorough history and physical exam are important to help narrow the differential diagnosis and direct imaging. Musculoskeletal causes are usually diagnosed based on history and physical exam (point tenderness, reproducibility with palpation) without the need for diagnostic imaging. Most patients should have an ECG and chest x-ray (CR).(Gulati,2021;Cayley,2005) CR is rapid, non-invasive and is usually appropriate in the initial evaluation of acute non-specific chest pain with a low probability of coronary artery disease (CAD).(Gulati,2021;Beache,2020) In patients without evidence of cardiac or pulmonary disease, evaluation for a GI cause is reasonable. An empiric trial of acid suppression may be merited. If this is ineffective or there are alarm symptoms, an EGD, pH probe and/or motility study should be considered.(Gulati, 2021;Frieling,2018;Yamaski,2017)

Patients with sickle cell disease and acute chest pain should have a CR initially. (Gulati,2021) Acute chest syndrome is defined by a new infiltrate on CR with fever and/or respiratory symptoms. In the presence of unexplained hypoxemia and an unremarkable CR, CT chest may be obtained to evaluate the pulmonary vasculature and lung parenchyma.(Jain,2017)

CR is usually appropriate for non-traumatic chest wall pain and no history of malignancy to evaluate for a specific etiology, such as rib fracture, pneumonia, or pneumothorax. (Stowell,2021) Following a normal CR, CT chest is usually appropriate to evaluate chest pain in the setting of known or suspected malignancy, suspected infectious or inflammatory condition, or a history of prior chest intervention.(Stowell,2021) CT is more sensitive than CR for characterizing chest wall neoplasms, chest wall infections, and

subtle osseous and soft tissue lesions. Chest MRI is useful if there is a high suspicion for necrotizing fasciitis and for surgical planning prior to debridement.(Stowell,2021)

Costochondritis/Other Musculoskeletal Chest Wall Syndrome (CH-4.2)

CH.CP.0004.2.A

v1.1.2025

- Costochondritis or other suggested musculoskeletal chest wall syndrome does not require advanced imaging (CT or MRI) unless it meets other criteria in these guidelines.

Evidence Discussion

Costochondritis is a common cause of chest wall pain in adult patients presenting to the emergency department and physician's office.(Proulx,2009;Mott,2021)It is defined as inflammation of costochondral junctions of ribs or costosternal joints, usually at multiple levels and without any swelling or induration.(Proulx,2009) It is a self-limited condition. The diagnosis is largely based on history and physical examination, which reproduces pain on palpation of the chest wall. Upper body movement, deep breathing, and exertional activities often exacerbate the pain. (Proulx,2009; Mott,2021) Tietze syndrome presents similarly to costochondritis but includes visible edema at the involved joint(s), typically is unilateral involving the second rib, and is often incited by infection or trauma. (Mott,2021)

There are no laboratory tests or imaging tests findings specifically for the diagnosis of costochondritis. If a patient relates a history of dyspnea or chest wall trauma, a chest radiograph or rib series may be indicated.(Mott,2021) Chest radiographs can help identify potential sources of previously undifferentiated chest pain such as pneumothorax, pneumomediastinum, fractured ribs, acute and chronic infections, and malignancies.[1]

Most treatment recommendations are conservative in nature and have been traditionally accepted, perhaps because of the self-limited nature of the condition. (Proulx,2009;Mott,2021)

A large observational study found that 91% of patients with new-onset costochondritis had resolution of pain after three weeks of treatment with rest and nonsteroidal anti-inflammatory drugs. Recalcitrant cases may respond to corticosteroid injections. (Mott,2021)

Background and Supporting Information

- Chest x-ray could identify pneumothorax, pneumomediastinum, fractured ribs, acute and chronic infections, and malignancies.[1]

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- Costochondritis can be readily diagnosed with palpation tenderness and/or hooking maneuver and imaging is non-specific.[3]

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Dyspnea/Shortness of Breath (CH-5)

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Dyspnea/Shortness of Breath (CH-5.1)

CH.SB.0005.1.A
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- Initial evaluation should include a recent chest x-ray.[1,2]
  - CT Chest without contrast (CPT® 71250) if x-ray is abnormal.[1,2]
  - CT Chest without contrast (CPT® 71250, including HRCT), or CT Chest with contrast (CPT® 71260) if the initial chest x-ray is indeterminate and the following evaluations have been conducted and are indeterminate:[2]
    - ECG, echocardiogram or stress testing,[2] and
    - Pulse oximetry and pulmonary function studies (PFT's)[2]
- If pulmonary embolus (PE) is suspected, See **Pulmonary Embolism (PE) (CH-25)**.

Evidence Discussion

There is no standard approach for the evaluation of chronic dyspnea, and data that test diagnostic algorithms against standard clinical care are limited; however, clinical practice algorithms have been proposed and found to be effective. (Hudler,2022;Budhwar,2020;Sunjaya,2022; Oelsner,2015) If the diagnosis is not evident after a history and physical exam, initial diagnostic testing with pulse oximetry, spirometry, chest radiography (CR), ECG, and labs is recommended.(Ferry 2019, Sunjaya 2022, Budhwar 2020) While the individual utility of these tests varies for a specific diagnosis, they are commonly available and easy to perform.(Ferry,2019)

Spirometry can identify obstructive lung disease or suggest restrictive lung disease. The flow-volume loop may suggest intra- or extra-thoracic airway obstruction. Some authors recommend full pulmonary function tests as part of the initial investigation, while others consider spirometry an appropriate initial test.(Hudler,2022;Sunjaya,2022) Diagnostic accuracy is improved when spirometry is done in addition to a clinical assessment. (Ferry,2019)

ECG has a high negative predictive value for cardiac disease but low specificity. Thus, further testing such as echo is often necessary.(Ferry,2019) The recommended timing of echocardiography differs between algorithms but echo is an important test for cardiac causes of dyspnea.(Budhwar,2020;Ferry,2019) The American College of Radiology (ACR) states that for dyspnea of suspected cardiac origin, the initial diagnostic imaging should usually be CR followed by transthoracic echo.(Expert Panel on Cardiac Imaging,2017)

CR remains a valuable first line investigation of dyspnea.(Budhwar,2020) The ACR states that CR should generally be the first imaging study.(Expert Panel on Thoracic Imaging,2018) It may reveal abnormalities or guide further imaging decisions. Data on the diagnostic utility of chest CT for chronic dyspnea are limited. It is often used

following an abnormal CR or if other initial testing is negative. The ACR states that CT may be useful when CR abnormalities require further characterization or clinical findings necessitate additional imaging despite a normal CR.(Expert Panel on Thoracic Imaging,2018) CT without intravenous contrast is usually sufficient unless there is a suspicion for vascular abnormalities. The disadvantage is exposure to ionizing radiation; therefore, CT "requires careful patient selection with consideration given to patient age, risk of diagnostic radiation exposure and estimated diagnostic yield."(Ferry,2019)

Background and Supporting Information

- Dyspnea is the subjective experience of breathing discomfort.

Pre-Operative Assessment (CH-5.2)

CH.SB.0005.2.A

v1.1.2025

- For pre-operative assessment prior to a planned segmental, lobar or lung removal,[3,4] as well as for pre-interventional assessment prior to a planned endobronchial valve (e.g. Zephyr valve) placement, the following can be considered:
  - "Split Function Studies" (CPT® 78597-Quantitative Differential Pulmonary Perfusion, Including Imaging When Performed or CPT® 78598-Quantitative Differential Pulmonary Perfusion and Ventilation (e.g., Aerosol or Gas), Including Imaging When Performed) or SPECT/CT (CPT® 78830)

    AND/OR
  - CT Chest (CPT® 71250, CPT® 71260 or CPT® 71270) for pre-interventional procedure assessment prior to a planned endobronchial valve (e.g. Zephyr Valve) placement.

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Post Endobronchial Valve (EBV) Placement (CH-5.3)

CH.SB.0005.3.A
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- Suspected Post EBV Complication:
  - Initial evaluation should include a recent chest x-ray
    - CT Chest without contrast (CPT® 71250) or CT Chest with contrast (CPT® 71260) is appropriate for:
      - acute loss of benefit, lack of initial benefit, increased dyspnea, sudden chest pain, increased cough, suspected valve malposition/migration, or to evaluate target lobe volume reduction

Evidence Discussion

The most common acute complications following EBV placement are pneumothorax, pneumonia, COPD exacerbation and valve migration.(Slebos,2017) Pneumothorax occurs in 20-30% of patients, the majority within the first 48 hours after the procedure. Patients who have an acute increase in dyspnea, cough or chest pain, or an acute perceived loss of benefit, should have a chest X-ray (CR) to rule out pneumothorax. If the CR is non-diagnostic, a CT chest should be done to evaluate the valve position, the target lobe and volume reduction more precisely.(Koster,2020)

Following EBV placement, it may take several days to one month for significant volume reduction and atelectasis of the target lobe to occur. If no significant lung volume reduction is seen on CR at one month, a CT should be done to evaluate valve position. (Slebos,2017) A CT chest is performed routinely at some centers 6-8 weeks after EBV placement.(Koster,2020) If there has been no clinical benefit and no lobar atelectasis is evident on CT at 6 weeks, a revision bronchoscopy may be necessary.(Klooster,2021) The two most common causes of lack of benefit are the presence of interlobar collateral ventilation or valve misplacement/migration.

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Hemoptysis (CH-6)

Guideline Page

Hemoptysis (CH-6.1)

CH.HS.0006.1.A

v1.1.2025

- Following a chest x-ray performed after hemoptysis started or worsened the following is indicated:
  - CT Chest with contrast (CPT® 71260) or CTA Chest (CPT® 71275)
- For recurrent hemoptysis, (hemoptysis occurring after medical therapy or embolization), the following is indicated:
  - CTA Chest (CPT® 71275)

NOTE:

- CT Chest without contrast, (CPT® 71250), is only warranted in individuals with poor renal function or life-threatening contrast allergy.
- There is no data to support the use of CT Chest without and with contrast, (CPT® 71270), in the diagnosis of hemoptysis.

Background and Supporting Information

- Chest x-ray has been shown to predict the side and cause of bleeding in up to 82% of individuals and can be abnormal in up to 90% of cases. The most common cause of hemoptysis was acute bronchitis with the second most common cause as respiratory tract neoplasm. Bronchiectasis and tuberculosis were additional common causes

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Reference (CH-6)

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Bronchiectasis (CH-7)

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Bronchiectasis (CH-7.1)

CH.BR.0007.1.A

v1.1.2025

- High resolution CT Chest (HRCT) without contrast (CPT® 71250) for ANY of the following:[4,5]
  - To confirm suspected diagnosis of bronchiectasis after an initial x-ray.[1,2]
  - For known bronchiectasis with worsening symptoms or worsening PFT's.[2]
  - For hemoptysis with known or suspected bronchiectasis.[3]

Evidence Discussion

The British Thoracic Society (BTS) recommends performing a baseline chest x ray (CR) in people with suspected bronchiectasis followed by a thin section (< or equal to 1 mm slice thickness) CT scan to confirm the diagnosis.(Hill,2019) According to the American College of Radiology (ACR), CR is relatively insensitive but is usually appropriate and often performed as initial imaging for evaluation of associated conditions and exclusion of diseases that cause similar symptoms.(Little,2024) High resolution CT chest (HRCT) is considered the most accurate imaging modality for the diagnosis of bronchiectasis. (Ledda,2021) The ACR states that CT chest WO is usually appropriate for suspected bronchiectasis to identify and characterize the severity and distribution of bronchiectasis and to evaluate any associated parenchymal lung diseases.(Little,2024) CT chest can help identify an etiology, such as allergic bronchopulmonary aspergillosis, Primary Ciliary Dyskinesia, tracheobronchomegaly, or a foreign body.(Hill,2019;Ledda,2021)

MRI chest for suspected bronchiectasis is not recommended because. It is inferior to CT for evaluating lung parenchyma, and its use is mainly limited to research settings. (Little,2024)

CR is often the initial chest imaging exam to evaluate acute conditions in people with bronchiectasis, such as pneumonia or hemoptysis. CT chest WO is usually appropriate for the evaluation of complications and assessing changes in clinical status.(Little,2024) CT chest with contrast may be appropriate in the setting of a suspected acute infection and associated complication, such as abscess.(Little,2024) The BTS recommends a CT chest for people with a deteriorating clinical status, such as worsening symptoms, increased frequency or severity of acute exacerbations, or decreasing lung function.(Hill,2019) They recommend a CT chest with contrast if PE is suspected. CTA chest with contrast may be appropriate in the setting of hemoptysis to identify dilated bronchial arteries or systemic collateral vessels and for pre-procedure planning.(Little,2024;Ledda,2021)

High quality evidence in favor of repeated imaging is lacking.(Ledda,2021)CR may not show structural changes. Repeat HRCT carries the risk of increased radiation. Patients

with diseases associated with bronchiectasis may be evaluated with CT to help guide therapy and provide prognostic information.(Little,2024)The current indication for repeat HRCT is clinical deterioration.(Hill,2019)

Adult Cystic Fibrosis (CH-7.2)

CH.BR.0007.2.A

v1.1.2025

- CT Chest without contrast (CPT® 71250) or with contrast (CPT® 71260) is indicated for the following (without initial chest x-ray):
  - Suspected or initial diagnosis of Cystic Fibrosis
  - Biennially, (every 2 years), for routine surveillance
  - Persistent respiratory symptoms with reduced lung function despite therapy
  - Exacerbations when chest x-ray is indeterminate
  - Hemoptysis
  - Suspected fungal pneumonia
  - Pre and post-lung transplant evaluation
- See **Bronchiectasis (CH-7.1)**

Evidence Discussion

Imaging is an important method of evaluating the lungs in people with cystic fibrosis (CF). It has a stronger correlation with disease severity than pulmonary function tests and facilitates prompt therapy which may help limit irreversible lung damage. (Crowley,2021) Chest x- ray (CR) is less sensitive than CT chest at detecting early structural changes and disease progression.(Ciet,2022) However, CR is still most commonly used as the first line imaging examination for the assessment of acute complications due to its low cost, availability, low radiation and speed of acquisition. (Murphy,2016) CT is increasingly being used to monitor disease progression and make treatment decisions, but the routine use of CT for short term follow up during pulmonary exacerbations is not recommended due to the risk of a high cumulative radiation dose. Low dose chest CT (LDCT) is useful in patients with persistent respiratory symptoms and decreased lung function despite appropriate therapy.(Ciet,2022) There is little evidence regarding the optimal timing of CT monitoring. The current best clinical practice in several European CF centers is a CT every two years with a radiation dose as low as reasonably achievable (ALARA). Follow up imaging is determined by individual patient-dependent clinical factors.(Ciet,2022) The CF Foundation guidelines for adult CF clinical care recommend CR every 2-4 years in those with a stable clinical status and state that imaging should be considered if there are symptoms or signs of an acute pulmonary exacerbation, pneumothorax, lobar atelectasis or hemoptysis. (Yankaskas,2004;Flume,2010)

Several emerging techniques offer promising means of pulmonary imaging using less ionizing radiation, including ultra-low dose CT (ULDCT) and MRI. (Crowley,2021;Goralski,2021) The radiation dose with CR is 0.02mSv, 5.4 mSv for standard dose CT, 1 to 2 mSv for LDCT, and 0.05-0.08mSv for ULDCT. While pulmonary

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MRI has promise as a means of routinely monitoring CF lung disease, it is currently limited by a lack of availability, high cost, lack of validation and standardized protocols, and the need for sedation or anesthesia in some patients.(Crowley,2021;Ciet,2022)

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Bronchitis (CH-8)

Guideline Page

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Bronchitis (CH-8.1)

CH.BH.0008.1.A

v1.1.2025

- Chest x-ray is indicated as initial imaging. Advanced imaging is not needed for bronchitis unless directed by condition specific guideline.
- See the following guidelines for additional information- For Pneumonia, see: **Pneumonia (CH-13.1).**
- See the following guidelines for additional information- For Cough, see: **Cough (CH-3.1)**.
- See the following guidelines for additional information- For Pleural Effusion, see: **Pleural Effusion (CH-18.1).**
- See the following guidelines for additional information- For pulmonary mass, see: **Pulmonary Nodule (CH-16.1).**

Evidence Discussion

Acute bronchitis is a self-limited respiratory infection characterized by cough due to acute inflammation of the trachea and large airways without evidence of pneumonia.[1, 2.] This syndrome should be distinguished from the common cold, an acute exacerbation of chronic bronchitis and acute asthma.[1]

Cough associated with acute bronchitis typically lasts about two to three weeks. Other diagnoses must be considered when cough persists for more than three weeks.[1] Acute bronchitis is mainly caused by viruses, and antibiotics are not typically indicated in patients without chronic lung disease[1, 2]. Imaging is primarily used to rule out pneumonia. Evidence-based guidelines from the American College of Chest Physicians state that imaging is not needed in patients with acute bronchitis symptoms who have normal vital signs and normal lung examination findings.[2]

Chest radiographs are indicated in patients with symptoms of dyspnea, tachycardia, tachypnea and fever more than 100^0F or lung findings suggestive of pneumonia.[2]

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Asbestos Exposure (CH-9)

Guideline Page

Asbestos Exposure (CH-9.1)

CH.AE.0009.1.A
v1.1.2025

- Chest x-ray as radiographic screening for asbestos exposure.[1,2]
  - Stable calcified pleural plaques on chest x-ray do not require advanced imaging of the chest.[2]
- CT Chest should not be used to screen populations at risk for asbestos-related diseases.[2]
- High resolution CT Chest (HRCT) (CPT® 71250) for ANY of the following:[2]
  - Any change seen on chest x-ray
  - Progressive respiratory symptoms that may indicate the development or progression of asbestos related interstitial fibrosis

Evidence Discussion

Several well-conducted epidemiologic studies of occupationally exposed workers, family contacts of workers, and persons living near asbestos mines have demonstrated that exposure to asbestos is associated with an increased incidence of asbestosis, lung cancer, mesothelioma, as well as other neoplasms. Asbestosis is a fibrotic lung disease caused by accumulation of asbestos fibers in the lungs. The diagnosis of asbestosis is most commonly made based on a history of exposure to asbestos, the presence of characteristic radiologic abnormalities, end-inspiratory rales, and other clinical features.

A chest x-ray of an individual exposed to asbestos may show pleural plaques, pleural calcifications, pleural fibrosis, or small irregular parenchymal opacities. Lung cancer risk is not elevated among individuals with asbestos-related pleural plaques in the absence of asbestosis.

Chest x-ray is currently indicated to screen for lung changes resulting from asbestos exposure and is recommended for those who have had relatively heavy exposure to asbestos. However, chest x-rays lack specificity. When a chest x-ray abnormality is indeterminate, High Resolution CT Chest (HRCT) is useful in revealing characteristic parenchymal abnormalities. There is a lack of consensus among experts regarding the value of HRCT for screening of asbestos-related pulmonary disease.

Background and Supporting Information

- Asbestosis and asbestos-related diseases include: pleural effusion, pleural plaques, lung cancer, and malignant mesothelioma. The risk of developing mesothelioma increases with increasing intensity and duration of exposure.

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Chronic Obstructive Pulmonary Disease (COPD) (CH-10)

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COPD (CH-10.1)

CH.PD.0010.1.A
v1.1.2025

- Chest x-ray should be performed initially.
  - CT Chest without contrast (CPT® 71250) or CT Chest with contrast (CPT® 71260)[1,2] can be performed if:
    - Emphysema is known or suspected and a pre-operative study for Lung Volume Reduction Surgery (LVRS) is being requested.[1] OR
    - Definitive diagnosis is not yet determined by PFT's, appropriate laboratory studies and chest x-ray and ONE of the following is suspected:
      - Bronchiectasis
      - Sarcoidosis
      - Emphysema
      - Pneumoconiosis
      - Idiopathic pulmonary fibrosis
      - Langerhans cell histiocytosis
      - Hypersensitivity pneumonitis
      - Bronchiolitis obliterans
      - Lipoid pneumonia
      - Drug toxicity
      - Lymphangitic cancer[2]
      - Alpha-1-Antitrypsin Deficiency
- Lung cancer screening is discussed in the following guideline:
  - See "Screening Indications" in **Lung Cancer Screening (CH-33)**
- Pre-interventional lung procedure assessment prior to a planned endobronchial valve (e.g. Zephyr valve) placement
  - See **Pre-Operative Assessment (CH-5.2)**

Evidence Discussion

Chest x-ray (CR) is usually the appropriate initial imaging study for suspected COPD to exclude alternative diagnoses and evaluate for comorbidities and complications. (2023 Gold Report,2023;Raoof,2023;Expert Panel on Thoracic Imaging,2018) CR, pulmonary function tests (PFT's) and selected blood tests lead to a specific diagnosis in a significant proportion of people with chronic dyspnea.(Raoof,2023) CT has increased sensitivity and specificity for determining the type, severity, and distribution of emphysema and bronchial abnormalities.(Raoof,2023;Expert Panel on Thoracic Imaging,2018) It is an important part of the pre-procedure evaluation process for lung volume reduction surgery, endobronchial valve placement, and lung transplantation.

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(Raoof,2023) The GOLD 2023 report recommends that CT be considered for COPD patients with persistent exacerbations and concern for another diagnosis, such as bronchiectasis or an atypical infection, or symptoms out of proportion to the disease severity suggested by PFT's.(2023 Gold Report,2023) Some authors have proposed broadening the definition of COPD to include CT-detected emphysema, air trapping or airway wall thickening, even in the absence of airflow obstruction on spirometry. (Lowe,2019;Ferrara,2021)

CT is helpful if a smoking-related interstitial lung disease, such as pulmonary Langerhans cell histiocytosis or Combined Pulmonary Fibrosis and Emphysema, is suspected.(Cottin,2022;Guiot,2022) It is recommended following a diagnosis of alpha-1 antitrypsin deficiency.(Stoller,2006) CT is also used in the evaluation of central airway abnormalities associated with COPD, such as tracheobronchomalacia and excessive dynamic airways collapse.(Raoof,2023) Annual lung cancer screening CT's should be performed in current or former smokers who meet the USPSTF criteria, but screening CT's are not recommended for those with COPD not due to smoking because there is insufficient evidence to establish benefit over harm.(2023 Gold Report,2023)

COPD exacerbations are characterized by dyspnea, cough and/or sputum which worsen over a period of less than two weeks.(2023 Gold Report,2023) They are mainly caused by respiratory viral infections. CR is often performed to rule out alternative diagnoses, such as pneumonia, pneumothorax or pulmonary edema.

Background and Supporting Information

- COPD includes asthmatic bronchitis, chronic bronchitis, and emphysema. COPD is airflow reduction (FEV1/FVC ratio <0.7 or FEV1 <80% predicted) in the presence of respiratory symptoms, such as dyspnea. Advanced chest imaging is not typically indicated in COPD exacerbation, which is an acute change in baseline dyspnea, cough, and/or sputum beyond normal day-to-day variations.[2]

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Interstitial Disease (CH-11)

Guideline Page

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Interstitial Lung Disease (ILD)/Diffuse Lung Disease (DLD) (CH-11.1)

CH.ID.0011.1.A

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- High resolution CT Chest (HRCT) (*see below) without contrast (CPT® 71250) is the diagnostic modality of choice to evaluate or CT Chest with contrast (CPT® 71260)[10] (See **Background and Supporting Information**) for:
  - Interstitial changes or diffuse parenchymal changes identified on other imaging (including chest x-ray) (See **Dyspnea/Shortness of Breath (CH-5.1)**[1-6]
  - In individuals with pulmonary symptoms and abnormal pulmonary function studies (PFT's) and normal chest x-ray with high clinical suspicion for ILD or DLD, including but not limited to entities such as Hypersensitivity Pneumonitis, Cryptogenic Organizing Pneumonia (COP, formally known as BOOP), and Eosinophilic Pneumonia, as chest x-ray can be normal in up to 10% of ILD[8,9]
  - Initial imaging to identify interstitial disease with a connective tissue disease diagnosis, or significant exposures including (chest x-ray not required):
    - rheumatoid arthritis
    - scleroderma
    - idiopathic inflammatory myopathies (polymyositis, dermatomyositis, inclusion body myositis)
    - systemic lupus erythematosus
    - Sjögren's syndrome
    - mixed connective tissue disease
    - significant exposure and concern for:
      - asbestosis
      - silicosis
      - Coal miner's lung disease[1-6,11]
  - At any time for detection of Progressive Pulmonary Fibrosis (PPF), in individuals with ILD of known or unknown etiology, defined by at least one of the following:[12]
    - New or worsening respiratory symptoms
    - Worsening PFT's, defined as decline of either:
      - FVC of 5% or greater within the past year
      - DLCO of 10% or greater within the past year
  - Once a year in individuals with known pulmonary fibrosis if needed for:[10]
    - serial examination for improvements in diagnostic accuracy, or
    - evaluation of disease reversibility, stability, or progression.

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- Concern for interstitial lung disease post-COVID See **Coronavirus Disease 2019 (COVID-19) (CH-13.2)**
- HRCT can be done even if a regular CT Chest has been done recently. HRCT is done with a thinner-slice protocol that can provide additional details to help determine ILD subtype.
- HRCT can also be done with inspiratory/expiratory and supine/prone views.

Evidence Discussion

ILD is often suspected in those with chronic dyspnea or non-productive cough, especially in the setting of an inhalational exposure or systemic disease known to be associated with lung involvement.(Expert Panel on Thoracic Imaging,2020;Expert Panel on Thoracic Imaging,2021;Castelino,2010;Joy,2023) Chest x-ray (CR) and CT chest without contrast are usually appropriate for suspected ILD and provide complementary information.(Expert Panel on Thoracic Imaging,2020;Expert Panel on Thoracic Imaging,2021) A normal CR does not rule out ILD. Its primary function is to evaluate for an alternative diagnosis. CR remains an important imaging modality to screen for occupational lung disease.(Expert Panel on Thoracic Imaging,2020) High resolution CT (HRCT) has higher sensitivity and specificity for ILD. HRCT may help guide a biopsy site or provide a definitive diagnosis, making a biopsy unnecessary. (Expert Panel on Thoracic Imaging,2020;Expert Panel on Thoracic Imaging,2021) CT can provide prognostic information: patients with honeycombing or a usual interstitial pneumonia (UIP) pattern on CT have increased mortality.(Montesi,2020)

CR and CT chest without contrast are usually appropriate for evaluation of an acute exacerbation of ILD.(Expert Panel on Thoracic Imaging,2021) They can help exclude alternative causes for worsening clinical symptoms and confirm abnormalities consistent with progression of ILD. There are no data to support routine surveillance imaging of ILD, but serial CT's can improve diagnostic accuracy and evaluate disease stability, reversibility or progression.(Expert Panel on Thoracic Imaging,2021) The optimal interval for follow up HRCT to determine disease progression in idiopathic pulmonary fibrosis (IPF) is unknown. Raghu et al recommend consideration of an annual HRCT in people with IPF if there is clinical suspicion of worsening fibrosis or to screen for complications such as lung cancer.(6) In people with an ILD other than IPF and radiologic evidence of fibrosis, disease progression on HRCT is one of three criteria used to define progressive pulmonary fibrosis.(Raghu,2022;Wong,2020)

Interstitial lung abnormalities (ILA) are abnormalities on CT suggestive of ILD in people without a prior clinical diagnosis.(Hatabu,2020;Hunninghake,2022) They are common incidental findings, especially in older people. ILA are a radiologic observation. Differentiation between ILA and clinical or subclinical ILD must be on the basis of a clinical evaluation. When respiratory signs/symptoms or functional impairment is present, ILA likely represent mild ILD. The morphology and distribution of ILA are important: subpleural fibrotic ILA are most likely to progress. There is minimal evidence

to support a specific management plan for ILA. Hatabu et al recommend that when ILA are detected, a dedicated HRCT chest can help confirm and characterize the abnormalities, especially if the initial scan was incomplete (ie a CT abdomen) or not performed with thin sections.(Hatabu,2020) Hunninghake et al recommend that a HRCT should be done in those with ILA.(Hunninghake,2022) If clinically significant ILD is ruled out, Hatabu et al recommend a repeat CT at 12-24 months for those with subpleural fibrotic ILA or other risk factors for progression to ILD. However, participants in a recent consensus survey disagreed about repeating a HRCT at the follow up evaluation. (Hunninghake,2022) People with nonfibrotic nonsubpleural ILA and no symptoms or physiologic impairment do not need reimaging.(Hatabu,2020; Tomassetti,2022)

Background and Supporting Information

- DLD refers to diffuse parenchymal lung diseases or interstitial lung diseases. There are a multitude of pathologies that demonstrate involvement of the alveola, airways, or both, in addition to the pulmonary interstitium. A single term of ILD would not fully address the entities that are mostly parenchymal in nature, hence the term Diffuse Lung Disease is more technically correct. Both terms are included here for convenience and recognition.
- There is no relevant literature to support the use of CT with IV contrast for initial or follow-up imaging of ILD; however, IV contrast may be of use in evaluation of alternative diagnoses with overlapping clinical features or conditions that also involve the pleura, mediastinum, and pulmonary vessels.
- Progression of fibrosis is typically assessed visually, relying on the percentage of lung volume containing fibrotic features in the upper, mid, and lower lung zones. An increased extent of fibrotic features denotes progression. These may include increased traction bronchiectasis and bronchiolectasis, new ground-glass opacity with traction bronchiectasis, new fine reticulation, increased coarseness of reticular abnormality, new or increased honeycombing, and increased lobar volume loss.[12]

E-cigarette, or Vaping, Product Use–Associated Lung Injury (EVALI) (CH-11.2)

CH.ID.0011.2.A

v1.1.2025

- CT Chest with or without contrast (CPT® 71250 or CPT® 71260) if EVALI is suspected.[7]

Evidence Discussion

EVALI is a toxic inhalational acute lung injury with imaging and histopathologic patterns of organizing pneumonia and/or diffuse alveolar damage.(Kligerman,2020;Friedman, 2022) Chest x-ray (CR) can exclude other diagnoses and is often the first imaging study. CR is not abnormal at initial assessment in all patients with EVALI. When pulmonary abnormalities are not identified on CR or when further characterization of CR findings are needed to evaluate for another potential cause of symptoms, CT chest can be obtained.(Kligerman, 2020;Friedman, 2022)

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Pneumonia and Coronavirus Disease 2019 (COVID-19) (CH-13)

Guideline Page

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Pneumonia (CH-13.1)

CH.PN.0013.1.A

v1.1.2025

- Chest x-ray should be performed initially in all individuals with suspected pneumonia, prior to considering advanced imaging.[1, 2]
  - CT Chest without or with contrast (CPT® 71250 or CPT® 71260) if initial or repeat chest x-ray findings reveal:
    - complication of pneumonia (e.g. abscess, effusion,necrotizing pneumonia, pneumothorax)[1,2]
    - possible lung mass associated with the infiltrate.2
  - CT Chest without or with contrast (CPT® 71250 or CPT® 71260) for hypoxia and/ or respiratory distress
  - CT Chest without or with contrast (CPT® 71250 or CPT®71260) after initial chest radiograph is negative or equivocal and one of the following:
    - Abnormal vital signs (including hypoxemia, pulse > 100, respiratory rate > 24, fever > 100)
    - Abnormal exam (including respiratory distress, dyspnea and or abnormal lung auscultation)
    - Advanced age (age>75), or other significant comorbidities
- If pulmonary emboli suspected, see **Pulmonary Embolism (CH-25.1).**
- CT Chest without or with contrast (CPT® 71250 or CPT® 71260) for immunocompromised individuals with any of the following:[15]
  - High suspicion for pneumonia despite equivocal or negative chest x-ray
  - Persistent radiographic abnormalities
  - Multiple or diffuse opacities or nodules

Evidence Discussion

Chest radiography (CR) is the appropriate first imaging modality in the evaluation of suspected pneumonia.(Dueck,2021) The American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA) define a clinical diagnosis of pneumonia as symptoms and signs of pneumonia with radiographic confirmation. (Metlay,2019)

CT is more accurate/sensitive than CR and may be warranted when there is a high clinical suspicion for pneumonia (typical or atypical) and a delay in diagnosis could be life threatening.

CT chest without contrast is usually appropriate and CT chest with contrast may be appropriate in immunocompromised people with an acute respiratory illness and a normal/equivocal/nonspecific CR or a CR that demonstrates multiple, diffuse or confluent opacities.(Expert Panel on Thoracic Imaging,2019)

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MRI is usually not appropriate for the imaging of pneumonia.(Expert Panel on Thoracic Imaging,2018;Expert Panel on Thoracic Imaging,2019) MRI has a potential role for follow up imaging of parenchymal (Chest wall/mediastinal) disease, but CT is more sensitive and is preferred.(Expert Panel on Thoracic Imaging,2019)

Routine use of follow up chest imaging in adults who are improving and whose symptoms have resolved within 5-7 days is not recommended by the ATS/IDSA. (Metlay,2019) Repeat CR or CT after the completion of therapy is generally reserved for high risk patients, suspected complications, disease progression or when the clinical course differs from CR interpretation.(Dueck,2021,Lampichler,2017)

Coronavirus Disease 2019 (COVID-19) (CH-13.2)

CH.PN.0013.2.A

v1.1.2025

- CT Chest without contrast (CPT®71250), or with contrast (CPT®71260) in the following clinical situations:
  - Imaging for initial diagnosis:
    - Symptomatic COVID-19 positive individuals with underlying comorbidities (including but not limited to age >65 years, chronic lung disease, current or former smoker, chronic kidney disease, chronic liver disease, dementia, diabetes, Down's syndrome, HIV or other primary, secondary or acquired immunodeficiency, mood disorders, BMI ≥30, pregnancy, solid organ or blood stem cell transplant, cerebrovascular disease, substance use disorder, tuberculosis, cardiovascular disease, malignancy, bronchopulmonary dysplasia, chronic infections, or immunocompromised state). See CDC's list of higher risk for severe COVID for additional information: **https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html**
    - Moderate to severe symptomatic individuals with evidence of significant pulmonary dysfunction or damage (e.g., hypoxemia, moderate-to-severe dyspnea), suspected of having COVID-19, regardless of COVID-19 test results or when viral testing is not available.
    - Thromboembolic complications including pulmonary embolism, stroke and mesenteric ischemia are recognized complications of COVID-19. See **Pulmonary Embolism (CH-25.1)**,**Mesenteric Ischemia (AB-6.1)** in the Abdomen Imaging Guidelines, and **Stroke/TIA (HD-21.1)** in the Head Imaging Guidelines for appropriate imaging guidance.
    - Other systemic complications are being recognized as medical knowledge about this condition evolves. Imaging for possible COVID-19 complications should be managed by the appropriate condition based guidelines.
  - Imaging after initial diagnosis:
    - Imaging in the following clinical circumstances:
      - If there is significant worsening of symptoms in a COVID-19 positive individual and imaging will be used to modify individual management.
      - A recovered COVID-19 positive individual with significant residual functional impairment and/or persistence hypoxemia.

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- Symptomatic post-COVID individuals with concern for interstitial lung disease including organizing pneumonia imaging can be considered pre and post treatment.[11]

Evidence Discussion

Chest imaging is not routinely indicated as a screening test for COVID-19 in asymptomatic people or in people with suspected COVID-19 and mild clinical features unless they are at risk for disease progression.(Rubin,2020)

The American College of Radiology (ACR) states that CT chest should not be used as a screen or first-line test to diagnose COVID-19.(American College of Radiology,2020) Viral testing is the only specific method of diagnosis and confirmation with a viral test is required even if radiologic findings on chest radiography (CR) or CT are suggestive of COVID-19.

Imaging is indicated in people with COVID-19 and a worsening respiratory status or in people who have suspected COVID-19, a high pretest probability of disease, and moderate to severe clinical features.(Rubin,2020) Although less sensitive than CT, chest radiography (CR) is typically the first line imaging modality. (Rubin,2020;Long,2022;Expert Panel on Thoracic Imaging,2018)

Johnston et al have proposed a management algorithm for patients with COVID-19 pneumonia which recommends a clinical assessment with CR and PFT's 3-6 months after discharge.(Johnston,2023) Performance of a high resolution CT chest (HRCT) is based on risk factors (ICU admission, noninvasive or mechanical ventilation; male sex; age>60) and serial assessment of lung function and symptoms.

There is an increased risk of pulmonary embolus (PE) in people with COVID-19, including both microvascular/ in situ thrombosis and macrothrombotic events.(Ortega-Paz,2023) It is currently recommended that the same diagnostic strategy and the same D-dimer threshold be used for people with COVID-19 and suspected PE as in those without COVID-19.(Ortega-Paz,2023;Suh,2021)

Background and Supporting Information

- The role of advanced imaging in the diagnosis and management of COVID-19 is very dynamic in this rapidly evolving condition.
- Comorbidities may include: chronic heart, lung, liver, or renal disease; diabetes mellitus; alcoholism; malignancy; asplenia; organic brain disease (dementia, CVA, delirium).
- Findings on both Chest x-ray and CT Chest are non-specific. Chest x-rays may show patchy opacities with lower lung predominance. CT may show peripheral multifocal ground glass opacities with lower lung predominance. However, a significant portion of cases have opacities without a clear or specific distribution.[3,4,6] A reverse halo

sign or other findings of organizing pneumonia may be seen later during the course of illness. Atypical findings include isolated lobar or segmental consolidation without ground glass opacities, discrete small centrilobular ("tree-in-bud") nodules, pleural effusion.[8]
  - Pediatric individuals may have less pronounced imaging findings than adults.
- CT Chest abnormalities are common 3 months after discharge in adults who have been hospitalized for COVID-19 and are associated with more severe acute disease. Fibrosis was seen in a minority of people.[13,14] Most people re-imaged at one year showed radiologic improvement.[13]
- Major professional society guidelines to date:
  - The American College of Radiology (ACR) recommends that CT Chest should not be used for screening or as a first-line test to diagnose COVID-19.[3]
  - The Centers for Disease Control and Prevention (CDC) recommends viral testing as the only specific method of diagnosis.[4]
  - The CDC has stated that symptoms may appear 2-14 days after exposure to the virus. These symptoms may include:[5]
    - fever or chills
    - cough
    - shortness of breath or difficulty breathing
    - fatigue
    - muscle or body aches
    - headache
    - new loss of taste or smell
    - sore throat
    - congestion or runny nose
    - nausea or vomiting
    - diarrhea
  - The Fleischner Society consensus statement published on April 7, 2020, recommends against the use of imaging in individuals with suspected COVID-19 who are either asymptomatic or have only mild symptoms without evidence of significant pulmonary dysfunction or damage (e.g., absence of hypoxemia, no or mild dyspnea).[6]
  - According to The American Society of Transplantation, screening donors is based on methods below. Screening donors encompasses three different methods.[7]
    - Epidemiologic screening for travel and potential exposures
    - Screening for symptoms suggestive of COVID-19
    - Viral testing (nucleic acid testing of specimens)
    - There is no current indication for screening asymptomatic donors with advanced imaging.

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Other Chest Infections (CH-14)

Guideline Page

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PPD or TB (Mycobacterium tuberculosis and Nontuberculous Mycobacterial Pulmonary Disease (NTM-PD)) (CH-14.1)

CH.CI.0014.1.A

v1.1.2025

- CT Chest with contrast (CPT® 71260) or CT Chest without contrast (CPT® 71250) with ANY of the following:
  - Normal or equivocal chest x-ray with ONE of the following:[1]
    - Positive PPD skin test or other positive tuberculin skin tests OR
    - Positive QuantiFERON-TB Gold OR
    - Suspected active (or reactivated) tuberculosis
  - Suspected complications or progression of tuberculosis (e.g. pleural tuberculosis, empyema, and mediastinitis)[2]
  - Suspected NTM-PD
  - If CT Chest is unremarkable, there is insufficient data to support performing subsequent CT Chest unless symptoms develop or chest x-ray shows a new abnormality.
  - Follow-up CT Chest with contrast (CPT® 71260) or without contrast (CPT® 71250) with frequency at the discretion of or in consultation with the pulmonary or infectious disease specialist (not to exceed 3 studies in 3 months).
  - Re-evaluate individuals undergoing active treatment who had abnormalities seen only on CT Chest.

Evidence Discussion

Chest radiography (CR) should be the initial for suspected active M. tuberculosis (MTB) infection based on clinical symptoms and demographics. a newly positive tuberculin skin test, (TST) or interferon-gamma release assay (IGRA). CT is appropriate if CR is equivocal and there is clinical suspicion of active MTB, especially in those with impaired cell-mediated immunity.(Wetscherek,2022) CT may be performed to evaluate suspected complications and monitor response to therapy.(Nel,2022;Expert Panel on Thoracic Imaging,2018)

CR is usually appropriate to distinguish latent from active MTB in people with evidence of new exposure (a newly positive TST/IGRA or a positive TST/IGRA with unknown prior status) but no clinical symptoms.(Ravenel,2017) The yield of CR for active MTB in the absence of clinical symptoms is low. CT is more sensitive than CR for the detection of

latent TB.(Moore,2023). CT is recommended when CR is equivocal for active MTB or when a diagnosis of latent MTB may affect future care.(Ravenel,2017;Piccazzo,2014)

When a TST is not available for people who are going to live in a group home, correctional institution or nursing facility, CR is usually appropriate as a surrogate screening measure.

Imaging (CR and CT) is an important component in the diagnosis and follow up of nontuberculous mycobacterial pulmonary disease (NTM-PD).(Lipman,2020) The diagnosis and determination of response to therapy are based upon radiologic, clinical, and microbiologic criteria.(Daley,2020;Haworth,2017) Serial CT imaging is important for monitoring disease progression and response to therapy. Radiologic findings provide prognostic information and may affect treatment recommendations.(Haworth,2017)

Fungal Infections (Suspected or Known) (CH-14.2)

CH.CI.0014.2.A

v1.1.2025

- CT Chest with contrast (CPT® 71260) or High resolution CT Chest (HRCT) without contrast (CPT® 71250):[3,4]
  - Initial diagnosis of any fungal pneumonia or chest infection[3,4]
  - Suspected complications or progression of the fungal chest infection (e.g. worsening pneumonitis; pleural effusion, empyema, mediastinitis)
  - Suspected Allergic Bronchopulmonary Aspergillosis (ABPA) in asthmatics with atypical presentation or poor response to conventional therapy[7,8,9]
- Follow-up CT Chest with contrast (CPT® 71260) or High Resolution CT Chest (HRCT) without contrast (CPT® 71250) with frequency at the discretion of or in consultation with the pulmonary or infectious disease specialist.

Evidence Discussion

CT chest is the imaging method of choice for suspected or known pulmonary fungal infections, especially in immunocompromised hosts.(Alexander,2021;Lewis,2023) Imaging findings are not specific but can lead to early detection of infection, help direct further diagnostic procedures and narrow the differential diagnosis. (Lewis,2023;Walker,2014) CT is also used to monitor response to therapy and identify complications.(Alexander,2021) The diagnosis of certain pulmonary fungal infections and determination of response to treatment require a combination of clinical, microbiologic and radiologic criteria.(Van Braeckel,2022; Setianingrum,2019;Denning,2016) Denning et al recommend follow up imaging 3-6 months after starting anti-fungal therapy for chronic pulmonary aspergillosis, then less frequently, or with any major change of clinical status based on the fact that radiologic change is slow and little change is visible on chest X-ray (CR) or CT in less than 3 months.(Denning,2016)

CT is not recommended in the routine evaluation of suspected asthma without a specific indication but may be of value to identify acute complications following a nondiagnostic CR, suspected alternative diagnoses or associated conditions, such as allergic bronchopulmonary aspergillosis.(Richards,2016;Ash,2017).

Wegener's Granulomatosis/ Granulomatosis with Polyangiitis and Related Entities (CH-14.3)

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- See **Small Vessel Vasculitis (PVD-6.11)** for concerns of Wegener's Granulomatosis and Related Entities in Peripheral Vascular Disease imaging guidelines.

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Suspected Sternal Dehiscence (CH-14.4)

CH.CI.0014.4.A
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- Sternal wound dehiscence is primarily a clinical determination.
- Chest x-ray is performed prior to advanced imaging to identify abnormalities in the sternal wire integrity and/or a midsternal stripe. Other findings include rotated, shifted or ruptured wires.
- CT Chest without contrast (CPT® 71250) or CT Chest with contrast (CPT® 71260) for:
  - differentiating sternal wire migration from sternal dehiscence[10]
  - planned debridement and/or repair

See **Infection – General (MS-9.1)** for concerns for osteomyelitis or soft tissue infection.

Evidence Discussion

Sternal dehiscence is defined as sternal separation with intact sternal wires migrating with a displaced sternal fragment.(Hota,2018) The diagnosis is often made clinically; however, early signs may be subtle, and it may be clinically occult. (Boiselle,1999). Early detection of sternal dehiscence on chest x-ray (CR) is important..(Hota,2018;Boiselle,1999;Hayward,1994; Boiselle,2002) CT may be used in equivocal cases to assess for sternal separation or for preoperative planning. (Hota,2018,Silverborn,2022)

CT provides the best evaluation of sternal non-union when suspected based on pain, clicking and clinical evidence of sternal instability for > 3 months in the absence of infection.(Hota,2018)

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Sarcoid (CH-15)

Guideline Page

Sarcoid (CH-15.1)

CH.SA.0015.1.A
v1.1.2025

- CT Chest with contrast (CPT® 71260) or without contrast (CPT® 71250) for:
  - Establish or rule out the diagnosis when suspected
- Subsequent CT Chest with contrast (CPT® 71260) or without contrast (CPT® 71250), in known sarcoidosis, for ANY of the following:[1]
  - Development of worsening symptoms
  - New symptoms appear after a period of being asymptomatic
  - Treatment change is being considered
- If CT is equivocal, definitive diagnosis can only be made by biopsy.[2,3,4]
- PET/CT should not be used in the standard work-up of all sarcoidosis individuals. There is currently no evidence to support the use of PET/CT for screening.
- PET/CT (CPT® 78815) can be considered under the following conditions:[5,6,7]
  - Help guide biopsy location if:
    - known lesion on CT Chest is difficult to access, to help identify alternative biopsy location
    - no apparent lung involvement and to identify an extrapulmonary biopsy site
  - Differentiation of reversible granulomatous disease from irreversible pulmonary fibrosis and will affect treatment options
  - Help identify treatment failure where either current treatment will be modified or new treatment will be introduced

Evidence Discussion

Sarcoidosis is a multisystem disease of unknown etiology characterized by the formation of noncaseating granulomas in various organs.(Seve,2021) The diagnosis is based on three major criteria: a compatible clinical presentation, the finding of nonnecrotizing granulomatous inflammation in a tissue sample, and the exclusion of alternative causes of granulomatous disease.(Crouser,2020) Imaging plays an important role in the diagnosis. Although chest x-ray (CR) is often the first imaging test used, high resolution chest CT (HRCT) is more sensitive than CR for the detection of nodules and subtle fibrosis.(Seve,2021) Histologic examination of tissue remains the gold standard for reaching a definitive diagnosis.(Tana,2020) However, in the appropriate clinical context, certain patterns of mediastinal and parenchymal involvement on HRCT are virtually diagnostic of sarcoidosis.(Tana,2020) The American Thoracic Society (ATS) states that if asymptomatic bilateral hilar lymphadenopathy is found on chest imaging, histologic confirmation is not always required.(Crouser,2020)

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The monitoring of patients with pulmonary sarcoidosis is not standardized. Changes in imaging along with clinical features have been used to assess changes in disease activity.(Keijsers,2020) If spirometry and pulmonary symptoms are worsening, additional chest imaging may be useful to detect progression of pulmonary disease or an alternative diagnosis.(Gupta,2022) HRCT can also provide prognostic information by differentiating reversible from irreversible (ie fibrotic) lesions and show complications, such as mycetomas or evidence of pulmonary hypertension.(Tana,2020)

There is interest in the use of FDG PET CT for the diagnosis and monitoring of sarcoidosis. PET CT may reveal a more easily accessible biopsy site which is not clinically evident.(Seve,2021;Keijsers,2020) It may detect multi-organ and/or extra-thoracic involvement and demonstrate active inflammation not easily recognized by physical exam or other methods.(Keijsers,2020;Vender,2022) Studies have shown that FDG uptake in sarcoidosis represents active granulomatous inflammation. (Keijsers,2020) The evaluation of disease activity is valuable when there is doubt regarding the activity of lesions and a change in therapy is being considered. (Tana,2020). Positive scans should be interpreted with caution, however, because FDG uptake can be present in other inflammatory processes and malignancy. A significant correlation between decreased metabolic activity in the lungs, increased pulmonary function tests and improved symptoms in response to immunosuppressive medication has been demonstrated.(Keijsers,2020;Vender,2026) Most of the data regarding PET CT and sarcoidosis come from retrospective studies. Prospective trials are needed to determine the role of PET CT in monitoring the efficacy of therapy and the importance of abnormal PET CT's in asymptomatic patients.(Vender,2022) The threshold SUV that distinguishes active disease from fibrosis has not been determined. Few studies have compared the value of HRCT vs PET CT for diagnosis. Data on appropriate time intervals for follow up assessments and the role of PET-guided therapy are scarce. (Vender,2022)

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Solitary Pulmonary Nodule (SPN) (CH-16)

Guideline Page

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Solitary Pulmonary Nodule (CH-16.0)

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- For Lung Cancer Screening (LDCT) including incidental findings from LDCT, See **Lung Cancer Screening (CH-33)**

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Solitary Pulmonary Nodule – Imaging (CH-16.1)

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- For these guidelines, manual nodule measurements should be based on the average of long- and short-axis diameters. The size threshold (<6 mm) corresponds to a rounded measurement of 5 mm or less in these guidelines. Measurements should be rounded to the nearest millimeter. Prediction models used to estimate malignancy yield better results with the average diameter than with the maximum transverse diameter. The dimension of small pulmonary nodules (<10mm) should be expressed as the average of the maximal long-axis and perpendicular maximal short-axis measurements in the same plane. For larger nodules and for masses larger than 10 mm, it is generally appropriate to record both long- and short-axis dimensions, with the long-axis dimension being used to determine the T factor in lung cancer staging and being a criterion for tumor response to treatment.[1,13]
- A pulmonary nodule can be determined to have changed in size when its average diameter has increased or decreased by at least 2mm (rounded to the nearest millimeter). Smaller changes do not reliably indicate change.[13]
- Maximum intensity projection (MIP), and Minimum intensity projection (MinIP) are 2D projections of the volumetric (3D) acquisition data.[11,12] These projections may be of use in evaluation pulmonary nodules, but these projections are included in the cross sectional imaging base codes, and is not separately reimbursable.
- CT Chest with contrast (CPT® 71260) or CT Chest without contrast (CPT® 71250) initially for discrete nodule(s) in the following scenarios:[1,2,3]
  - Lung nodule(s) seen on an imaging study other than a “dedicated” CT or MRI Chest. Examples of other studies:
    - Chest x-ray
    - CT abdomen
    - MRI spine
    - Coronary CTA[1]
  - But NOT in the following which are considered initial dedicated advanced chest imaging:
    - CT Chest without and with contrast (CPT® 71270)
    - CTA Chest (CPT® 71275)
    - MRI Chest without contrast (CPT® 71550)
    - MRI Chest without and with contrast (CPT® 71552)
    - MRA Chest without and with contrast (CPT® 71555)

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- Comparisons should include the earliest available study and the more recent previous CT Chest scans to determine if nodule was present and stable.[1]
  - Similar-sized pleural nodule(s) is treated as a pulmonary nodule(s)
- The size of the lung or pleural nodule(s) is crucial information for decisions making regarding follow-up. The largest of multiple lung and/or pleural nodules will guide the surveillance interval. (See **Incidental Pulmonary Nodules Detected on CT Images (CH-16.2)**, and **Pleural-Based Nodules and Other Abnormalities (CH-17.1)**
- A lung nodule is defined as an approximately rounded opacity (more or less well-defined) measuring up to 3 cm in diameter.
- Rounded lesions measuring more than 3 cm in diameter are termed lung masses and should be considered indicative of lung cancer until histologically proven otherwise. Approach to lung masses differ from that of nodules and these guideline are specifically for those abnormalities, occurring within the chest, that meet the definition of a pulmonary nodule(s).

Evidence Discussion

A pulmonary nodule is defined as a well or poorly defined rounded opacity < 3 cm in diameter. Focal pulmonary lesions > 3 cm are considered masses. Nodule measurement is currently determined by standard linear measurement with electronic calipers. Measurements and averages should be expressed to the nearest whole millimeter. The dimension of small pulmonary nodules (<10mm) should be expressed as the average of the maximal long-axis and perpendicular maximal short-axis measurements in the same plane. For larger nodules and masses, both long- and short-axis dimensions should be recorded.(Bankier,2017) Semi-automated nodule volumetry has superior sensitivity for detecting growth and is recommended as the preferred method by the British Thoracic Society (BTS), but it requires dedicated software and is currently not widely used in clinical practice. (Bankier,2017;Callister,2015) Nodule growth is defined as an increase of > 1.5 mm (> 2 cubic mm) by the Lung-RADS criteria, greater than or equal to 2 mm change in average diameter by the Fleischner criteria or an increase of at least 25% in volume by the BTS.(Callister,2015;MacMahon,2017;Christensen,2024) A number of studies have established the advantage of post-processing 3D CT techniques, such as maximum intensity projection (MIP), minimum intensity projection (MinIP) and volume rendering (VR) in the detection and assessment of pulmonary nodules. (Callister,2015;Naeem,2021;Li,2019)

If an indeterminate nodule is seen on a CR or CT, prior studies should be reviewed to determine possible growth or stability, including comparison with the earliest available study and more recent ones.(MacMahon,2017;Gould,2013;Martin,2023). If stability of a nodule seen on CR cannot be determined, CT chest is appropriate. (Gould,2013;Martin,2023) CT is the modality of choice to evaluate pulmonary nodules. (Martin,2023) Intravenous contrast is not required to identify or characterize nodules.

The size of the nodule is crucial for determining the appropriate timing of follow up surveillance imaging.(MacMahon,2017).

For nodules which are detected incidentally on incomplete thoracic CT scans (e.g. cardiac, neck, spine or abdominal CT), the Fleischner society recommends no follow up for most nodules< 6 mm based on the estimated low risk of malignancy. The ACR states that an optional follow up CT may be done at 12 months for nodules < 6 mm with a suspicious morphology and/or upper lobe location.(Martin,2023) For nodules 6-8 mm, Fleischner and ACR guidelines recommend a CT chest after the appropriate interval (3-12 months, depending on clinical risk). For a nodule> 8 mm or a very suspicious nodule, an immediate CT chest is recommended.(MacMahon,2017;Martin,2023)

Background and Supporting Information

Abnormality examples include: mass, opacity, lesion, density, nodule, and calcification.

Incidental Pulmonary Nodules Detected on CT Images (CH-16.2)

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Solid Pulmonary Nodules

- These time intervals refer to the time from initial detection of the nodule(s).

Incidentally Detected Solid Pulmonary Nodules Follow-up Recommendations				
Nodule Type	**<6 mm (<100 mm ^{3})**	**6–8 mm**	**>8 mm**	**Comments**
Single Nodule	Follow-up (optional) CT at 12 months. No routine follow-up if stable at 12 months	CT at 6–12 months, then CT at 18–24 months if stable	CT at 3 months, then CT at 6-12 and then at 18-24 months if stable. Consider PET/CT* or biopsy	Certain individuals at high-risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-month follow-up
Multiple Nodules	Follow-up (optional) CT at 12 months. *No routine follow-up if stable at 12 months	CT at 3–6 months, then at 18–24 months if stable	CT at 3–6 months, then at 18–24 months if stable. Consider PET/CT* or biopsy	Use most suspicious nodule as a guide to management. Follow-up intervals may vary according to size and risk.

- *PET/CT consider for ≥8 mm solid lung nodule or solid component of a sub-solid nodule, not for groundglass opacity.
- Follow-up indications after PET/CT:

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- If a PET/CT was found to be negative, follow-up with CT at 3 months, 9 months, and 21–24 months, if stable.
- If a PET/CT was found to be positive, a biopsy was negative or non-diagnostic, follow-up with CT at 3 months, 9-12 months, and 24 months, if stable.

- These criteria are not intended for use in the following groups:
  - Individuals aged 35 years or younger
    - Considered to have an overall low risk for pulmonary malignancy
    - In this age group, nodules are most likely to be infectious rather than cancer
    - Management of incidentally-found pulmonary nodules in this group should be individualized
  - Known primary cancer with risks for metastases
  - Immunocompromised individuals at risk for infection

Sub-Solid Pulmonary Nodules

- These time intervals refer to the time from initial detection of the nodule(s).

Incidentally Detected Sub-Solid Pulmonary Nodules Follow-up Recommendations			
Nodule Type	**<6mm (<100 mm ^{3})**	**≥6mm (≥100 mm ^{3})**	**Comments**
Single Ground glass opacity (GGO)	Consider follow-up at 2 and 4 years. If solid component(s) or growth develops, consider resection.	CT at 6–12 months to confirm persistence, then follow-up with CT every 2 years until 5 years	In certain suspicious nodules, <6 mm, consider follow-up at 2 and 4 years. If solid component(s) or growth develops, consider resection.

Incidentally Detected Sub-Solid Pulmonary Nodules Follow-up Recommendations			
Single Sub-solid	Consider follow-up at 2 and 4 years. If growth develops, consider resection.	CT at 3–6 months to confirm persistence. If unchanged and solid component remains <6 mm, then annual CT should be performed for 5 years. If the solid component has suspicious morphology (i.e., lobulated margins or cystic components), is >8 mm or is growing: Consider PET/CT* or biopsy	In practice, part-solid nodules cannot be defined as such until ≥6 mm. Persistent part-solid nodules with solid components ≥6 mm should be considered highly suspicious.
Multiple Sub-Solid	CT at 3–6 months. If stable, consider CT at 2 and 4 years.	CT at 3–6 months. Subsequent management based on the most suspicious nodule(s).	Multiple <6 mm pure ground-glass nodules are usually benign.

• *PET/CT consider for ≥8 mm solid lung nodule or solid component of a sub-solid nodule, not for groundglass opacity.

- Follow-up indications after PET/CT:
  - If a PET/CT was found to be negative, follow-up with CT at 3 months, 9 months, and 21–24 months, if stable.
  - If a PET/CT was found to be positive, a biopsy was negative or non-diagnostic, follow-up with CT at 3 months, 9-12 months, and 24 months, if stable.
- These criteria are not intended for use in the following groups:
  - Individuals aged 35 years or younger
    - Considered to have an overall low risk for pulmonary malignancy
    - In this age group, nodules are most likely to be infectious rather than cancer
    - Management of incidentally-found pulmonary nodules in this group should be individualized
  - Known primary cancer with risks for metastases
  - Immunocompromised individuals at risk for infection

- Sub-solid nodules may either be a part-solid nodule, comprising of both solid and ground glass components or a pure ground glass nodule, the latter may also be referred to as "non-solid".
- For pulmonary nodule follow-up studies a CT Chest without IV contrast (CPT® 71250) is usually appropriate. IV contrast is not required to identify, characterize, or determine stability of pulmonary nodules in clinical practice)

Pulmonary Cyst(s) [10]

- May represent a rare form of adenocarcinoma, squamous cell carcinoma, or small cell carcinoma.
- Short-term initial imaging to exclude rapid growth can be considered at 3-6 months.
- Further imaging can be managed according to the sub-solid pathway above.

Evidence Discussion

A pulmonary nodule is defined as a well or poorly defined rounded opacity < 3 cm in diameter. The Fleischner Society guidelines for the management of incidental pulmonary nodules detected on CT were last updated in 2017.(MacMahon,2017) The purpose of the guidelines is to minimize both the number of unnecessary follow up exams and the chance of a malignancy advancing in stage during CT follow up prior to diagnosis. Surveillance is most appropriate if there is a very low probability of cancer or a high risk of complications from surgery or biopsy.(Gould,2013) It is important to establish the clinical probability of malignancy before ordering imaging. (MacMahon,2017;Gould;Callister,2015) The Fleischner guidelines are not intended to apply to people younger than 35, people with known primary cancers at risk of metastases or to immunocompromised people at risk of infection. They do not apply to patients with unexplained fever or respiratory symptoms.(Martin,2023) For patients younger than 35, lung cancer is rare. Management should be on a case by case basis, and the use of serial CT's should be minimized.(MacMahon,2017)

Solid nodules < 6 mm do not require follow up in patients at low risk of lung cancer or in all patients at high risk. Nodules which have a suspicious morphology or an upper lobe location may be followed up with a CT in 12 months. Solid nodules 6-8 mm may be followed with a CT at 6-12 months in low risk patients with a further follow up at 18-24 months in high risk patients. Two follow up CT's should be sufficient to rule out growth in most patients.

For solid nodules> 8 mm, the options are CT surveillance, an FDG PET/CT, tissue sampling or a combination of these. Surveillance CT scans for solid nodules> 8 mm may be done at 3 months, 6-12 months and 18-24 months.(MacMahon,2017).The American College of Chest Physicians (ACCP) guidelines recommend a PET/CT or nonsurgical biopsy for solid nodules of at least 8 mm when the pretest probability of malignancy is low to moderate.(Gould,2013) The pretest probability affects the interpretation of PET/CT results: high risk patients are at risk of false negative results and low risk patients

are at risk of false positive results.(Callister,2015) If there is a high pretest probability of cancer, a negative PET/CT does not reliably rule out cancer and either continued surveillance for at least 2 years or tissue sampling is advised.(Gould,2013;Maiga,2018) The ACCP states that the optimal interval for surveillance CT's for solid nodules> 8 mm is not determined, but standard practice is 3-6 months, 9-12 months and 18-24 months. They suggest surveillance with CT if the clinical probability of cancer is very low, the clinical probability of malignancy is low and a PET CT is negative, a PET CT is negative and a needle biopsy is non-diagnostic, or an informed patient prefers a non-aggressive approach. If a solid nodule shows clear growth on serial CT's, a non-surgical biopsy or surgical resection is recommended unless there are specific contraindications. (Gould,2013) A surgical diagnosis is recommended if there is a high clinical probability of lung cancer, the nodule is intensely hypermetabolic on PET/CT, a non-surgical biopsy is suspicious for cancer or a patient prefers a definitive diagnosis.(Gould,2013)

Multiple solid nodules < 6 mm are usually benign, representing granulomas or intrapulmonary lymph nodes. A 12 month follow up CT may be considered in high risk patients. If there is clinical evidence of infection or the patient is immunocompromised, infection should be considered. A short term follow CT may be appropriate. Multiple solid nodules with at least one nodule greater than or equal to 6 mm can be followed with CT's at 3-6 months and 18-24 months. Management should be based on the largest/ most suspicious nodule. Most metastases will grow over 3 months. The risk of cancer increases as the number of nodules increases from 1 to 4 but decreases if the number is greater than 4.

Subsolid nodules (SSN) include pure ground glass nodules (GGN) and part-solid nodules (PSN). SSN are more likely to be malignant than solid nodules but have a better prognosis than lung cancers which present as solid nodules.(Callister,2015) Many have slow growth rates and may remain stable for years. Pure GGN < 6 mm do not require routine follow up. However, this should not preclude the option of follow up CT's at 2 and 4 years in high risk patients. GGN greater than or equal to 6 mm can be followed at 6-12 months and then every two years until 5 years. The Fleischner Society states that these guidelines are not intended to preclude either shorter or longer term follow up in individual patients when deemed clinically appropriate. The ACCP states there is controversy regarding how long to follow part solid or ground glass nodules and that follow up over several years may be appropriate.

Solitary PSN < 6 mm do not require routine follow up. A follow up CT may be done at 2 and 4 years. For PSN greater than or equal to 6 mm with a solid component < 6 mm, a follow up CT may be done at 3-6 months and then annually for a minimum of 5 years. The 5 year period is somewhat arbitrary but considered reasonable if the nodule is unequivocally stable during that time period. If the solid component is at least 6 mm, follow up at 3-6 months should be done. A persistent PSN with a solid component of at least 6 mm or a growing solid component is highly suspicious. If the nodule has suspicious morphology, if the solid component is growing or > 8 mm, PET/CT or biopsy

should be considered.(MacMahon,2017;Callister,2015) Multiple PSN< 6 mm are often infectious. A repeat CT can be done at 3-6 months, then at 2 and 4 years. If at least one of the nodules is greater than or equal to 6 mm, a repeat CT can be done at 3-6 months, and management should be based on the most suspicious nodule.

Pulmonary cystic lesions may represent a cyst-related primary lung malignancy. There are no uniform surveillance criteria for these lesions, but some authors recommend a CT at 3-6 months to exclude rapid growth and then follow up CT's according to the SSN nodule guidelines.(Mets,2018)

NCCN guidelines for the management of incidental pulmonary nodules are consistent with the Fleischner guidelines.(NCCN,2023) For pulmonary nodules detected on lung cancer screening CT's, adherence to the American College of Radiology (ACR) Lung-RADS guidelines is recommended. (MacMahon,2017;Martin,2023;NCCN,2023;Christensen,2024) The British Thoracic Society and ACCP guidelines do not distinguish the management of screening-detected nodules from nodules detected incidentally.(Gould,2013;Callister,2015)

Interval Imaging Outcomes (CH-16.3)

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- No further advanced imaging is necessary if a nodule has been:
  - Stable for 2 years
    - Nodules(s) stable on chest x-ray
    - Nodule(s) ≥6mm stable on CT Chest[1]
  - Stable for 1 year
    - Nodule(s) <6mm[1]
  - At any time, if:
    - classically benign characteristics by chest x-ray or previous CT (e.g. benign calcification pattern typical for a granuloma or hamartoma)
    - decreasing in size, (≥ 6 mm at start, should be followed for a 2 year period as outlined in CH-16.2) disappearing nodule(s)
- Lung nodule(s) which increases in size or number should no longer be considered for CT screening or surveillance.[1,2,3,7]
  - with an increase in nodule(s) size or number, tissue sampling or other further diagnostic investigations should be considered.
  - PET, for solid nodules ≥8mm, should be considered (See **PET (CH-16.4)**

Evidence Discussion

If a chest x-ray (CR) or chest CT has demonstrated that a pulmonary nodule has benign characteristics, further imaging is not necessary. Benign characteristics include intranodular fat or a diffuse, central, laminated or popcorn pattern of calcification. (Gould,2013)

If an indeterminate nodule is seen on a CR or CT, prior studies should be reviewed to determine possible growth or stability, including comparison with the earliest available study and more recent ones.(Gould,2013;MacMahon,2017;Martin,2023). If stability of a nodule seen on CR cannot be determined, CT chest is appropriate. (Gould,2013;Martin,2023) If a solid nodule has been stable for at least 2 years, no additional evaluation is necessary.(Gould,2013)Two years of radiographic stability is considered strong presumptive evidence of a benign nodule. For solid nodules seen on CT, further follow up is not needed if nodules < 6 mm have been stable for one year or if nodules greater than or equal to 6 mm have been stable for two years(MacMahon,2017). Malignant nodules show a wide range of growth rates with some demonstrating regression at times. Solid nodules greater than or equal to 6 mm that decrease in size but do not completely resolve should be followed to resolution or lack of growth over 2 years.(Gould,2013;Callister,2015)

There is controversy regarding how long to follow part solid or ground glass nodules. Follow up over several years may be appropriate.(Gould,2013) The Fleischner guidelines state that subsolid nodules< 6 mm may be followed for up to 4 years but that the guidelines are not intended to preclude either shorter or longer term follow up in individual patients when deemed clinically appropriate(MacMahon,2017). Subsolid nodules greater than or equal to 6 mm may be followed for 5 years. The 5 year period is "somewhat arbitrary but considered reasonable if the nodule is unequivocally stable during that time period."(MacMahon,2017)

PET/CT should be considered for solid nodules greater than or equal to 8 mm. (Gould,2013;MacMahon,2017) If a solid nodule shows clear growth on serial CT's, a non-surgical biopsy or surgical resection is recommended unless there are specific contraindications.(Gould,2013) Non-solid nodules which grow or develop solid components are often malignant and further evaluation and/or resection should be considered. (Gould,2013;Christensen,2024)

If a CT demonstrates multiple solid nodules< 6 mm and there is clinical evidence of infection or the patient is immunocompromised, infection should be considered and a short term follow up CT may be appropriate.(MacMahon,2017) Certain findings on a lung cancer screening CT which suggest an infectious or inflammatory process (e.g. >6 new nodules or solid nodules which are greater than or equal to 8 mm appearing in a short interval) are reported as Lung-RADS 0 and may be followed up with a LDCT in 1-3 months.(Christensen,2024) Some findings indicative of an infectious/inflammatory process may not warrant short-term follow-up (e.g. tree-in-bud nodules or new <3 cm ground glass nodules).

Background and Supporting Information:

- Approximately 20% of observed cancers have decreased in size at least at some point during their observation period. Therefore, a decreasing size of a nodule cannot be a reliable indicator of being benign.[(1)]
- For nodules that increase in number, this is not meant for known stable or benign nodules to be counted.
  - Example, known 4 mm nodule stable for 3 years, now presents with a new solid 8 mm pulmonary nodule, follow-up will be driven by new nodule size and type.
  - Example #2, known granuloma 5 mm from prior CT Chest one year ago and now CT Chest reveals a new 6 mm sub-solid nodule, follow-up would be driven by the new nodule size and type.

PET (CH-16.4)

CH.SN.0016.4.A

v1.1.2025

- PET/CT (CPT® 78815) for a solid lung nodule ≥8 mm on dedicated advanced chest imaging, as described in **Solitary Pulmonary Nodule – Imaging (CH-16.1).** See **Non-Small Cell Lung Cancer – Suspected/Diagnosis (ONC-8.2)** in the Oncology Imaging Guidelines for lung mass ≥3.1 cm
  - If there is a history of malignancy, refer to the appropriate Oncology restaging/ recurrence guideline for indications for PET imaging.
  - Pleural nodule, See **Pleural-Based Nodules and Other Abnormalities (CH-17.1)**
  - Serial PET studies are not considered indicated
  - Not indicated for infiltrate, ground glass opacity, or hilar enlargement
  - Mediastinal lymphadenopathy - See **Mediastinal Lymphadenopathy (CH-2.3)** or Sarcoid concerns – See **Sarcoid (CH-15.1)**
- If a CT finding led to ordering a PET scan, and if that CT was >3 months ago, a repeat CT (CPT® 71250 or (CPT® 72160) is indicated prior to considering a PET scan.
  - A change in the status of the original finding may find that a PET scan is no longer appropriate.

Evidence Discussion

PET/CT may be performed for evaluation of a solid lung nodule greater than or equal to 8 mm on chest CT.(MacMahon,2017;Gould,2013;NCCN,2023) PET/CT has good sensitivity and moderate specificity for detecting malignancy in patients with a high risk of cancer and a nodule greater than or equal to 10 mm.(Callister,2015) Consensus opinion is that that nodules < 8 to 10 mm are not reliably characterized by PET/CT. (Gould, 2013;Callister,2015) The false negative rate of PET/CT is higher for nodules < 8 mm and for malignancies with low metabolic activity, such as adenocarcinoma in situ or well differentiated carcinoid tumor. PET/CT has a lower sensitivity and higher false negative rate for ground glass or part solid nodules.(Gould, 2013;Callister,2015) Infections and inflammatory disorders may cause false positive results.

Repeating a PET/CT is discouraged. If there is a high pretest probability of cancer, a negative PET/CT does not reliably rule out cancer and either continued surveillance for at least 2 years or tissue sampling is advised.(Gould, 2013;Maiga,2018). If a solid nodule shows clear growth on serial CT's, a non-surgical biopsy or surgical resection is recommended unless there are specific contraindications.(2) A surgical diagnosis is recommended if the nodule is hypermetabolic on PET/CT.(2)

PET/CT may be indicated for the pre-treatment staging of patients with confirmed or strongly suspected lung cancer, as detailed in the oncology guidelines. (Gould,2013;NCCN,2023)

Background and Supporting Information

- A **nodule** is any pulmonary or pleural lesion that is a discrete, spherical opacity 2-30 mm in diameter surrounded by normal lung tissue. A larger nodule is called a mass. Entities that are not nodules, and are considered benign, include non-spherical linear, sheet-like, two-dimensional or scarring opacities.[3]
- **Malignant** nodule features can include spiculation, abnormal calcification, size greater than 7-10 mm, interval growth, history of a cancer that tends to metastasize to the lung or mediastinum, and/or smoking history.[1,3]
  - A nodule that grows at a rate consistent with cancer (doubling time 100 to 400 days) may be sampled for biopsy or resected.[1]
  - Less than 1% of <6 mm lung nodules are malignant.[1]
  - Three percent of all 8 mm lung nodules are malignant.[1]
  - Only one follow-up at 6-12 months is sufficient for 6-8 mm nodules and not all require traditional 2 year follow-up.[1]
  - The larger the solid component of a subsolid nodule, the greater the risk of invasiveness and metastases.[1]
  - Increased risk of primary cancer as the total nodule count increased from 1 to 4 but decreased risk in individuals with 5 or more nodules, most of which likely resulted from prior granulomatous infection.[1]
  - A nodule that does not grow in 6 months has a risk of malignancy at <10%.
- **Benign** features in solid nodules can include benign calcification (80% granuloma, 10% hamartoma), multiple areas of calcification, small size, multiple nodules, negative PET, and stability of size over 2 years.[3]
- **Ground glass** or subsolid opacities, which can harbor indolent adenocarcinoma with average doubling times of 3–5 years.[1]
- **Repeat PET** is discouraged. If the original PET is positive, biopsy may be performed. If the original PET is negative but subsequent CT Chest shows an increase in nodule size, biopsy may be performed.
- **Positive PET** is defined as a standardized uptake value (SUV) in the lung nodule greater than the baseline mediastinal blood pool. A positive PET can occur with infection or inflammation, including absence of lung cancer with localized infection, presence of lung cancer with associated (post-obstructive) infection and/or related inflammation.
- **False negative PET** can be seen in individuals with adenocarcinoma in situ (formally known as bronchoalveolar carcinoma), carcinoid tumors, a small size nodule, non-solid or ground glass opacity.[9] High pre-test likelihood of malignancy with negative findings on PET only reduces the likelihood of malignancy to 14%; while in an

individual with a low pre-test likelihood (20%) of malignancy, a negative PET reduces the likelihood of malignancy to 1%.[6]

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Pleural-Based Nodules and Other Abnormalities (CH-17)

Guideline Page

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Pleural-Based Nodules and Other Abnormalities (CH-17.1)

CH.PB.0017.1.A

v1.1.2025

- CT Chest with contrast (CPT® 71260) or CT Chest without contrast (CPT® 71250) (with contrast is preferred for initial evaluation) for pleural nodule(s).[1]
  - Pleural nodule(s) seen on an imaging study other than a "dedicated" CT or MRI Chest.[1]
  - Pleural nodule(s) identified incidentally on any of the following dedicated chest studies can replace CT Chest as the initial dedicated study.[1]
    - CT Chest without and with contrast (CPT® 71270).
    - CTA Chest (CPT® 71275).
    - MRI Chest without contrast (CPT® 71550).
    - MRI Chest without and with contrast (CPT® 71552).
    - MRA Chest without and with contrast (CPT® 71555).
  - After preliminary comparison with any available previous chest films to determine presence and stability
  - Using largest measurement of multiple nodule(s). (See **Solitary Pulmonary Nodule – Imaging (CH-16.1)**)
  - Following the Fleischner Society Guidelines for high-risk. (See **Incidental Pulmonary Nodules Detected on CT Images (CH-16.2)**)[1]
- PET/CT (CPT® 78815) can be considered if dedicated CT or MRI Chest identifies a pleural nodule/mass or defined area of pleural thickening that is ≥8 mm when there is a likelihood of malignancy including current or previous malignancy, pleural effusion, bone erosion, chest pain.[1]

Evidence Discussion

- CT Chest is indicated for the evaluation of pleural nodules[1,2,3]. CT scan is widely available and allows for easy access to isotropic 3-D reformatting[3]. A study looking at the utility of CT in investigation for malignancy showed a sensitivity of 68%, a specificity of 78%, a positive predictive value of 80% and a negative predictive value of 65% when CT findings were reported as malignant[3]. CT also carries the risk of exposure to iodinated contrast and ionizing radiation.
- Follow up for previously detected pleural nodules follows guidelines addressed elsewhere in these guidelines (See Solitary Pulmonary Nodule – Imaging (CH-16.1) and Incidental Pulmonary Nodules Detected on CT Images (CH-16.2)[1].
  - Of note, a study looking at over 8,700 LDCT chest scans identified 943 noncalcified nodules attached to the costal pleura, of these 897 were < 10 mm in

size. There were 603 that were either lentiform, oval, semicircular or triangular in shape and had smooth margins. All of these nodules, that met these qualifications of shape, size and smooth margins, were benign. Follow-up with annual screening, rather than more immediate work-up, was recommended.[2]

- PET/CT may be considered when the identified pleural nodule/mass or thickening is ≥ 8 mm and there is a likelihood of malignancy[1]. PET/CT may be useful in differentiating between benign and malignant disease; however, studies have shown a broad range of sensitivities (88-100%) and specifies (35-100%)[3]. PET/CT may be complicated by false positives such as infections and prior pleurodesis with talc, or false negatives such as low grade/low metabolic activity epithelioid mesothelioma[3].

Background and Supporting Information

- Pleural nodule/mass or thickening without suggestion of malignancy would undergo surveillance or biopsy.
- A study looking at over 8,700 LDCT chest scans identified 943 noncalcified nodules attached to the costal pleura, of these 897 were < 10 mm in size. There were 603 that were either lentiform, oval, semicircular or triangular in shape and had smooth margins. All of these nodules, that met these qualifications of shape, size and smooth margins, were benign. Follow-up with annual screening, rather than more immediate work-up, was recommended.[2]

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Pleural Effusion (CH-18)

Guideline Page

Pleural Effusion (CH-18.1)

CH.EF.0018.1.A
v1.1.2025

- CT Chest with contrast (CPT® 71260) after:[1,2]
- Chest x-ray, (upright posterior/anterior/lateral best), (lateral decubitus films can improve sensitivity); **and**

  one of the following:

  - Thoracentesis, (if possible)* to determine if fluid is exudative or transudative and remove as much as possible (this fluid can obscure the underlying lung parenchyma and possibly a mass)
  - Concern for loculated effusion, empyema, paramediastinal location, subpleural lung abscess or cavitation[3]
  - Check position of chest tube(s) or drainage catheters[2]
  - Surgical planning[2]
- Chest ultrasound (CPT® 76604) can be used as an alternative to chest x-ray to evaluate for the presence of fluid within the pleural spaces and guide thoracentesis.

Evidence Discussion

The most common initial diagnostic test suggesting a pleural effusion is often chest radiography (CR).(Bashour,2022) CR remains the most accessible form of chest imaging and will often be the initial study for suspected pleural disease. (Sundaralingam,2020;Shen,2017; Heffner,2017) Lateral decubitus CR has higher sensitivity and specificity for pleural effusion than other positions.(Zaki,2024) However, complicated effusions are often loculated and may not layer dependently. Lower lobe consolidation may mask the presence of an effusion. The American Association for Thoracic Surgery (AATS) states that CR, although useful as a first step, should be combined with additional imaging if pleural space infection is suspected.(Shen,2017) The American College of Radiology (ACR) states that consensus recommendations endorse CR as the initial imaging modality for suspected parapneumonic or malignant effusion, but there are limited empiric data to support this.(Morris,2023)

Ultrasound (US) is at least as effective as lateral decubitus views for the detection of pleural fluid and provides a better estimation of fluid volume. (Sundaralingam,2020;Shen,2017;Zaki,2024) When standard CR cannot rule out a pleural effusion, US has largely replaced decubitus views due to its speed, portability and greater sensitivity.(Heffner,2017) Identification of a pleural effusion for possible US-guided thoracentesis is the primary reason for chest US.(Morris,2023) The AATS guidelines state that CR and US are class 1 recommendations (should be done) for suspected pleural space infection.(Shen,2017)

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Although diagnostic imaging plays an important role in the evaluation of pleural effusions, thoracentesis with pleural fluid analysis remains the necessary first invasive step.(Bashour,2022) Pleural fluid analysis is considered mandatory unless the clinical presentation suggests a high pretest probability of a transudative effusion.(Sundaralingam,2020;Feller-Kopman,2018) Initial evaluation should include an ultrasound (US)-guided thoracentesis to categorize the effusion as a transudate or exudate and obtain specimens for microbiology and cytology.(Feller-Kopman,2018;Beaudoin,2018;Roberts,2023) If a parapneumonic effusion is suspected, diagnostic aspiration must be performed to identify patients with a complicated effusion that requires drainage.(Shen,2017; Beaudoin,2018)

CT is not used routinely as the initial imaging study for pleural effusion unless there is suspicion for loculated fluid in an interlobar fissure or paramediastinal location, or CR demonstrates parenchymal lesions suggestive of cancer, septic emboli or cavitation.(Heffner,2017) CT can better distinguish between a loculated empyema and subpleural lung abscess. CT with IV contrast optimizes imaging of the pleura. CT chest with contrast is a class 2a recommendation (reasonable) for suspected pleural space infection in the AATS guidelines.(Shen,2017) If the etiology of an exudative effusion cannot be identified, or if it is not safe to perform a thoracentesis, a CT chest with contrast is appropriate.(Beaudoin,2018;Roberts,2023) The American College of Radiology (ACR) states that CR or CT chest with IV contrast is usually appropriate as initial imaging for people with recent pneumonia and suspected parapneumonic effusion or for people with dyspnea, cough or chest pain with a suspected malignant pleural effusion.(Morris,2023) Thoracentesis and chest CT cannot rule out malignancy or tuberculosis. Pleural biopsy is indicated for a recurrent undiagnosed exudative effusion (Sundaralingam,2020;Beaudoin,2018;Roberts,2023) When a diagnosis cannot be made, monitoring with interval CT scans for up to 2 years is appropriate.(Roberts,2023) CT is used in the diagnosis and management of late-stage empyema and malignant pleural effusion and can be used to check the position of drains and plan for surgical intervention.(Sundaralingam,2020)

Background and Supporting Information

- Bilateral effusions are more often systemic related transudates (congestive heart failure, renal failure, liver insufficiency, etc.), and advanced imaging is rarely needed. Large unilateral effusions can be malignant. Analysis of fluid may include: cytology, culture, cell count, and biochemical studies.
- PA chest x-ray can show a pleural effusion with approximately 200 ml of pleural fluid while a lateral view can reduce this to 50 ml. Ultrasound is even more sensitive with as little as 3-5 ml of fluid being detected. *Thoracentesis can only be safely performed with adequate fluid present. If only a trace effusion or inadequate amount of fluid is seen, a thoracentesis may not be possible.

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Pneumothorax/ Hemothorax (CH-19)

Guideline Page

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Pneumothorax/Hemothorax (CH-19.1)

CH.PT.0019.1.A
v1.1.2025

Chest x-ray and CT Chest are the first line tests for detecting pneumothorax/hemothorax and ruling out other lung diseases.[8]

- Chest x-ray initially.
  - CT Chest with contrast (CPT® 71260) or without contrast (CPT® 71250) if:
    - diagnosis of a small pneumothorax is in doubt, and the presence of a pneumothorax will affect individual treatment decisions[1]
    - preoperative study for treatment of pneumothorax[1]
    - pneumothorax associated with hemothorax[2]
    - suspected complications from hemothorax (e.g. empyema)[2]
    - suspected Alpha-1-Antitrypsin Deficiency (even without pneumothorax)[3]
    - suspected cystic lung disease, including lymphangioleiomyomatosis (LAM), tuberous sclerosis (TS), or Birt-Hogg-Dube (BHD) syndrome[6,7]
    - to determine the etiology of persistent pneumothorax/air leak, such as chest tube malposition, bronchopleural fistula, loculated pneumothorax, lung parenchymal disease[11]
    - suspected catamenial pneumothorax/thoracic endometriosis[8]
- MRI Chest without and with contrast (CPT® 71552) or MRI Chest without contrast (CPT® 71550) for:
  - detecting diaphragmatic endometriosis
  - pre-surgical planning for thoracic endometriosis[8,9,10]

Evidence Discussion

The majority of pneumothorax cases can be confirmed by upright PA chest radiography (CR), which remains the standard initial exam (Tschopp,2015;Noppen,2010).

While CT is more sensitive than CR in detecting pneumothorax, it is generally not required for diagnosis and should be avoided due to excess radiation (Tschopp,2015). CT may be necessary for diagnosing a very small pneumothorax or differentiating between a pneumothorax and a giant bulla in bullous emphysema (Noppen,2010). Although CT is the best method to measure the size of a pneumothorax, current evidence does not support basing treatment decisions solely on size (Mendogni,2020).

The 2001 ACCP guidelines advise against routine CT use for a first-time primary spontaneous pneumothorax (PSP). However, CT may be indicated to evaluate suspected pulmonary disorders not apparent on CR. For secondary spontaneous

pneumothorax (SSP), CT is acceptable for managing recurrent pneumothorax, persistent air leak, and surgical planning.

In contrast, the 2023 British Thoracic Society recommends CT chest for individuals with symptoms and high-risk characteristics. These include hemodynamic compromise, significant hypoxia, bilateral pneumothorax, underlying lung disease, hemopneumothorax, or age over 49 with a significant smoking history. This recommendation applies if the pneumothorax size on CR is insufficient for safe needle aspiration or chest tube intervention. The European Respiratory Society suggests that CT may be useful in complicated cases, when chest tube misalignment is suspected, when underlying lung disease is suspected, and in patients requiring surgery (Tschopp,2015).

High-resolution CT (HRCT) has better sensitivity than routine CT in the pre-operative detection of blebs and bullae (Mendogni,2020). However, it is unclear whether HRCT can predict the risk of recurrence or identify which patients may benefit from surgical intervention. It may help to identify those at lower risk: the positive predictive value of CT bleb scores for ipsilateral recurrence is relatively low at 68%, while the negative predictive value is high at 94% (Barton,2023)

Some experts advise considering a CT scan after a first time PSP if there are factors such as a family history of pneumothorax, presence of blebs, cysts, or bullae; female sex; or a family or personal history and/or physical examination findings suggestive of a pneumothorax-associated syndrome.(Baryon,2023; Boone,2019)

Although they have low specificity, the most sensitive tests for detecting pneumothorax and hemothorax are CR and CT. For detecting diaphragmatic endometriosis, Magnetic Resonance Imaging (MRI) of the chest is preferable.(Nezhat,2019)

Pneumomediastinum; Subcutaneous Emphysema (CH-19.2)

CH.PT.0019.2.A
v1.1.2025

- Chest x-ray initially.
  - CT Chest with contrast (CPT® 71260) or without contrast (CPT® 71250) if:
    - recent vomiting and/or suspected esophageal perforation[4,5]
    - associated pneumopericardium[4,5]
    - associated pneumothorax[4,5]
    - preoperative study for treatment[4,5]

Evidence Discussion

The diagnosis of Pneumomediastinum (PM) is usually established by a clinical exam and CR. The CR should include a lateral view. (Takada,2009; Dirweesh,2017) CR is the most common diagnostic imaging study.(Magouliotis,2023;Morgan,2021;Okada,2014;Alemu,2021) The reported sensitivity of CR ranges from 60-90%. (Magouliotis,2023;Caceres,2008;Kaneki,2000;Iyer,2009;Susai,2024) CT is more sensitive than CR, especially in cases of small amounts of air in the mediastinum. (Takada,2009;Dirweesh,2017; Kaneki,2000)

There is no evidence defining when CT should be used to evaluate pneumomediastinum (PM).CT should be done if the suspicion for PM remains high despite a normal CR or if there is concern for secondary PM due to a specific pathologic event.(Takada,2009; Magouliotis,2023)

CT can be beneficial in detecting injury to the tracheobronchial system, pneumothorax, pneumopericardium or esophageal perforation.(Susai,2024) Despite the usually benign and self-limiting course of spontaneous PM, additional imaging is often undertaken to rule out esophageal perforation or other underlying disorder. A retrospective review of adolescents and young adults with spontaneous PM demonstrated that no clear criteria were used for obtaining a CT and that the CT's did not impact clinical decisions. (Wald,2024) The authors concluded that advanced imaging is over-utilized in patients with suspected spontaneous PM without clinical evidence of necessity.

Background and Supporting Information

- An expiration chest x-ray can enhance the evaluation of equivocal plain x-ray. There is no data supporting the use of serial CT Chest to follow individuals with a known pneumothorax, pneumomediastinum, or hemothorax who are asymptomatic or have

stable symptoms. With the exception of the indications above, advanced imaging of the chest is rarely indicated in the diagnosis or management of pneumothorax, or pneumomediastinum. Inspiratory/expiratory chest x-rays are helpful in defining whether a pneumothorax is present.

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v1.1.2025

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Mediastinal Mass (CH-20)

Guideline Page

Mediastinal Mass (CH-20.1)

CH.MM.0020.1.A

v1.1.2025

- CT Chest with contrast (CPT® 71260) or CT Chest without contrast (CPT® 71250) or MRI Chest without and with contrast (CPT® 71552) or MRI Chest without contrast (CPT® 71550), to evaluate mediastinal abnormalities, may include, but not limited to mediastinal cyst including bronchogenic, thymic, pericardial or esophageal, seen on chest x-ray or other non-dedicated chest imaging.
- MRI Chest without and with contrast (CPT® 71552) or MRI Chest without contrast (CPT® 71550) can be considered for indeterminate mediastinal mass on CT Chest.
  - Lesions that remain indeterminate on MRI, if biopsy is not performed, surveillance imaging could be performed at 3-12 month intervals over 2 years or more with MRI Chest, depending upon level of clinical concern.
- FDG PET/CT offers limited additional value beyond that of conventional CT in the initial assessment of mediastinal mass(es), with the exception of primary mediastinal lymphoma. See **Non-Hodgkin Lymphomas (ONC-27)** or **Hodgkin Lymphoma (ONC-28)** in the Oncology Imaging Guidelines. A positive FDG PET/CT has little value for discrimination between benign and malignant lesions. A negative FDG PET/CT does not prevent serial CT/MRIs, due to appreciable false negative rate.
  - MRI Chest without and with contrast (CPT® 71552) or MRI Chest without contrast (CPT® 71550) can be considered for indeterminate mediastinal mass on FDG PET/CT
- CT Chest with contrast (CPT® 71260), or CT Chest without contrast (CPT® 71250) or MRI Chest without and with contrast (CPT® 71552), or MRI Chest without contrast (CPT® 71550) for subsequent evaluations if:
  - new signs or symptoms, or
  - preoperative assessment
- For Adenopathy; See **Lymphadenopathy (CH-2).**
- For Goiter; See **Thyroid Nodule (NECK-8.1)** in the Neck Imaging Guidelines.
- For Myasthenia Gravis; See **Neuromuscular Junction Disorders (PN-6.1)** in the Peripheral Nerve Disorders Imaging Guidelines.

Evidence Discussion

Mediastinal nodules or masses may present as incidental findings on chest radiographs and cross-sectional imaging. Alternatively, they may be found during the evaluation of symptoms and signs that include chest pain, cough, dyspnea, dysphagia, cardiac tamponade, diaphragmatic paralysis, central venous thrombosis, superior vena cava syndrome, B-symptoms (in lymphoma), myasthenia gravis, and other paraneoplastic syndromes. The incidence rate is low with a reported prevalence of 0.73-4%. The most

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frequent lesions encountered in the mediastinum are thymoma, neurogenic tumours and benign cysts (English,2020;Juanpere,2013)

CT is superior to chest radiography for detection of invasion of the mass across tissue planes, secondary to its higher contrast resolution. Anterior mediastinal tumors account for 50% of all mediastinal masses. CT has the ability to show the precise location, morphology, and pattern of contrast enhancement of an anterior mediastinal mass as well as its relationship to other mediastinal components or borders. (English,2020;Juanpere,2013)

MRI remains superior to CT for detection of invasion of the mass across tissue planes, including the chest wall and diaphragm, and involvement of neurovascular structures secondary to its higher soft-tissue contrast. MRI allows further tissue characterization of mediastinal masses beyond that of CT and FDG-PET/CT. Chemical-shift MRI has been shown to be useful in distinguishing normal thymus and thymic hyperplasia from thymic neoplasms and lymphoma. It can also prove the cystic nature of an indeterminate, non–water attenuation thymic mass on CT, preventing unnecessary biopsy and thymectomy. (English,2020;Juanpere,2013)

(FDG)-PET/CT offers limited additional value beyond that of conventional CT in the initial assessment of mediastinal masses, with the exception of its use for primary mediastinal lymphoma staging and surveillance and detection of metastatic lymphadenopathy. A positive FDG-PET/CT has little value for discrimination between benign and malignant lesions.(English,2020)

It is reasonable to perform a chest radiograph as an initial imaging step. Chest radiography can help localize a mass to a specific mediastinal compartment and thereby narrow the differential diagnosis. Chest radiography offers limited assistance regarding tissue characterization of mediastinal masses, with the exception of its occasional demonstration of calcium within a lesion.(English,2020)

There is little relevant literature to support the use of ultrasound (US) in the initial evaluation of a clinically suspected mediastinal mass.(English,2020)

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Chest Trauma (CH-21)

Guideline Page

Chest Trauma (CH-21.1)

CH.CT.0021.1.A
v1.1.2025

- Chest x-ray initially.
  - CT Chest without contrast (CPT® 71250) or with contrast (CPT® 71260) for the following situations:[1]
    - Rib[1] or Sternal[2] Fracture:
      - With associated complications identified clinically or by other imaging, including pneumothorax, hemothorax, pulmonary contusion, atelectasis, flail chest, cardiovascular injury and/or injuries to solid or hollow abdominal organs.[1]
      - Uncomplicated, single fractures, multiple fractures, non-acute fractures, or occult rib fractures are NOT an indication for CT Chest unless malignancy is suspected as the etiology.[1]
    - Routine follow-up advanced imaging of rib or sternal fractures is not indicated.[1]
- CT Chest without contrast (CPT® 71250) or Tc-99m bone scan whole body (CPT® 78306) for suspected pathological rib fractures, with or without a history of trauma.[1]
- Clavicle Fractures:
  - CT Chest with contrast (CPT® 71260) or CT Chest without contrast (CPT® 71250) or MRI Chest without and with contrast (CPT® 71552) or MRI Chest without contrast (CPT® 71550) for proximal (medial) 1/3 fractures or sternoclavicular dislocations.[3]
  - X-ray is adequate for evaluation of middle and distal 1/3 fractures.[3]
- No advanced imaging of the abdomen or pelvis is indicated when there is chest trauma and no physical examination or laboratory evidence of abdominal and/or pelvic injury.

Evidence Discussion

- Chest x-ray, in combination with physical exam, is the appropriate initial diagnostic modality in those with suspected rib or sternal fracture after chest trauma. Although chest x-ray has low sensitivity (approximately 50%) for detection of rib fracture (Expert Panel on Thoracic Imaging,2019) it has the benefit of being widely and readily available and able to detect complications that may require additional imaging such as pneumo- or hemothorax and pulmonary contusions.(Expert Panel on Thoracic Imaging,2019; Lewis,2021) In addition, failure to detect rib fractures in uncomplicated cases does not significantly alter the patient management or outcomes. A study by Bansidhar et al. showed no difference in treatment in patient with minor chest trauma who did and did not have rib fractures diagnosed either clinically or radiographically.(Expert Panel on Thoracic Imaging,2019) Therefore in

uncomplicated cases additional advanced imaging is not indicated. Rodriguez et al. demonstrated that yield for CT of thoracic injury with major clinical significance after a normal chest x-ray is 1.5% (Rodriguez,2014) and would only detect one major injury for every 67 studies.(Rodriguez,2017)

- In cases where complications are identified clinically or by other imaging, additional imaging with CT chest is merited. CT does have higher sensitivity for detection of rib fractures (Expert Panel on Thoracic Imaging,2019) and in the detection and extent of pulmonary injuries.(Lewis,2021) It also may be useful in differentiating blunt cardiac injury from acute myocardial infarction. (Clancy,2012) However, CT does carry with it the risk of contrast related renal injury and allergic reactions.(Rodriguez,2017) It also exposes the patient to a greater amount of ionizing radiation than a chest x-ray and subsequent increased risk of induced cancers.(Rodriguez,2017) It is estimated that undergoing chest CT will result in one radiation induced cancer per every 720 40-year-old females and 1,538 40-year-old males. (Rodriguez,2017)
- If a pathological rib fracture is suspected imaging with either a CT chest or Tc-99m bone scan is warranted. CT may be helpful in differentiating primary tumor from metastasis and may aid in detection of the primary malignancy. (Expert Panel on Thoracic Imaging,2019) Tc-99mm bone scan has low specificity but high sensitivity (>95%) for detection of pathologic rib fractures. (Expert Panel on Thoracic Imaging,2019)
- Medial clavicular fractures are rare (<5% of cases) (Flores,2020)and may necessitate additional imaging with CT or MRI for evaluation. Midshaft and distal clavicular fractures are usually sufficiently evaluated by x-ray. (Flores,2020; Throckmorton,2007)
- Chest x-ray has poor sensitivity for identification of sternoclavicular dislocations. Given the risk for complications such as pneumothorax in posterior displacement advanced imaging may be required. CT is advantageous as it has superior image resolution. It also allows for 3D reconstruction to determine exact position of the sternoclavicular joint. MRI can also be utilized but it has poorer resolution than CT. However, it may be advantageous for evaluation of soft tissue conditions or ligamentous injury. (Morell,2016)
- Isolated chest injury without signs or symptoms of abdominal or pelvic injury does not support advanced imaging of the abdomen or pelvis. If abdominal or pelvic injury is suspected imaging is as dictated elsewhere in these guidelines.

References (CH-21)

v1.1.2025

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Chest Wall Mass (CH-22)

Guideline Page

Chest Wall Mass (CH-22.1)

CH.CM.0022.1.A

v1.1.2025

- Chest x-ray is useful in the workup of a soft-tissue mass and is almost always indicated as the initial imaging study.[1]
  - Chest ultrasound (CPT® 76604) may be useful as an initial imaging study in the setting of a suspected superficial or subcutaneous lipoma. This modality may also be valuable in differentiating cystic from solid lesions and has also been used to assess the vascularity of lesions.[1]
  - Following a non-diagnostic Chest x-ray that does not show an obvious lipoma(s) or clearly benign entity (see **Soft Tissue Mass or Lesion of Bone (MS-10)** in the Musculoskeletal Imaging Guidelines), the following may be appropriate:[1,2]
    - MRI Chest without and with contrast (CPT® 71552) or
    - MRI Chest without contrast (CPT® 71550) or when MRI is contraindicated,
    - CT Chest with contrast (CPT® 71260)

Evidence Discussion

Radiography is usually the appropriate initial imaging study for both superficial and non-superficial soft tissue masses. Radiography can help identify calcifications, bone involvement, intrinsic fat and unsuspected skeletal abnormality or deformity. In general, radiographic findings related to a soft tissue mass can provide helpful insight in determining the next most appropriate imaging modality for further characterization.[1, 2]Non-contrast enhanced ultrasound is also an excellent triage tool for evaluating superficial soft tissue masses like superficial lipomas.[1]

MRI without and with IV contrast is usually appropriate as the next imaging study for a soft tissue mass following non-diagnostic radiographs or non-contrast enhanced ultrasound.[1, 2]

MRI helps to define intrinsic tumor characterization, vascular structures, neurovascular involvement, hemorrhage, edema and tumor necrosis. MRI without IV contrast may be beneficial compared with CT but use of MR contrast improves the differentiation of benign from malignant soft tissue masses[1, 2]. At least 20% to 25% of soft tissue masses can demonstrate features that allow for confident diagnosis based on MRI alone many of which are benign and thus would not warrant biopsy.[1]

When MRI is contraindicated, CT with IV contrast is usually appropriate following non-diagnostic radiograph or ultrasound.

CT with IV contrast is useful in distinguishing vascularized from potentially necrotic regions of a tumor or calcification. CT without IV contrast is usually not beneficial.[1, 2]

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Background and Supporting Information

- Chest x-rays of chest wall masses can detect calcification, ossification, or bone destruction as well as location and size.[1,2]
- CT Chest without contrast is usually not beneficial in the evaluation of a soft tissue mass. With modern CT technology, calcification can usually be distinguished from vascular enhancement on contrast enhanced scan. In the evaluation of suspected tumors, contrast imaging is especially useful in distinguishing vascularized from potentially necrotic regions of the tumor.[1]

References (CH-22)

v1.1.2025

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Pectus Excavatum and Pectus Carinatum (CH-23)

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Pectus Excavatum and Carinatum (CH-23.1)

CH.EC.0023.1.A

v1.1.2025

- CT Chest without contrast (CPT® 71250) or MRI Chest without and with contrast (CPT® 71552) and 3-D reconstruction (CPT® 76377 or CPT® 76376) if:
  - candidates for surgical correction[1,2]
  - cardiac or pulmonary dysfunction has been identified[1,2]
    - ECG and echocardiography if cardiac symptoms or evidence of cardiac function abnormalities
    - Chest x-ray and PFT's if increasing shortness of breath.[1]

Evidence Discussion

- Measurements of the chest, such as the Haller Index, aid in the pre-operative assessment of pectus deformities. Chest CT is commonly used for pre-operative planning. (Abid,2017;Scalise,2023;Janssen,2023) Chest CT can also be utilized to assess cardiac compression or the presence of concomitant thoracic anomalies (Abid,2017;Scalise,2023;Janssen,2023;Coorens,2024) and allows for 3D reconstruction of the chest wall. (Coorens,2024) However, CT does carry with it the risk of ionizing radiation. (Abid,2017;Scalise,2023;Janssen,2023;Coorens,2024;Sun,2019) MRI can also be utilized for preoperative planning and does not carry the risk of ionizing radiation (Janssen,2023;Coorens,2024;Sun,2019) and allows for possible real-time imaging. (Coorens,2024) However, MRI has a longer acquisition time,(Sun,2019) can be complicated by motion artifacts (Sun,2019) and is incompatible with some implanted devices and metallic objects. Chest x-ray has also been used for the pre-operative calculation of pectus indices (Correns,2024;)Scalise,2023) and has the benefit of reduced radiation exposure as compared to CT. Studies have shown, however, that it had decreased measurement accuracy in cases of unbalanced asymmetry as compared to CT. (Coorens,2024)
- For individuals with cardiac symptoms further workup with ECC and echocardiography is warranted. (Janssen,2023)
- For individuals with pulmonary dysfunction further work up with spirometry is warranted. (Janssen,2023).

Background and Supporting Information

- Chest measurements derived from CT Chest, such as the Haller Index or the correction index, are helpful to the thoracic surgeon in pre-operative assessment of

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chest wall deformities to assess for the appropriateness of operative repair prior to the development of symptomatic pectus deformities.

- The Haller index is calculated using the width of the chest divided by the distance between the posterior surface of the sternum and the anterior surface of the spine. A Haller index score is normal at 2.5 to 2.7 and severe at 3.25 or greater. The correction index uses an equation of (b−a)/b×100, in which a is the minimum distance between the anterior spine and the posterior surface of the sternum, and b is the maximum distance between the anterior spine and most anterior internal rib. It yields a percentage that the chest would need to be corrected to achieve normal dimensions, with a normal level being 10% or less.[3]
- Some have suggested that a CXR can replace the CT Chest for Haller Index calculation with a strong correlation and high diagnostic accuracy.[4]
- Expert consensus from The Society of Thoracic Surgeons 2023, recommended that a comprehensive evaluation with spirometry, ECG, and echocardiography be done with any cardio-pulmonary complaint. The Haller index, correction index, pulmonary compression or failed previous repair, in and of itself, was not an indication for surgery. Corrective surgery indications for those with severe pectus excavatum included; progression of deformity, presence of cardio-pulmonary symptoms, mitral valve prolapse, arrhythmia, significant body image disturbances, abnormal PFTs, abnormal cardiac function test or the presence of cardiac compression on imaging, (echo or CT).[5]

References (CH-23)

v1.1.2025

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Pulmonary Arteriovenous Fistula (AVM) (CH-24)

Guideline Page

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Pulmonary AVM (CH-24.1)

CH.AV.0024.1.A

v1.1.2025

- CT Chest with contrast (CPT® 71260), CT Chest without contrast (CPT® 71250), CTA Chest (preferred modality for pre-intervention planning) (CPT® 71275), or MRA Chest (CPT® 71555) for evaluation of:[1,2,3,5,6,7]
  - suspected pulmonary AVM, including individuals with HHT (Hereditary Hemorrhagic Telangiectasia) or who have a first degree relative with HHT[4,5]
  - first degree relatives of an individual with a primary pulmonary AVM
  - evaluation of individuals with paradoxical embolus/stroke and no evidence of patent foramen ovale on echocardiogram
  - follow-up of treated AVM's at 6 months post embolization and then every 3-5 years[4]
  - follow-up of untreated AVM's to be determined by treating physician but no more than annually. Usually the interval is 3-5 years due to the slow-growth nature of PAVM's[4]
  - treated or untreated PAVM's with recurrent symptoms[4]

Evidence Discussion

Chest x-ray is the most appropriate initial imaging exam with presentation of hypoxemia or hemoptysis but it does have low sensitivity for pulmonary arteriovenous malformation (PAVM).(Hanley,2016)

CT chest is the test of choice for diagnosing a PAVM. Contrast may be considered for an atypical nodule/soft tissue lesion on CT chest without contrast and suspicion for a PAVM. CTA chest is the gold standard for defining the vascular anatomy of a previously identified PAVM. It is not routinely used for diagnosis except in the setting of concomitant embolization therapy, diagnostic uncertainty, or pre-intervention planning.(Hanley,2016) MRA chest avoids ionizing radiation but is not as sensitive or specific as CT for the diagnosis of PAVM and has limitations detecting PAVM < 5 mm.(Hanley,2016) It has a potential role in younger people with Hereditary Hemorrhagic Telangiectasia (HHT) who may require lifelong surveillance.(Hanley,2016)

CT chest without contrast may be done to screen for PAVM in people with possible or confirmed Hereditary Hemorrhagic Telangiectasia (HHT). (Faughnan,2020;Faughnan,2011) A negative CT chest with or without contrast helps to exclude a clinically significant PAVM.(Shovlin,2017)

Background and Supporting Information

- Pulmonary AVMs are abnormal connections between pulmonary arteries and veins, usually found in the lower lobes, that can be either primary (such as in individuals with HHT) or acquired (such as trauma, bronchiectasis). They can be identified in up to 98% of chest x-rays by a peripheral, circumscribed, non-calcified lesion connected by blood vessels to the hilum of the lung. Treatment is often by surgery or embolization of the feeding artery using platinum coils or detachable balloons.

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Pulmonary Embolism (PE) (CH-25)

Guideline Page

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Pulmonary Embolism (CH-25.1)

CH.PE.0025.1.A

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- CT Chest with contrast with PE protocol (CPT® 71260) or CTA Chest (CPT® 71275) if at least one symptom, clinical/laboratory finding or risk factor from each of the lists below are present.
  - With any ONE of the 3:[6,7,8]
    - Dyspnea, new onset and otherwise unexplained;
    - Chest pain, pleuritic;
    - Tachypnea
  - AND, with any ONE of the 3:[6,7,8]
    - Abnormal **D-dimer** test;
    - Wells Criteria score* higher than 4 points;
    - One risk factor** or symptom** of new onset demonstrating high clinical probability of PE

RISK FACTORS**[6,7,8]	SYMPTOMS ATTRIBUTED TO PE**[6,7,8]
Immobilization at least 3 days or surgery in last 4 weeks or recent trauma	Signs or symptoms of DVT
Previous history of DVT or PE	Hemoptysis
Cancer actively treated in last 6 months or receiving palliative treatment	Right heart strain or failure
Recent history of a long airplane flight	Systolic BP <90
Use of estrogen-based contraceptives (birth control pills, the patch, and vaginal ring)/Oral estrogen[1]	Syncope
Advanced age (≥70)	Cough
Congestive heart failure	Heart Rate >100
Obesity (BMI ≥35)	Palpitations

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RISK FACTORS**[6,7,8]	SYMPTOMS ATTRIBUTED TO PE**[6,7,8]
Suspicion or diagnosis of COVID-19	

Well's Criteria for Clinical Probability of PE*[6]	
Clinical signs/symptoms of DVT (at minimum: leg swelling and pain with palpation of the deep veins)	3
PE is likely or equally likely diagnosis	3
Heart rate >100	1.5
Immobilization at least 3 days or surgery in last 4 weeks	1.5
Previous history of DVT or PE	1.5
Hemoptysis	1
Cancer actively treated in last 6 months or receiving palliative treatment	1
Calculate Probability: Low <2 Moderate 2 to 6 High >6	
Using the above criteria, only 3% of individuals with a low pretest probability had PE versus 63% of those with a high pretest probability.	

- Non-urgent cases which do not meet above 2-step criteria, should undergo prior to advanced imaging:[9]
  - Chest x-ray (to rule out other causes of acute chest pain)
  - Primary cardiac and pulmonary etiologies should be eliminated
- Pregnancy is a risk factor for thrombo-embolic events in and of itself. Additional risk factors are not required. Pregnant individuals with suspected PE are suggested to proceed with:[11,12,13]
  - If signs/symptoms of DVT are present, Doppler studies of the lower extremities (CPT® 93970 bilateral study or CPT® 93971 unilateral study) should be performed.
  - If no signs/symptoms of DVT, then chest x-ray should be done first.

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  - If chest x-ray is normal, then V/Q scan (CPT® 78580 or CPT® 78582) (preferred test), or CTA Chest (CPT® 71275) or CT Chest with contrast with PE protocol (CPT® 71260)[1]
  - If chest x-ray is abnormal or after non-diagnostic V/Q scan or if V/Q scanning is not readily available, then CTA Chest (CPT® 71275) or CT Chest with contrast with PE protocol (CPT® 71260).
- Ventilation-perfusion scans, also called V/Q, scans (CPT® 78580-Pulmonary Perfusion Imaging; CPT® 78582-Pulmonary Ventilation (e.g., Aerosol or Gas) and Perfusion Imaging) or SPECT/CT (CPT® 78830):[15]
  - Is not a replacement for CTA Chest[9]
  - Can be considered in any of the following:
    - Suspected pulmonary embolism if there is a contraindication to CT or CTA Chest (ventilation-perfusion scans CPT® 78582)
    - Suspected pulmonary embolism when a chest x-ray is negative and CTA Chest is not diagnostic (CPT® 78580 or CPT® 78582)
    - Follow-up of an equivocal or positive recent ventilation-perfusion lung scan to evaluate for interval change (CPT® 78580)
    - Suspected Chronic thromboembolic disease or Chronic thromboembolic pulmonary hypertension*, usually after 3 months of effective anticoagulation[14]
- Follow-up imaging in stable or asymptomatic individuals with known PE is not warranted[2,3,4,10]
- Follow-up imaging with CT Chest with contrast with PE protocol (CPT® 71260) or CTA Chest (CPT® 71275) for ANY of the following indications:
  - Recurrent or persistent signs or symptoms such as dyspnea, particularly if present after 3 months of anticoagulation, or
  - Elevated D-dimer which is persistent or recurrently elevated, or
  - Right heart strain or failure identified by EKG, ECHO or heart catheterization
- *Pulmonary Artery Hypertension (PAH) - See **Pulmonary Artery Hypertension (PAH) – Indications (CD-8.1)** in the Cardiac Imaging Guidelines

Evidence Discussion

Symptoms and signs of pulmonary embolus (PE) are nonspecific and common; therefore, knowing whom to test for PE is challenging.(Kahn,2022) In North America, PE is diagnosed in only 5% of people tested for it.(Konstantinides,2019) Chest x-ray (CR) is nonspecific but may rule out other causes of dyspnea and chest pain. (3) Avoiding the overuse of imaging tests is important, given the potential harms of radiation exposure, high costs and complications. The pretest clinical probability has an important effect on the predictive value of CT pulmonary angiography (CTPA). (Konstantinides,2019) Determining the clinical pretest probability of PE depends on clinical judgment, which lacks standardization and is subjective, or prediction rules.

(Konstantinides,2019;Ishaaya,2020) Kahn et al recommend diagnostic imaging in those with a likelihood of PE greater than or equal to 15%, based on the "implicit sense" of the clinician, and either a structured clinical probability score (Wells, Revised or Simplified Geneva score) or a D-dimer above a pre-specified threshold.(Kahn,2022) Other experts recommend that imaging be done in those with a high pretest probability based on empirical clinical judgment or a prediction rule and in those with a low/ intermediate pretest probability and a positive D-dimer.(Konstantinides,2019,Expert Panel on Cardiac Imaging,2019) Imaging can be avoided in people with both a structured clinical probability score at or below the given cutoff and a D-dimer below the given cutoff value.(Kahn,2022) Imaging is likewise not appropriate in those with a low/ intermediate pretest probability based on clinical judgement and a normal D-dimer. (Konstantinides,2019,Expert Panel on Cardiac Imaging,2019)

CTPA is highly sensitive and specific and is the imaging method of choice for suspected PE.(Kahn,2022;Konstantinides,2019;Expert Panel on Cardiac Imaging,2019;Ishaaya,2020) It may also demonstrate other potential causes of the presenting symptoms. CTPA is a CT angiogram with intravenous (IV) contrast. The timing of the scan is tailored so that contrast enhances the pulmonary arterial system to identify potential filling defects. CT with contrast is usually not appropriate. According to the American College of Radiology, when IV contrast is given during CT acquisition for suspected PE, the study should be performed as a CTPA.(Expert Panel on Cardiac Imaging,2019)

Planar V/Q may preferentially be used in outpatients with a low clinical probability of PE and normal CR, in young (especially female) patients, pregnant women and patients with a history of contrast allergy or renal failure.(Konstantinides,2019) The proportion of diagnostic V/Q scans is higher in patients with a normal CXR. A normal V/Q scan has a high negative predictive value, but there is a high proportion of non-diagnostic scans and it cannot provide alternative diagnoses.(Expert Panel on Cardiac Imaging,2019) Abnormal regional lung perfusion may suggest PE but is not specific and requires correlation with ventilation studies or other imaging. Investigators have studied single-photon emission CT (SPECT) to improve the sensitivity and specificity of V/Q scans. Kahn et al state that V/Q SPECT is a low radiation option to minimize lung and breast tissue irradiation in younger patients.(Kahn,2022) Some authors believe that V/Q SPECT should be the preferred study in the evaluation of suspected PE.(Currie,2023) However, large scale prospective trials are needed to validate SPECT techniques before its widespread incorporation into diagnostic algorithms. (Konstantinides,2019;Parker,2012)

A normal perfusion scan and a negative CTPA appear equally safe for ruling out PE in pregnancy.(Konstantinides,2019) There is debate regarding which is the first test of choice. CTPA is more expensive and exposes the pregnant woman to more radiation than the fetus; V/Q scans have low radiation and no contrast-related side effects. (Kalaitzopoulos,2022) A compression duplex ultrasound of the lower extremity should be

performed if there are symptoms/signs of a DVT. If a DVT is diagnosed, anticoagulation can be administered without further imaging. A CXR is usually appropriate. An alternative diagnosis may be found, and it can inform the choice between CTPA and a V/Q scan as the next test when there is no clinical evidence of a DVT.(Expert Panel on Cardiac Imaging,2019) If there is no DVT and a CXR is normal, CTPA or a perfusion scan is appropriate. If the perfusion scan is normal, a ventilation scan may not be needed. If the CXR is abnormal, alternative causes have been considered and PE is still suspected, CTPA should be done.(Konstantinides,2019)

Acute PE is treated for at least 3 months with anticoagulation. Whether anticoagulation is stopped after 3 months or continued indefinitely depends on whether the reduced risk of recurrent venous thromboembolism (VTE) outweighs the increased risk of bleeding.(Konstantinides,2019) The risk of recurrent VTE after stopping anticoagulation is related to the risk factor category for the index PE/VTE event. There are many genetic and acquired risk factors for VTE associated with a low, intermediate or high risk of recurrence.(Konstantinides,2019;Ishaaya,2020)

Patency of the pulmonary arterial bed is restored in the majority of people within the first few months, and no routine CTPA imaging is needed.(Konstantinides,2019) Konstantinides et al recommend a transthoracic echocardiogram in those with dyspnea or functional limitation at follow up. If the probability of pulmonary hypertension is felt to be high, planar V/Q is considered the first line imaging test for suspected chronic thromboembolic pulmonary hypertension (CTEPH). CTPA should not be used as a stand alone test to rule out CTEPH. The diagnosis is based upon measurements made during right heart catheterization and mismatched perfusion defects on V/Q scan more than 3 months after an acute PE.(Konstantinides,2019)

Background and Supporting Information

- Pulmonary embolism is found in approximately 10% of all those that present with suspicion of PE. Dyspnea, pleuritic chest pain and tachypnea occur with about 50% incidence with leg swelling or pain just over 50%.
- D-dimer level has a high sensitivity and low specificity for diagnosing PE.
  - A negative D-dimer in combination with low or moderate PE risk classification has a negative predictive value approaching 100%.
  - D-dimer can be falsely elevated with recent surgery, injury, malignancy, sepsis, diabetes, pregnancy, or other conditions where fibrin products are likely to be present.
- CT imaging has supplanted V/Q scanning since the latter is difficult to obtain quickly, does not provide a substantial cost savings, and does not diagnose other pulmonary pathology.
- The decision to terminate anticoagulation treatment after previous pulmonary embolism (PE) with absent or stable symptoms is based on clinical evaluation and risk factors.

- Repeat studies do not allow one the ability to distinguish new from residual clot, with luminal diameter and clot character poorly correlated to symptoms and ECHO findings.
- Two thirds of individuals with primary thromboembolism have residual pulmonary artery clot at 6 months and 50% remain at one year.
- Subsequent persistence or elevation of D-dimer is associated with increased risk of recurrent PE. ECHO and Right Heart Catheterization (RHC) can identify those with pulmonary hypertension. Yet, 1/2 of all have persistent or new pulmonary hypertension after primary thromboembolism and only half of this latter group has dyspnea at rest or exercise intolerance.
- Of note, pregnancy is accompanied by a progressive increase in D-dimer levels and as such, D-Dimer levels may not be helpful to rule-in or rule-out DVT/PE in pregnancy.[11,12]

Modality	Fetal radiation exposure in mGy
CXR	0.002-0.1
V/Q	0.32 – 0.74
CTPA	0.03 – 0.66

- Compared with V/Q scan, computed tomography pulmonary angiography (CTPA), is associated with a higher radiation dose to the mother: the calculated doses to breast and lung tissue have been estimated to range from 10 to 60 mGy and 39.5 mGy, respectively with CTPA as compared with 0.98 to 1.07 mGy and 5.7 to 13.5 mGy, respectively with V/Q scan.[12]

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Pulmonary Hypertension (CH-26)

Pulmonary Hypertension (CH-26.1)

CH.PH.0026.1.A

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- See the **Pulmonary Artery Hypertension (PAH) – Indications (CD-8.1)**

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Subclavian Steal Syndrome (CH-27)

Guideline Page

Subclavian Steal Syndrome (CH-27.1)

CH.SS.0027.1.A

v1.1.2025

- See **Subclavian Steal Syndrome (PVD-4.1)** for concerns of Subclavian Steal Syndrome in Peripheral Vascular Disease imaging guidelines.

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Superior Vena Cava (SVC) Syndrome (CH-28)

Guideline Page

SVC Syndrome (CH-28.1)

CH.SV.0028.1.A

v1.1.2025

- See **SVC syndrome (PVD-4.2)** for concerns of SVC syndrome in Peripheral Vascular Disease imaging guidelines.

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Elevated Hemidiaphragm (CH-30)

Guideline Page

Elevated Hemidiaphragm (CH-30.1)

CH.EH.0030.1.A

v1.1.2025

- CT Chest with contrast (CPT® 71260) and/or CT Neck with contrast (CPT® 70491) with new diaphragmatic paralysis after:[1,2]
  - previous chest x-rays are available and reviewed to determine if the diaphragmatic elevation is a new finding, and/or
  - fluoroscopic examination (“sniff test”) to differentiate true paralysis from weakness
- CT Abdomen with contrast (CPT® 74160) to rule out liver or abdominal process if CT Chest is negative.[1,2]
- Repeat advanced imaging studies in the absence of new signs or symptoms are not indicated.

Evidence Discussion

Diaphragmatic dysfunction includes eventration, weakness and paralysis. Diagnosis is based in part on static and dynamic imaging tests.(Ricoy,2019) Unilateral diaphragmatic paralysis is often asymptomatic and suspected when an elevated hemidiaphragm is found incidentally on chest x-ray (CR). CR is a simple and effective test to evaluate the pulmonary parenchyma and the diaphragm.(Ricoy,2019) The positive and negative predictive value of an elevated hemidiaphragm on CXR for diaphragmatic dysfunction is 33% and 93%, respectively. The presence of diaphragm elevation is not necessarily a sign of dysfunction, but its absence makes it unlikely.(Ricoy,2019)

Flouroscopy has traditionally been the gold standard for diagnosing diaphragmatic paralysis since it can visualize the diaphragm throughout the respiratory cycle and during forced inspiratory maneuvers (ie the "sniff test"). Some authors now consider US to be the imaging method of choice for the evaluation of diaphragmatic dysfunction. (Ricoy,2019;Windisch,2016) US is non-invasive, portable, quick and does not expose the patient to ionizing radiation. Absence of thickening of the diaphragm during inspiration, absence of caudal movement during normal inspiration or paradoxical movement during the sniff maneuver confirms paralysis.

A common concern is whether there is an underlying serious condition in those patients with unilateral hemidiaphragm paralysis with no evident etiology after a history, physical exam and CR. Piehler et al concluded that such patients are unlikely to have an underlying occult malignant or neurologic condition.(Piehler,1982) However, Windisch et al recommended that a one-time CT chest be done if there is clinical suspicion of possible malignancy with damage to the phrenic nerve.(Windisch,2016)

Additional imaging may be needed to rule out conditions which can cause an elevated hemidiaphragm but are not associated with respiratory muscle weakness. For

example, abdominal imaging can be done for suspected hepatic abscess, ascites, or splenomegaly.

Background and Supporting Information

- The right hemidiaphragm sits about 2 cm higher than the left.
- “Eventration” is thin membranous replacement of muscle, usually on the right, as the most common cause of elevation.
- Any injury to the phrenic nerve from neck to diaphragm can lead to paralysis.
- Common phrenic causes are traumatic or surgical injury or malignancy involving the mediastinum.
- Any loss of lung volume or increased abdominal pressure can lead to diaphragm elevation.

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Thoracic Outlet Syndrome (TOS) (CH-31)

Guideline Page

Thoracic Outlet Syndrome (CH-31.1)

CH.TO.0031.1.A

v1.1.2025

- See **Thoracic Outlet Syndrome (PVD-4.2)** for concerns of Thoracic Outlet Syndrome in Peripheral Vascular Disease imaging guidelines.

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Lung Transplantation (CH-32)

Guideline Page

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Pre-Transplant Imaging Studies (CH-32.1)

CH.LT.0032.1.A
v1.1.2025

- Individuals on the waiting list or being considered for the lung transplant can undergo advanced imaging per that institution's protocol as long as the studies do not exceed the following:
  - CT Chest with and without contrast (CPT® 71270), CT Chest with contrast (CPT® 71260), or CT Chest without contrast (CPT® 71250)
  - ECHO
  - Imaging Stress Test (MPI, SE, MRI) or Heart Catheterization (Right and Left); Heart catheterization can also be done after a positive stress test.
  - CTA Chest (CPT® 71275), and/or CTA Abdomen and Pelvis (CPT® 74174) and/or CTA Aorta with bilateral lower extremity run-off (CPT® 75635) is indicated without initial ABI's and/or arterial duplex for the following individuals:
    - Prior abdominal or lower extremity vascular intervention (any timeframe is acceptable)
    - Known peripheral artery disease (PAD) from prior imaging
    - Current symptoms of claudication, rest pain or gangrene
  - CTA Chest (CPT® 71275) and/or CTA Abdomen and Pelvis (CPT® 74174) and/or CTA Aorta with bilateral lower extremity run-off (CPT® 75635) is indicated after initial ABI's and/or arterial duplex for the following individuals:
    - Initial ABI's and/or arterial duplex suggest the presence of PAD per one of the following:
      - ABI of <0.9
      - Presence of plaque
      - Presence of vascular calcification, stenosis or occlusion
      - Small vessel size on the duplex
  - CT Abdomen and Pelvis with or without contrast (CPT® 74177 or CPT® 74176) for determining extracorporeal membrane oxygenation (ECMO) candidacy
- Other studies that will be considered include V/Q scan, Six Minute Walk Test.
- See **Transplant (CD-1.6)** in the Cardiac Imaging Guidelines.

Evidence Discussion

- Computed Tomography (CT) is often performed for evaluation of individuals prior to lung transplantation. CT allows for surgical planning,to delineate extent of the disease

and assess for any contraindications to transplant (Ng, 2009;Kim,2021). CT carries the risk of exposure to iodinated contrast and ionizing radiation.

- Evaluation of donors is commonly performed by chest radiography. (Kim,2021)
- Cardiac evaluation with echo and/or ischemic evaluation (image stress testing or heart catheterization) is also appropriate prior to lung transplantation.
- Extracorporeal Membrane Oxygenation (ECMO) has been increasingly utilized for bridging prior to lung transplantation or as an adjunct procedure post-transplant. (Hoetzenecker,2020;Faccioli,2021) Given the risk of vascular complications (Bonicolini, 2019) preoperative evaluation of the vasculature is reasonable. For those that are asymptomatic without previously known peripheral artery disease (PAD) initial work up with ankle-brachial index (ABI) and/or arterial duplex (Gerhard-Herman,2017) is supported. For those that are symptomatic, have a history of known PAD (either from prior imaging or previous vascular intervention) or initial work up has suggested the presence of PAD advanced imaging is indicated for further evaluation (Gerhard-Herman,2017).

Post-Transplant Imaging Studies (CH-32.2)

CH.LT.0032.2.A

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- CT Chest with and without contrast (CPT® 71270), CT Chest with contrast (CPT® 71260), or CT Chest without contrast (CPT® 71250) is supported for:[2]
  - initial post-transplant follow-up
  - suspected complication, either surgical, medical or infectious, (See **Background and Supporting Information**)
  - worsening PFT's
  - new finding on other imaging, including chest x-ray
- See **Transplant (CD-1.6)** in the Cardiac Imaging Guidelines.

Evidence Discussion

- There are no universally accepted follow-up protocols for routine post-transplant surveillance (Kim,2021). CT chest is supported for initial post-transplant follow up (Ng, 2009; Kim,2021;DeFreitas,2021). CT carries with it the risk of exposure to iodinated contrast and ionizing radiation.
- Additional follow-up is based on clinical presentation, suspected complication or findings on other imaging. (Ng, 2009;Kim,2021;DeFreitas,2021)

Background and Supporting Information

- Complications from lung transplantation are a major cause of morbidity and mortality.
- The three main categories of complications are surgical, medical and infectious.
  - Surgical complications include; anastomotic complications, bronchial dehiscence, bronchial stenosis, pneumothorax, hemothorax, hematoma, wound dehiscence and infection.
  - Medical complications include; primary graft dysfunction, pulmonary embolism and pulmonary infarction, Tracheobronchomalacia, posttransplant lymphoproliferative disease, primary disease recurrence, acute and chronic allograft rejection, including bronchiolitis obliterans and restrictive allograft syndrome.
  - Infectious complications include; hospital and community acquired nonmycobacterial pulmonary infections, mycobacterial infections, fungal infections, and viral infections, (CMV most common).

Reference (CH-32)

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Lung Cancer Screening (CH-33)

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U.S. Preventive Services Task Force: Lung Cancer Screening (Commercial and Medicaid) (CH-33.1)

CH.CS.0033.1.A

v1.1.2025

- Low-dose CT Chest (CPT® 71271) for lung cancer screening in asymptomatic individuals* annually if all of the following criteria are met:

Screening Indications – Commercial and Medicaid	Imaging Study
• All criteria below must be met: ◦ Individual has not received a low-dose CT lung screening in less than 12 months; and ◦ Individual has NO health problems that substantially limit life expectancy or the ability or willingness to have curative lung surgery**; and ◦ Individual is between 50 and 80 years of age; and ◦ Individual has at least a 20 pack-year history of cigarette smoking; and ◦ Currently smokes or quit within the past ≤15 years	Low-Dose CT Chest without contrast (CPT® 71271)

*Symptoms of lung cancer (e.g., hemoptysis, unexplained cough, and/or unexplained weight loss of >15 pounds in the past year) warrant diagnostic evaluation, not screening.

For those that no longer qualify for annual LDCT for lung cancer screening but have known lung nodules, follow criteria for follow-up under CH-16. For example, a nodule that is new on the last screening LDCT may warrant continued diagnostic CT evaluation per CH-16.2.

**This is based on a range of chest or other organ signs, symptoms or conditions which would question the member's ability to undergo surgical or non-surgical treatment if a lung cancer was discovered. For example, congestive heart failure, advanced cancer from another site or a member with COPD who uses oxygen when ambulating, would be examples of conditions that would "substantially limit life expectancy." Conversely, stable COPD and its symptoms, including cough, shortness of breath would not "substantially limit life expectancy."

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National Coverage Determination (NCD) for Lung Cancer Screening with Low Dose Computed Tomography (LDCT) (Medicare) (CH-33.2)

CH.CS.0033.2.A

v1.1.2025

- Medicare criteria for LDCT for Lung Cancer Screening (CPT® 71271) See *NCD 210.14*

Incidental Pulmonary Nodules Detected on Low Dose CT Chest (LDCT) Images (CH-33.3)

CH.CS.0033.3.A

v1.1.2025

- Any Lung-RADS less than 1 year interval follow-up is coded as Low-Dose CT Chest (CPT® 71250) (Not CPT® 71271 which is ONLY the annual screen)
- For lung nodules, including incidental findings from studies other than screening LDCT, or if no longer qualify for screening LDCT, See **Incidental Pulmonary Nodules Detected on CT Images (CH-16.2)**

Lung-RADS Primary Category/ Category Descriptor	Management
0: Incomplete	If findings suggestive of an inflammatory or infectious process, follow-up with LDCT (CPT 71250) in 1-3 months
2: Benign appearance or behavior - very low likelihood of becoming a clinically active cancer due to size or lack of growth	Annual LDCT screening (CPT® 71271) in 12 months
3: Probably benign finding(s) - short term follow-up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	6 month LDCT (CPT® 71250) and if unchanged on this CT it is coded as category 2 and returned to annual LDCT screening (CPT® 71271) in 12 months
4A: Suspicious - Findings for which additional diagnostic testing and/ or tissue sampling is recommended	PET/CT (CPT® 78815) when there is a ≥8 mm solid nodule or solid-component Follow-up with LDCT (CPT® 71250) in 3 months and if stable or decreased in size on this CT, it is coded as category 3 with follow-up LDCT (71250) at 6 months, if stable or decreased in size on this CT, return to annual LDCT screening (CPT® 71271) in 12 months

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Lung-RADS Primary Category/ Category Descriptor	Management
4B or 4X: Suspicious - Findings for which additional diagnostic testing and/ or tissue sampling is recommended	CT Chest with or without contrast, PET/ CT (CPT® 78815) and/or tissue sampling depending on the probability of malignancy and comorbidities. PET/CT (CPT® 78815) when there is a ≥8 mm solid component. If there is low suspicion of lung cancer, follow-up with LDCT (CPT® 71250) in 3 months with another LDCT (CPT® 71250) in 6 months and if unchanged on this CT return to annual LDCT screening (CPT® 71271) in 12 months

For those that no longer qualify for annual LDCT for lung cancer screening but have known lung nodules, follow criteria for follow-up under CH-16. For example, a nodule that is new on the last screening LDCT may warrant continued diagnostic CT evaluation per **CH-16.2**.

For a summary of changes and updates concerning Lung-RADS v2022 by the ACR:

Lung-RADS v2022 Summary Feb2023 (acr.org)

Evidence Discussion

- Low-dose computed tomography (LDCT) Chest for lung cancer screening has been shown to have sensitivity ranging from 59% to 100%, a specificity of 26.4% to 99.7%, a negative predictive value of 97.7% to 100% and a positive predictive value from 3.3% to 43.5%.(US Preventive Services Task Force,2021)The benefit of lung cancer screening is early detection and treatment. The NLST trial showed a relative risk reduction in lung cancer mortality of 20% (US Preventive Services Task Force,2021). The radiation dose of a LDCT is typically 10% to 30% of a standard-dose CT. (US Preventive Services Task Force,2021) The harms of a screening program would include false-positive results and subsequent unnecessary tests and procedures, the exposure to ionizing radiation and ensuing radiation-induced cancer, and increased patient anxiety and distress (US Preventive Services Task Force,2021).
- The risk of malignancy associated with a Lung CT Screening Reporting and Data System (Lung-RADS) score is as follows: a score of 2 is <1%; a score of 3 is 1-2%; a score of 4A is 5-15%; a score of 4B and 4X is >15%. (Lung-RADS,2019) The American College of Radiology (ACR) recommends follow up imaging of incidental pulmonary nodules detected on low dose lung cancer screening CT's based on

the Lung-RADS score (Lung-RADS,2019; Christensen, 2024) however, there is limited data on the impact of screening intervals (Christensen, 2024). The NLST and NELSON studies demonstrating reduction in lung cancer mortality were based on screening intervals of 1 year and 1, 3 and 5.5 years respectively (Christensen, 2024). Multiple studies have shown that the 3 month follow up recommended for Lung-RADS 4A nodules is optimal, but have raised concerns on stepwise downgrading of a stable 4A nodule to a Lung-RAD 2.(Christensen, 2024) Therefore the ACR has modified follow up intervals with stepped management using the following criteria:

- Nodules that are stable or decreased at follow-up are downgraded to the next lower Lung-RADS category Christensen, 2024)
- Nodules that completely resolve or are proven benign after an appropriate diagnostic evaluation are reclassified based on the most concerning finding (Christensen, 2024)
- Follow-up recommendations are timed from the current examination (Christensen, 2024)

References (CH-33)

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