

**American College of Radiology
ACR Appropriateness Criteria®
Workup of Pleural Effusion or Pleural Disease**

Variant 1: Recent pneumonia with suspected parapneumonic effusion or empyema. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	⊕
CT chest with IV contrast	Usually Appropriate	⊕⊕⊕
US chest	May Be Appropriate (Disagreement)	○
CT chest without IV contrast	May Be Appropriate	⊕⊕⊕
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕
CTA chest with IV contrast	Usually Not Appropriate	⊕⊕⊕

Variant 2: Recent minor blunt trauma with suspected pleural effusion. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	⊕
CT chest with IV contrast	Usually Appropriate	⊕⊕⊕
US chest	May Be Appropriate (Disagreement)	○
CT chest without IV contrast	May Be Appropriate	⊕⊕⊕
CTA chest with IV contrast	May Be Appropriate (Disagreement)	⊕⊕⊕
Image-guided aspiration chest	Usually Not Appropriate	Varies
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕

Variant 3: Dyspnea, cough, or chest pain with suspected pleural effusion, noninfectious. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	⊕
CT chest with IV contrast	Usually Appropriate	⊕⊕⊕
US chest	May Be Appropriate (Disagreement)	○
CT chest without IV contrast	May Be Appropriate	⊕⊕⊕
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕
CTA chest with IV contrast	Usually Not Appropriate	⊕⊕⊕

Variant 4:**Pleural effusion incidentally detected on incomplete thoracic imaging study. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US chest	May Be Appropriate (Disagreement)	○
Radiography chest	May Be Appropriate (Disagreement)	⊕
CT chest with IV contrast	May Be Appropriate (Disagreement)	⊕⊕⊕
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT chest without IV contrast	Usually Not Appropriate	⊕⊕⊕
CTA chest with IV contrast	Usually Not Appropriate	⊕⊕⊕

WORKUP OF PLEURAL EFFUSION OR PLEURAL DISEASE

Expert Panel on Thoracic Imaging: Michael F. Morris, MD^a; Travis S. Henry, MD^b; Constantine A. Raptis, MD^c; Alpesh N. Amin, MD, MBA^d; William F. Auffermann, MD, PhD^e; Benjamin W. Hatten, MD, MPH^f; Aine Marie Kelly, MBBCh^g; Andrew R. Lai, MD, MPH^h; Maria D. Martin, MDⁱ; Kim L. Sandler, MD^j; Arlene Sirajuddin, MD^k; Devaki Shilpa Surasi, MD^l; Jonathan H. Chung, MD.^m

Summary of Literature Review

Introduction/Background

Under normal circumstances, approximately 0.1 to 0.2 mL/kg body weight of pleural fluid resides in the pleural space [1]. Abnormal accumulation of pleural fluid is the most common clinical manifestation of pleural disease [2], typically caused by increased pulmonary capillary pressure, increased pleural membrane permeability, decreased oncotic pressure, or lymphatic obstruction [3]. Pleural effusions are categorized as transudative or exudative [4], with transudative effusions usually reflecting the sequela of a systemic etiology and exudative effusions usually resulting from a process localized to the pleura [5]. Common causes of transudative pleural effusions include congestive heart failure, cirrhosis, and renal failure, whereas exudative effusions are typically due to infection, malignancy, or autoimmune disorders [6], emphasizing the importance of prompt diagnosis to aid in patient management [7]. In general, physical examination findings have a lower positive likelihood ratio for detection of pleural effusions [8], supporting the use of imaging to aid in identification of clinically significant pleural effusions.

When imaging pleural effusions, chest radiographs can typically detect >75 mL on the lateral view and >175 mL on the frontal view [9]. Thoracic ultrasound (US) can detect >20 mL of pleural fluid [10]. Chest CT can detect >10 mL of pleural fluid, and is considered the reference standard for imaging [11].

Special Imaging Considerations

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the [ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography \(CTA\)](#) [12]:

“CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial and/or venous enhancement, depending on the vascular structures to be analyzed. The resultant volumetric data set is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings.”

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and reconstructions/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care)

OR

^aUniversity of Arizona College of Medicine, Tucson, Arizona. ^bPanel Chair, Duke University, Durham, North Carolina. ^cPanel Vice-Chair, Mallinckrodt Institute of Radiology, Saint Louis, Missouri. ^dUniversity of California Irvine, Irvine, California; American College of Physicians. ^eUniversity of Utah, Salt Lake City, Utah. ^fUniversity of Colorado School of Medicine Anschutz Medical Campus, Aurora, Colorado; American College of Emergency Physicians. ^gEmory University Hospital, Atlanta, Georgia. ^hUniversity of California San Francisco, San Francisco, California, Hospitalist. ⁱUniversity of Wisconsin School of Medicine and Public Health, Madison, Wisconsin. ^jVanderbilt University Medical Center, Nashville, Tennessee. ^kNational Institutes of Health, Bethesda, Maryland. ^lThe University of Texas MD Anderson Cancer Center, Houston, Texas; Commission on Nuclear Medicine and Molecular Imaging. ^mSpecialty Chair, University of Chicago, Chicago, Illinois.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through representation of such organizations on expert panels. Participation on the expert panel does not necessarily imply endorsement of the final document by individual contributors or their respective organization.

Reprint requests to: publications@acr.org

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Recent pneumonia with suspected parapneumonic effusion or empyema. Initial imaging.

CT Chest With IV Contrast

Current American Association for Thoracic Surgery consensus guidelines recommend CT chest with intravenous (IV) contrast in cases of suspected parapneumonic effusion (class IIa) [13]. A recent meta-analysis reported 5 chest CT findings most commonly associated with the diagnosis of empyema: pleural enhancement (sensitivity 84%, 95% confidence interval [CI], 62%-94%; specificity 83%, 95% CI, 75%-89%), pleural thickening (sensitivity 68%, 95% CI, 56%-77%; specificity 87%, 95% CI, 80%-92%), loculation (sensitivity 52%, 95% CI, 44%-59%; specificity 89%; 95% CI, 82%-94%), extrapleural fat proliferation (sensitivity 53%, 95% CI, 47%-60%; specificity 91%, 95% CI, 82%-96%), and increased attenuation of the extrapleural fat (sensitivity 39%, 95% CI, 32%-48%; specificity 97%, 95% CI, 94%-98%) [14]. Of note, these pooled sensitivities and specificities include CT chest with IV contrast or CT chest without IV contrast. Pleural enhancement has the highest area under curve for the diagnosis of empyema (0.86) and for distinguishing between simple parapneumonic effusion and empyema (0.83) [14]. In a secondary analysis of the Multi-centre Intra-pleural Sepsis Trial (MIST) 2 trial of patients with laboratory proven pleural infection, the combination of parietal pleural enhancement and pleural thickening was seen in 98.7% of patients (95% CI, 92.8%-99.8%) on pleural-phase contrast-enhanced CT [15]. The presence of pleural enhancement with pleural gas/microbubbles [16] or larger pleural effusion size [17] also boosts the accuracy for identifying parapneumonic effusions requiring thoracentesis [16,17]. Parapneumonic effusions <2.5 cm in anteroposterior (AP) dimension can often be managed without thoracentesis [18]. From a technical perspective, acquiring the CT scan 60 seconds after the IV contrast bolus optimizes visualization of the pleura [19,20].

CT Chest Without and With IV Contrast

There is no relevant literature to support the use of CT chest without and with IV contrast in the initial imaging of recent pneumonia with suspected parapneumonic effusion or empyema.

CT Chest Without IV Contrast

There is no relevant literature to support the use of CT chest without IV contrast in the initial imaging of recent pneumonia with suspected parapneumonic effusion or empyema. If a noncontrast CT is obtained, 4 out of 5 chest CT findings most commonly associated with the diagnosis of empyema in a recent meta-analysis may be ascertained without IV contrast: pleural thickening (sensitivity 68%, 95% CI, 56%-77%; specificity 87%; 95% CI, 80%-92%), loculation (sensitivity 52%, 95% CI, 44%-59%; specificity 89%; 95% CI, 82%-94%), fat thickening (sensitivity 53%, 95% CI, 47%-60%; specificity 91%; 95% CI, 82%-96%), and fat stranding (sensitivity 39%, 95% CI, 32%-48%; specificity 97%; 95% CI, 94%-98%) [14]. Of note, these pooled sensitivities and specificities include CT chest with IV contrast or CT chest without IV contrast. Gas in the pleural space is another specific marker for complicated parapneumonic effusion, with specificities ranging from 81% (95% CI, 73%-87%) to 96% (95% CI, 86%-99%) [16,17]. Parapneumonic effusions <2.5 cm in AP dimension can often be managed without thoracentesis [18].

CTA Chest With IV Contrast

There is no relevant literature to support the use of CTA chest with IV contrast in the initial imaging of recent pneumonia with suspected parapneumonic effusion or empyema. Note that CTA often employs contrast timing that is earlier than 60 seconds and therefore does not allow sufficient time for pleural enhancement.

MRI Chest Without and With IV Contrast

There is no relevant literature to support the use of MRI chest without and with IV contrast in the initial imaging of recent pneumonia with suspected parapneumonic effusion or empyema in adults. In case reports, MRI chest without and with IV contrast has been used as an adjunctive modality for the diagnosis of empyema necessitans [21]. In pediatric patients, limited data suggests MRI is noninferior to CT chest with IV contrast for the diagnosis of empyema [22-24].

MRI Chest Without IV Contrast

There is no relevant literature to support the use of MRI chest without IV contrast in the initial imaging of recent pneumonia with suspected parapneumonic effusion or empyema. In small studies, diffusion weighted imaging [25]

and T1 mapping [26] have shown promise in distinguishing exudative from transudative pleural effusions without contrast material.

Radiography Chest

Consensus recommendations endorse chest radiography as the initial imaging modality for patients with recent pneumonia and suspected pleural effusion [27,28]; however, there are limited empiric data to support these recommendations. Posteroanterior (PA) and lateral radiographs have a significantly greater sensitivity for the detection of parapneumonic effusions than single-view AP radiographs. In a retrospective analysis of patients from the Community-Acquired Pneumonia Organization international cohort study, PA and lateral radiographs had a sensitivity of 83.9% versus 67.3% for AP radiographs when using CT as the reference standard [29]. Single-view PA, single lateral view, or single-view AP radiographs have been shown to have statistically equivalent sensitivities for detection of parapneumonic effusions [30], with most missed parapneumonic effusions occurring in patients with coexistent lower lobe consolidation [30]. The specificity of chest radiography for the detection of complicated parapneumonic effusions, defined as those requiring thoracentesis, is modest. For example, in a retrospective study of 66 patients undergoing thoracentesis for parapneumonic effusions, chest radiography had a specificity of 60% for the detection of complicated parapneumonic effusions [31].

US Chest

Identification of a pleural effusion for possible US-guided thoracentesis is currently the primary reason for chest US [32]. Current American Association for Thoracic Surgery consensus guidelines recommend thoracic US for the diagnostic evaluation of pleural space infection (class I), typically occurring in patients with prior imaging documenting the presence of a pleural effusion [13]. US findings of septations [33,34], increased echogenicity of the pleural effusion [31,35], pleural thickening [36], and microbubbles [37] are associated with parapneumonic effusion/empyema. A retrospective study of 66 patients with suspected parapneumonic effusion found that US chest had a significantly higher specificity (90%, 95% CI, 76.3%-97.2%) and a nonsignificant difference in sensitivity (69.2%, 95% CI, 48.2%-87.7%) compared with CT chest for the diagnosis of complicated parapneumonic effusion [31]. A retrospective comparison of US chest and CT chest in pediatric patients found similar accuracy for the detection of parapneumonic effusion [38].

Variant 2: Recent minor blunt trauma with suspected pleural effusion. Initial imaging.

The definition of minor blunt trauma involves isolated minor injury to the chest (eg, abrasions, contusion, or ecchymoses) and/or no more than 2 rib fractures without flail chest [39,40]. For patients with major blunt trauma please refer to the ACR Appropriateness Criteria® topic on “[Major Blunt Trauma](#)” [41].

CT Chest With IV Contrast

CT chest with IV contrast or CTA chest with IV contrast is regarded as the reference standard for the noninvasive assessment of thoracic injury in patients with chest trauma, regardless of severity, and a clinical indication for imaging [42]. The goal of CT chest with IV contrast is to identify hemothorax and contrast extravasation. The incidence of pleural effusion on chest CT in minor blunt trauma is unknown; however, in a retrospective study of 2,440 multiple trauma patients undergoing whole body CT with IV contrast, 2.2% had an incidental pleural effusion [43]. In a secondary analysis of the prospective observational NEXUS Chest and NEXUS Chest CT studies of patients with major or minor blunt trauma, 1.8% of patients had a hemothorax on CTA chest with IV contrast [44].

CT Chest Without and With IV Contrast

There is no relevant literature to support the use of CT chest without and with IV contrast in the initial imaging of recent minor blunt trauma with suspected pleural effusion.

CT Chest Without IV Contrast

In patients with blunt trauma, regardless of severity and suspected pleural effusion, CT chest without IV contrast is generally reserved for patients with renal dysfunction, risk factors for contrast nephropathy, or known contrast allergy [45]. The incidence of pleural effusion on chest CT without IV contrast in minor blunt trauma is unknown. On CT chest without IV contrast, a pleural effusion threshold of ≥ 15.6 Hounsfield units (HU) (sensitivity 86.8%, specificity 97.4%) and HU ratio of pleural fluid to aortic blood of $\geq 30\%$ (sensitivity 94.7%, specificity 83.3%) were best able to discriminate hemothorax from pleural effusion after blunt chest trauma [45].

CTA Chest With IV Contrast

CTA chest with IV contrast or CT chest with IV contrast is regarded as the reference standard for the noninvasive assessment of thoracic injury in patients with chest trauma and a clinical indication for imaging [42]. The goal of

CTA chest with IV contrast is to identify hemothorax and contrast extravasation. The incidence of pleural effusion on chest CT in minor blunt trauma is unknown; however, in a retrospective study of 2,440 multiple trauma patients undergoing whole body CT with IV contrast, 2.2% had an incidental pleural effusion [43]. In a secondary analysis of the prospective observational NEXUS Chest and NEXUS Chest CT studies of patients with major or minor blunt trauma, 1.8% of patients had a hemothorax on CTA chest with IV contrast [44].

Image-Guided Aspiration Chest

There is no relevant literature to support the use of image-guided aspiration chest in the initial imaging of recent minor blunt trauma with suspected pleural effusion.

MRI Chest Without and With IV Contrast

There is no relevant literature to support the use of MRI chest without and with IV contrast in the initial imaging of recent minor blunt trauma with suspected pleural effusion.

MRI Chest Without IV Contrast

There is no relevant literature to support the use of MRI chest without IV contrast in the initial imaging of recent minor blunt trauma with suspected pleural effusion.

Radiography Chest

Chest radiography is considered a first-line imaging test for patients with chest trauma and a clinical indication for imaging [46]. In the prospective NEXUS Chest CT trial, blunt trauma patients without an abnormal chest radiograph and 6 clinical criteria could avoid an unnecessary chest CT (sensitivity 99.2%; 95% CI, 95.4%-100%, specificity 20.8%; 95% CI, 19.2%-22.4%) [47]. A meta-analysis of the pooled sensitivity and specificity of chest radiographs for the detection of hemothorax in patients with chest trauma was 54% (95% CI, 33%-75%) and 99% (95% CI, 94%-100%), respectively, when using chest CT as the reference standard [48]. A study of 24 patients using only PA radiographs found a similar sensitivity of 62.5% and specificity of 100% for the detection of pleural effusions in patients with chest trauma [49]. In 2 prospective series of patients with minor blunt thoracic trauma and an initial normal chest radiograph, 7.4% to 11.8% had a pleural effusion on follow-up radiography within 2 weeks, clinically ascribed as a delayed hemothorax [39,40]. A delayed hemothorax on chest radiographs after minor blunt thoracic trauma was significantly more likely in patients with at least 1 fracture between the third and ninth ribs [50].

US Chest

The sensitivity and specificity of chest US for only minor blunt trauma has not been reported. Identification of a hemothorax for possible US-guided thoracentesis is the primary reason for chest US [32]. A recent meta-analysis reported chest US had a 60% sensitivity (95% CI, 31%-86%) and a 98% specificity (95% CI, 94%-99%) for traumatic hemothorax [51].

Variant 3: Dyspnea, cough, or chest pain with suspected pleural effusion, noninfectious. Initial imaging.

CT Chest With IV Contrast

In patients with suspected malignant pleural effusion or suspected unilateral pleural effusion with an increased pretest probability of malignancy, CT chest with IV contrast is recommended [52,53], although this is not limited to patients with dyspnea, cough, or chest pain. Acquiring the CT scan 60 seconds after the contrast bolus improves visualization of pleural abnormalities associated with malignancy [19].

CT Chest Without and With IV Contrast

There is no relevant literature to support the use of CT chest without and with IV contrast in the initial imaging of dyspnea, cough, or chest pain with suspected noninfectious pleural effusion.

CT Chest Without IV Contrast

There is no relevant literature to support the use of CT chest without IV contrast in the initial imaging of dyspnea, cough, or chest pain with suspected noninfectious pleural effusion. Heart failure, liver failure, and renal failure are common noninfectious causes of pleural effusion, and these patients may present with dyspnea, cough, or chest pain and undergo CT chest without IV contrast as part of their diagnostic workup [54,55].

CTA Chest With IV Contrast

In patients with dyspnea, cough, or chest pain and suspected noninfectious pleural effusion, CTA chest with IV contrast is typically performed when there is clinical concern for pulmonary embolism [56] or aortopathy [57]. Pleural effusions in these patients are usually small and not associated with adverse clinical outcomes [57,58].

MRI Chest Without and With IV Contrast

There is no relevant literature to support the use of MRI chest without and with IV contrast in the initial imaging of dyspnea, cough, or chest pain with suspected noninfectious pleural effusion. Incidental pleural effusions have been reported in a minority of patients undergoing MRI with contrast for dyspnea, cough, or chest pain. For example, 6.6% (34/514) of patients had a moderate or large pleural effusion on contrast-enhanced MRA ordered for pulmonary embolism evaluation [59], and 4.3% (17/399) patients had a pleural effusion on stress cardiac MRI for possible acute coronary syndrome [60].

MRI Chest Without IV Contrast

There is no relevant literature to support the use of MRI chest without IV contrast in the initial imaging of dyspnea, cough, or chest pain with suspected noninfectious pleural effusion.

Radiography Chest

Consensus recommendations endorse chest radiography as the initial imaging modality for patients with suspected noninfectious pleural effusion [7,61]; however, there are limited empiric data to support these recommendations.

US Chest

Identification of a pleural effusion for possible US-guided thoracentesis is currently the primary reason for chest US [32]. Chest US is increasingly used as part of the diagnostic pathway for patients in the emergency department [62] and in the intensive care setting [63]. A recent meta-analysis found that chest US had a pooled sensitivity of 91% (95% CI, 83%-96%) and specificity of 92% (95% CI, 82%-97%) using CT as the reference standard for identification of pleural effusion in patients in the intensive care unit [63]. Adding chest US to the conventional diagnostic pathway has been shown to reduce the time to final diagnosis in the emergency department in patients with infectious and noninfectious causes of dyspnea [64].

Variant 4: Pleural effusion incidentally detected on incomplete thoracic imaging study. Next imaging study.

The frequency of an incidental pleural effusion detected on an incomplete thoracic imaging study including neck, spine, and abdomen varies based on the indication and type of imaging modality, in the range of 1% to 5% [65-71]. The clinical significance of these incidental pleural effusions is variable. In a retrospective study of patients undergoing run-off CTA, 4.2% (9/214) had an incidental pleural effusion, leading to the diagnosis of pneumonia in 22% (2/9) and optimization of heart failure therapy in 44% (4/9) [72]. However, in a study of 352 patients undergoing MRA of the abdomen, pelvis, and lower extremities, 2.9% had an incidental pleural effusion, and no patients required follow-up diagnostic testing or change in therapy.

CT Chest With IV Contrast

There is no relevant literature to support the use of CT chest with IV contrast as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up CT chest with IV contrast should be based on clinical assessment (eg, clinical suspicion of malignancy).

CT Chest Without and With IV Contrast

There is no relevant literature to support the use of CT chest without and with IV contrast as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up CT chest without and with IV contrast should be based on clinical assessment.

CT Chest Without IV Contrast

There is no relevant literature to support the use of CT chest without IV contrast as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up CT chest without IV contrast should be based on clinical assessment (eg, clinical suspicion of malignancy).

CTA Chest With IV Contrast

There is no relevant literature to support the use of CTA chest with IV contrast as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up CTA chest with IV contrast should be based on clinical assessment.

MRI Chest Without and With IV Contrast

There is no relevant literature to support the use of MRI chest without and with IV contrast as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up MRI chest without and with IV contrast should be based on clinical assessment.

MRI Chest Without IV Contrast

There is no relevant literature to support the use of MRI chest without IV contrast as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up MRI chest without IV contrast should be based on clinical assessment.

Radiography Chest

There is no relevant literature to support the use of chest radiography as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up chest radiograph should be based on clinical assessment (eg, clinical suspicion of malignancy).

US Chest

There is no relevant literature to support the use of US chest as the next imaging study following a pleural effusion incidentally detected on prior abdominal imaging. The recommendation for a follow-up US chest should be based on clinical assessment.

Summary of Recommendations

- **Variation 1:** Radiography chest or CT chest with IV contrast is usually appropriate for the initial imaging for patients with recent pneumonia with suspected parapneumonic effusion or empyema. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). If CT chest with IV contrast is performed, acquiring the CT scan 60 seconds after the IV contrast bolus optimizes visualization of the pleura. The panel did not agree on recommending US chest for patients with recent pneumonia with suspected parapneumonic effusion or empyema. There is insufficient medical literature to conclude whether or not these patients would benefit from this modality. Imaging in this patient population is controversial but may be appropriate.
- **Variation 2:** Radiography chest or CT chest with IV contrast is usually appropriate for the initial imaging for patients with recent minor blunt trauma with suspected pleural effusion. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending US chest or CTA chest with IV contrast for patients' with recent minor blunt trauma with suspected pleural effusion. There is insufficient medical literature to conclude whether or not these patients would benefit from these modalities. Imaging in this patient population is controversial but may be appropriate.
- **Variation 3:** Radiography chest or CT chest with IV contrast is usually appropriate for the initial imaging for patients with dyspnea, cough, or chest pain with suspected pleural effusion with suspected noninfectious pleural effusion. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). If CT chest with IV contrast is performed, acquiring the CT scan 60 seconds after the IV contrast bolus optimizes visualization of the pleura. The panel did not agree on recommending US chest for patients' with dyspnea, cough, or chest pain with suspected noninfectious pleural effusion. There is insufficient medical literature to conclude whether or not these patients would benefit from this modality. Imaging in this patient population is controversial but may be appropriate.
- **Variation 4:** The panel did not agree on recommending US chest, radiography chest or CT chest with IV contrast for patients' with pleural effusion incidentally detected on incomplete thoracic imaging study. There is insufficient medical literature to conclude whether or not these patients would benefit from these modalities. Imaging in this patient population is controversial but may be appropriate.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [73].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊕	<0.1 mSv	<0.03 mSv
⊕⊕	0.1-1 mSv	0.03-0.3 mSv
⊕⊕⊕	1-10 mSv	0.3-3 mSv
⊕⊕⊕⊕	10-30 mSv	3-10 mSv
⊕⊕⊕⊕⊕	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

References

1. Rahman NM, Chapman SJ, Davies RJ. Pleural effusion: a structured approach to care. *Br Med Bull* 2004;72:31-47.
2. Kruger D. Evaluating the adult with new-onset pleural effusion. *JAAPA* 2013;26:20-7.

3. Maskell NA, Butland RJ, Pleural Diseases Group SoCCBTS. BTS guidelines for the investigation of a unilateral pleural effusion in adults. *Thorax* 2003;58 Suppl 2:ii8-17.
4. Light RW, Macgregor MI, Luchsinger PC, Ball WC, Jr. Pleural effusions: the diagnostic separation of transudates and exudates. *Ann Intern Med* 1972;77:507-13.
5. Ferreiro L, Toubes ME, San Jose ME, Suarez-Antelo J, Golpe A, Valdes L. Advances in pleural effusion diagnostics. *Expert Rev Respir Med* 2020;14:51-66.
6. Light RW. Pleural effusions. *Med Clin North Am* 2011;95:1055-70.
7. Hooper C, Lee YC, Maskell N, Group BTSPG. Investigation of a unilateral pleural effusion in adults: British Thoracic Society Pleural Disease Guideline 2010. *Thorax* 2010;65 Suppl 2:ii4-17.
8. Shellenberger RA, Balakrishnan B, Avula S, Ebel A, Shaik S. Diagnostic value of the physical examination in patients with dyspnea. *Cleve Clin J Med* 2017;84:943-50.
9. Yalcin NG, Choong CK, Eizenberg N. Anatomy and pathophysiology of the pleura and pleural space. *Thorac Surg Clin* 2013;23:1-10, v.
10. Porcel JM. Chest imaging for the diagnosis of complicated parapneumonic effusions. *Curr Opin Pulm Med* 2018;24:398-402.
11. Moy MP, Levsky JM, Berko NS, Godelman A, Jain VR, Haramati LB. A new, simple method for estimating pleural effusion size on CT scans. *Chest* 2013;143:1054-59.
12. American College of Radiology. ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/body-cta.pdf>. Accessed September 29, 2023.
13. Shen KR, Bribriesco A, Crabtree T, et al. The American Association for Thoracic Surgery consensus guidelines for the management of empyema. *J Thorac Cardiovasc Surg* 2017;153:e129-e46.
14. Zettinig D, D'Antonoli TA, Wilder-Smith A, Bremerich J, Roth JA, Sexauer R. Diagnostic Accuracy of Imaging Findings in Pleural Empyema: Systematic Review and Meta-Analysis. *J Imaging* 2021;8.
15. Franklin J, Talwar A, Addala D, et al. CT appearances of pleural infection: analysis of the Second Multi-centre Intra-pleural Sepsis Trial (MIST 2) cohort. *Clin Radiol* 2021;76:436-42.
16. Porcel JM, Pardina M, Aleman C, Pallisa E, Light RW, Bielsa S. Computed tomography scoring system for discriminating between parapneumonic effusions eventually drained and those cured only with antibiotics. *Respirology* 2017;22:1199-204.
17. Tsujimoto N, Saraya T, Light RW, et al. A Simple Method for Differentiating Complicated Parapneumonic Effusion/Empyema from Parapneumonic Effusion Using the Split Pleura Sign and the Amount of Pleural Effusion on Thoracic CT. *PLoS One* 2015;10:e0130141.
18. Moffett BK, Panchabhai TS, Anaya E, et al. Computed tomography measurements of parapneumonic effusion indicative of thoracentesis. *Eur Respir J* 2011;38:1406-11.
19. Raj V, Kirke R, Bankart MJ, Entwisle JJ. Multidetector CT imaging of pleura: comparison of two contrast infusion protocols. *Br J Radiol* 2011;84:796-9.
20. Reza A, Kalia P, Gandy N, Chana H. Arterial versus pleural phase CT chest: an assessment of image quality and radiation dose. *Clin Radiol* 2020;75:E8.
21. Spoto S, Ciccozzi M, Angeletti S. A rare case of subcutaneous abscess with intercostal muscles involvement by pleural tuberculosis in a Malagasy young traveller. *J Travel Med* 2017;24.
22. Sodhi KS, Bhatia A, Nichat V, et al. Chest MRI as an emerging modality in the evaluation of empyema in children with specific indications: Pilot study. *Pediatr Pulmonol* 2021;56:2668-75.
23. Konietzke P, Mueller J, Wuennemann F, et al. The value of chest magnetic resonance imaging compared to chest radiographs with and without additional lung ultrasound in children with complicated pneumonia. *PLoS One* 2020;15:e0230252.
24. Stein R, Manson D. Magnetic resonance imaging findings of empyema necessitatis in a child with a group A streptococcus infection. *J Thorac Imaging* 2012;27:W13-4.
25. Inan N, Arslan A, Akansel G, Arslan Z, Elemen L, Demirci A. Diffusion-weighted MRI in the characterization of pleural effusions. *Diagn Interv Radiol* 2009;15:13-8.
26. Rosmini S, Seraphim A, Knott K, et al. Non-invasive characterization of pleural and pericardial effusions using T1 mapping by magnetic resonance imaging. *Eur Heart J Cardiovasc Imaging* 2022;23:1117-26.
27. Metlay JP, Kapoor WN, Fine MJ. Does this patient have community-acquired pneumonia? Diagnosing pneumonia by history and physical examination. *JAMA* 1997;278:1440-5.

28. Mandell LA, Wunderink RG, Anzueto A, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis* 2007;44 Suppl 2:S27-72.
29. Moffett BK, Panchabhai TS, Nakamatsu R, et al. Comparing posteroanterior with lateral and anteroposterior chest radiography in the initial detection of parapneumonic effusions. *Am J Emerg Med* 2016;34:2402-07.
30. Brixey AG, Luo Y, Skouras V, Awdankiewicz A, Light RW. The efficacy of chest radiographs in detecting parapneumonic effusions. *Respirology* 2011;16:1000-4.
31. Svigals PZ, Chopra A, Ravenel JG, Nietert PJ, Huggins JT. The accuracy of pleural ultrasonography in diagnosing complicated parapneumonic pleural effusions. *Thorax* 2017;72:94-95.
32. Laursen CB, Clive A, Hallifax R, et al. European Respiratory Society statement on thoracic ultrasound. *Eur Respir J* 2021;57.
33. Chen KY, Liaw YS, Wang HC, Luh KT, Yang PC. Sonographic septation: a useful prognostic indicator of acute thoracic empyema. *J Ultrasound Med* 2000;19:837-43.
34. Chen CH, Chen W, Chen HJ, et al. Transthoracic ultrasonography in predicting the outcome of small-bore catheter drainage in empyemas or complicated parapneumonic effusions. *Ultrasound Med Biol* 2009;35:1468-74.
35. James CA, Braswell LE, Pezeshkmehr AH, Roberson PK, Parks JA, Moore MB. Stratifying fibrinolytic dosing in pediatric parapneumonic effusion based on ultrasound grade correlation. *Pediatr Radiol* 2017;47:89-95.
36. Maffey A, Colom A, Venialgo C, et al. Clinical, functional, and radiological outcome in children with pleural empyema. *Pediatr Pulmonol* 2019;54:525-30.
37. Lin FC, Chou CW, Chang SC. Usefulness of the suspended microbubble sign in differentiating empyemic and nonempyemic hydropneumothorax. *J Ultrasound Med* 2001;20:1341-5.
38. Kurian J, Levin TL, Han BK, Taragin BH, Weinstein S. Comparison of ultrasound and CT in the evaluation of pneumonia complicated by parapneumonic effusion in children. *AJR Am J Roentgenol* 2009;193:1648-54.
39. Misthos P, Kakaris S, Sepsas E, Athanassiadi K, Skottis I. A prospective analysis of occult pneumothorax, delayed pneumothorax and delayed hemothorax after minor blunt thoracic trauma. *Eur J Cardiothorac Surg* 2004;25:859-64.
40. Plourde M, Emond M, Lavoie A, et al. Cohort study on the prevalence and risk factors for delayed pulmonary complications in adults following minor blunt thoracic trauma. *CJEM* 2014;16:136-43.
41. Shyu JY, Khurana B, Soto JA, et al. ACR Appropriateness Criteria® Major Blunt Trauma. *J Am Coll Radiol* 2020;17:S160-S74.
42. Langdorf MI, Medak AJ, Hendey GW, et al. Prevalence and Clinical Import of Thoracic Injury Identified by Chest Computed Tomography but Not Chest Radiography in Blunt Trauma: Multicenter Prospective Cohort Study. *Ann Emerg Med* 2015;66:589-600.
43. Kroczek EK, Wieners G, Steffen I, et al. Non-traumatic incidental findings in patients undergoing whole-body computed tomography at initial emergency admission. *Emerg Med J* 2017;34:643-46.
44. Rodriguez RM, Canseco K, Baumann BM, et al. Pneumothorax and Hemothorax in the Era of Frequent Chest Computed Tomography for the Evaluation of Adult Patients With Blunt Trauma. *Ann Emerg Med* 2019;73:58-65.
45. Liu F, Huang YC, Ng Y-B, Liang JH. Differentiate pleural effusion from hemothorax after blunt chest trauma; comparison of computed tomography attenuation values. *Journal of Acute Medicine* 2016;6:1-6.
46. Rodriguez RM, Hendey GW, Mower W, et al. Derivation of a decision instrument for selective chest radiography in blunt trauma. *J Trauma* 2011;71:549-53.
47. Rodriguez RM, Langdorf MI, Nishijima D, et al. Derivation and validation of two decision instruments for selective chest CT in blunt trauma: a multicenter prospective observational study (NEXUS Chest CT). *PLoS Med* 2015;12:e1001883.
48. Rahimi-Movaghar V, Yousefifard M, Ghelichkhani P, et al. Application of Ultrasonography and Radiography in Detection of Hemothorax; a Systematic Review and Meta-Analysis. *Emerg (Tehran)* 2016;4:116-26.
49. Tataroglu O, Erdogan ST, Erdogan MO, et al. Diagnostic Accuracy of Initial Chest X-Rays in Thorax Trauma. *J Coll Physicians Surg Pak* 2018;28:546-48.
50. Emond M, Guimont C, Chauny JM, et al. Clinical prediction rule for delayed hemothorax after minor thoracic injury: a multicentre derivation and validation study. *CMAJ Open* 2017;5:E444-E53.
51. Staub LJ, Biscaro RRM, Kaszubowski E, Maurici R. Chest ultrasonography for the emergency diagnosis of traumatic pneumothorax and haemothorax: A systematic review and meta-analysis. *Injury* 2018;49:457-66.

52. Reuter S, Lindgaard D, Laursen C, Fischer BM, Clementsen PF, Bodtger U. Computed tomography of the chest in unilateral pleural effusions: outcome of the British Thoracic Society guideline. *J Thorac Dis* 2019;11:1336-46.
53. Traill ZC, Davies RJ, Gleeson FV. Thoracic computed tomography in patients with suspected malignant pleural effusions. *Clin Radiol* 2001;56:193-6.
54. Korczynski P, Gorska K, Konopka D, Al-Haj D, Filipiak KJ, Krenke R. Significance of congestive heart failure as a cause of pleural effusion: Pilot data from a large multidisciplinary teaching hospital. *Cardiol J* 2020;27:254-61.
55. Walker SP, Morley AJ, Staddon L, et al. Nonmalignant Pleural Effusions: A Prospective Study of 356 Consecutive Unselected Patients. *Chest* 2017;151:1099-105.
56. Liu M, Cui A, Zhai ZG, et al. Incidence of pleural effusion in patients with pulmonary embolism. *Chin Med J (Engl)* 2015;128:1032-6.
57. Yamada Y, Tanno J, Nakano S, Kasai T, Senbonmatsu T, Nishimura S. Clinical implications of pleural effusion in patients with acute type B aortic dissection. *Eur Heart J Acute Cardiovasc Care* 2016;5:72-81.
58. Porcel JM, Madronero AB, Pardina M, Vives M, Esquerda A, Light RW. Analysis of pleural effusions in acute pulmonary embolism: radiological and pleural fluid data from 230 patients. *Respirology* 2007;12:234-9.
59. Schiebler ML, Ahuja J, Reppinger MD, et al. Incidence of actionable findings on contrast enhanced magnetic resonance angiography ordered for pulmonary embolism evaluation. *Eur J Radiol* 2016;85:1383-9.
60. Ziegler CE, Painter DM, Borawski JB, Kim RJ, Kim HW, Limkakeng AT, Jr. Unexpected Cardiac MRI Findings in Patients Presenting to the Emergency Department for Possible Acute Coronary Syndrome. *Crit Pathw Cardiol* 2018;17:167-71.
61. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *Eur Heart J* 2021;42:3599-726.
62. Gallard E, Redonnet JP, Bourcier JE, et al. Diagnostic performance of cardiopulmonary ultrasound performed by the emergency physician in the management of acute dyspnea. *Am J Emerg Med* 2015;33:352-8.
63. Hansell L, Milross M, Delaney A, Tian DH, Ntoumenopoulos G. Lung ultrasound has greater accuracy than conventional respiratory assessment tools for the diagnosis of pleural effusion, lung consolidation and collapse: a systematic review. *J Physiother* 2021;67:41-48.
64. Zanobetti M, Scorpiniti M, Gigli C, et al. Point-of-Care Ultrasonography for Evaluation of Acute Dyspnea in the ED. *Chest* 2017;151:1295-301.
65. Belloni E, Tentoni S, Fiorina I, et al. Reported and Unreported Potentially Important Incidental Findings in Urgent Nonenhanced Abdominal CT for Renal Colic. *Med Princ Pract* 2021;30:355-60.
66. Kaplan EÇ, E. Incidental thorax imaging findings in abdominal computed tomography: Results of a tertiary center. *J Surg Med* 2021;5:500-03.
67. Sohns JM, Menke J, Bergau L, et al. Extra-vascular findings in patients undergoing magnetic resonance angiography of the abdomen, pelvis and lower extremities: A retrospective study of 352 patients. *Vascular* 2018;26:27-38.
68. Glockner JF. Incidental findings on renal MR angiography. *AJR Am J Roentgenol* 2007;189:693-700.
69. Sohns JM, Staab W, Dabir D, et al. Current role and future potential of magnetic resonance cholangiopancreatography with an emphasis on incidental findings. *Clin Imaging* 2014;38:35-41.
70. Zidan MMA, Hassan IA, Elnour AM, et al. Incidental Extraplural Findings in the Thoracic Spine during Magnetic Resonance Imaging of Intervertebral Discs. *J Clin Imaging Sci* 2019;9:37.
71. Chen G, Xue Y, Wei J, Duan Q. The undiagnosed potential clinically significant incidental findings of neck CTA: A large retrospective single-center study. *Medicine (Baltimore)* 2020;99:e22440.
72. Preuss A, Schaafs LA, Werncke T, Steffen IG, Hamm B, Elgeti T. Run-Off Computed Tomography Angiography (CTA) for Discriminating the Underlying Causes of Intermittent Claudication. *PLoS One* 2016;11:e0152780.
73. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed September 29, 2023.

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.