

**American College of Radiology  
ACR Appropriateness Criteria®  
Acute Left Upper Quadrant Pain**

**Variant: 1 Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**

| Procedure  | Appropriateness Category | Relative Radiation Level |
|--|--------------------------|--------------------------|
| US abdomen   | Usually Appropriate      | ○                        |
| CT abdomen and pelvis with IV contrast             | Usually Appropriate      | ⦿⦿⦿                      |
| MRI abdomen without and with IV contrast           | May Be Appropriate       | ○                        |
| MRI abdomen without IV contrast                    | May Be Appropriate       | ○                        |
| CT abdomen and pelvis without IV contrast          | May Be Appropriate       | ⦿⦿⦿                      |
| Radiography abdomen                                | Usually Not Appropriate  | ⦿⦿                       |
| CT abdomen and pelvis without and with IV contrast | Usually Not Appropriate  | ⦿⦿⦿⦿⦿                    |
| FDG-PET/CT skull base to mid-thigh                 | Usually Not Appropriate  | ⦿⦿⦿⦿⦿                    |

**Variant: 2 Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

| Procedure  | Appropriateness Category | Relative Radiation Level |
|--|--------------------------|--------------------------|
| CT abdomen and pelvis with IV contrast             | Usually Appropriate      | ⦿⦿⦿                      |
| US abdomen   | May Be Appropriate       | ○                        |
| MRI abdomen without and with IV contrast           | May Be Appropriate       | ○                        |
| MRI abdomen without IV contrast                    | May Be Appropriate       | ○                        |
| CT abdomen and pelvis without IV contrast          | May Be Appropriate       | ⦿⦿⦿                      |
| Radiography abdomen                                | Usually Not Appropriate  | ⦿⦿                       |
| CT abdomen and pelvis without and with IV contrast | Usually Not Appropriate  | ⦿⦿⦿⦿⦿                    |
| FDG-PET/CT skull base to mid-thigh                 | Usually Not Appropriate  | ⦿⦿⦿⦿⦿                    |

**Variant: 3 Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

| Procedure  | Appropriateness Category | Relative Radiation Level |
|--|--------------------------|--------------------------|
| CT abdomen and pelvis with IV contrast             | Usually Appropriate      | ⦿⦿⦿                      |
| US abdomen   | May Be Appropriate       | ○                        |
| MRI abdomen without and with IV contrast           | May Be Appropriate       | ○                        |
| CT abdomen and pelvis without IV contrast          | May Be Appropriate       | ⦿⦿⦿                      |
| Radiography abdomen                                | Usually Not Appropriate  | ⦿⦿                       |
| MRI abdomen without IV contrast                    | Usually Not Appropriate  | ○                        |
| CT abdomen and pelvis without and with IV contrast | Usually Not Appropriate  | ⦿⦿⦿⦿⦿                    |
| FDG-PET/CT skull base to mid-thigh                 | Usually Not Appropriate  | ⦿⦿⦿⦿⦿                    |

**Panel Members**

Ihab R. Kamel, MD, PhD<sup>a</sup>, Sahar Soleimani, MD, PhD<sup>b</sup>, Kevin J. Chang, MD<sup>c</sup>, Twyla B. Bartel, DO, MBA<sup>d</sup>, Priya R. Bhosale, MD<sup>e</sup>, Brooks D. Cash, MD<sup>f</sup>, Victoria Chernyak, MD, MS<sup>g</sup>, Robin A. Felker, MD<sup>h</sup>, Ayushi Gupta, MD<sup>i</sup>, Hao S. Lo, MD, MBA<sup>j</sup>, Michael Magnetta, MD<sup>k</sup>, Richard D. Shih, MD<sup>l</sup>, Joseph H. Yacoub, MD<sup>m</sup>, Kathryn J. Fowler, MD<sup>n</sup>

## Summary of Literature Review

### Introduction/Background

Acute abdominal pain is one of the most common chief complaints encountered in the emergency department and outpatient setting [1]. Physical examination plays a key role in determining the urgency of the problem and the subsequent diagnostic plan. Across all sites, the left upper quadrant (LUQ) is the least common location for abdominal pain with <5% of patients localizing their pain specifically to the LUQ [2], with reportedly the lowest physical examination interrater agreement among attendings and trainees [3,4]. The limited sensitivity of physical examination combined with an uncommon and nonspecific clinical presentation makes assessment of LUQ pain challenging. Delays in diagnosis and complications in management lead to more adverse outcomes, especially in the elderly, who are often unable to provide reliable histories and suffer from many comorbidities [5].

Anatomically, the LUQ contains the spleen, stomach, bowel, pancreas, left lobe of the liver, left kidney, and left adrenal gland. LUQ pain in a significant majority of patients is a referred pain, most commonly from peptic ulcer disease, gastritis, esophagitis, pancreatitis, renal colic, cardiac angina, or pericarditis [6-8]. Less commonly, pleuritic pain such as in pneumonia or osseous pain such as in spinal stress fractures or metastases may present as referred LUQ. These topics have been addressed with dedicated references to each topic such as the ACR Appropriateness Criteria topics on "[Epigastric Pain](#)" [9], "[Acute Pancreatitis](#)" [10], "[Acute Onset Flank Pain-Suspicion of Stone Disease \(Urolithiasis\)](#)" [11], "[Acute Pyelonephritis](#)" [12], "[Acute Nonspecific Chest Pain-Low Probability of Coronary Artery Disease](#)" [13], "[Acute Respiratory Illness in Immunocompetent Patients](#)" [14], "[Thoracic Back Pain](#)" [15], and "[Acute Nonlocalized Abdominal Pain](#)" [16].

This document aims to address clinical scenarios in which reported acute LUQ pain is not suspected to arise from the above-mentioned etiologies and is uniquely arising from the LUQ. In this setting, suspected or known splenomegaly from underlying hematologic disorders, malignancy, liver disease, or viral illness may present with LUQ pain without any specific physical examination findings or laboratory marker abnormalities. Splenomegaly increases the risk of splenic infarction, rupture, torsion, aneurysmal rupture, or venous thrombosis [8,17,18]. The presence of fever in addition to LUQ pain often requires urgent diagnostic workup because fever raises concern for intraabdominal infection, abscess, or hematologic malignancy.

This document provides a framework for initial imaging evaluation of patients with acute LUQ pain in the setting of known or suspected splenomegaly, acute LUQ pain with fever, and acute LUQ pain not otherwise specified. The rating and recommendations for this document specifically relate to adult nonpregnant patients unless otherwise stated. Contraindications, availability, and cost are not considered in the appropriateness assessment.

### 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

- 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: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**

Past medical history or physical examination may raise concern for splenomegaly with or without the presence of pain. Common causes of splenomegaly include infections such as mononucleosis (in the setting of Epstein Barr virus), granulomatous infections, portal hypertension, sickle cell disease, lymphoproliferative disorders, sarcoidosis, or metastasis. Splenomegaly with capsular expansion can cause pain and increases the risk of splenic rupture, infarction, hematoma, microabscesses, and susceptibility to trauma [17-19]. In sickle cell disease, acute LUQ pain with a sudden drop in hematocrit suggests splenic sequestration, which increases the risk of shock and death [20,21]. Vascular complications such as venous thrombosis or arterial pseudoaneurysm may present with pain and are usually a harbinger of serious underlying conditions. Pancreatitis, pancreatic cancer, inflammatory bowel disease, other inflammatory processes, or hypercoagulopathic states may lead to splenic venous thrombosis. Splenic artery ruptured aneurysm or pseudoaneurysm can present with LUQ pain, although these lesions are increasingly found incidentally at the present time [22].

### **Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**

#### **A. CT abdomen and pelvis with IV contrast**

CT is the workhorse of diagnostic abdominal imaging and the preferred choice in a broad range of clinical presentations, including acute abdominal pain [23-25]. CT abdomen and pelvis can be performed with intravenous (IV) and/or oral contrast administration, commonly acquired during a single venous phase. IV contrast improves visualization of small structures, enhances delineation of normal from abnormal visceral parenchyma, and better depicts the gastrointestinal wall lining [26,27]. High-density positive oral contrast is used for evaluation of a potential leak, fistula, or differentiation of small bowel loops from lymph nodes or peritoneal implants. In the acute setting, oral contrast may lead to a delay in throughput and scan acquisition without a definite diagnostic value. Positive oral contrast may also obscure gastrointestinal lining or intraluminal masses, or create pseudotumors in the stomach [28,29]. High-volume low-density neutral contrast, such as water, improves gastrointestinal luminal evaluation without the above-mentioned problems.

In a retrospective study of LUQ pain in the emergency department, CT was reported to have a 69% sensitivity to detect an acute abdominal abnormality [25]. Of those patients with an abnormality detected, 27% had an acute abnormal CT finding that represented the cause of their pain. Of the remaining patients, 12% were diagnosed clinically with a pathology that was undetectable on imaging. The remaining patients with negative CT were not found to have a significant pathology by clinical evaluation. The authors concluded that CT is a useful tool for patients with LUQ pain in the emergency setting with moderate sensitivity and excellent specificity [25].

CT is highly sensitive for the detection of splenic infarction and its underlying cause. Retrospective studies demonstrated the superiority of CT with IV contrast over other modalities in splenic infarct from microvascular involvement such as in sickle cell disease, thromboembolic causes in endocarditis or cardiac thrombus, and global infarction from advanced pancreatic cancer, splenic torsion, or vascular intervention [17,30].

CT is also an excellent tool for the visualization and volumetric quantification of the spleen. Splenomegaly detected and monitored by CT can be a marker of disease progression in hematologic disorders and impact management [31-33]. The pattern of splenic enhancement as well as the presence of abnormal vascularity and collateralization on CT with IV contrast can aid in the diagnosis of cirrhotic and noncirrhotic portal hypertension, associated splenomegaly, gastropathy, or variceal bleeding [26,27]. CT is also well suited to the evaluation of infiltrative processes such as lymphoma or sarcoidosis, which may present with splenomegaly, a solitary splenic mass, or micronodular or macronodular splenic infiltration [34].

This superior anatomical delineation of CT makes it a valuable tool in detecting complications such as the development of infection, fluid collections, and pseudoaneurysms and impacts their management with CT-guided interventions [35,36].

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**B. CT abdomen and pelvis without and with IV contrast**

The addition of noncontrast CT to routine CT with IV contrast is helpful in the differentiation of calcifications and surgical material from contrast enhancement. However, in the setting of acute LUQ pain, the additional noncontrast examination is of limited diagnostic value and comes with a longer examination time.

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**C. CT abdomen and pelvis without IV contrast**

The absence of IV contrast limits the evaluation of vasculature and diminishes the conspicuity of small structures and the gastrointestinal lining. More specifically, splenic infarcts and small lesions may appear isodense to normal splenic parenchyma on noncontrast CT. However, splenomegaly, lymphadenopathy, hematoma, and fluid collections can be characterized on noncontrast CT, and therefore, it may still be useful in the workup of LUQ pain.

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**D. FDG-PET/CT skull base to mid-thigh**

Fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT has been used in the workup of splenomegaly, fever, lymphadenopathy, immunocompromised patients who may suffer from lymphoma, fungal infection, and other miscellaneous infections and malignancies. However, this modality does not provide adequate information to enable differentiation of these diagnoses, and it is primarily used to find an appropriate target for tissue biopsy [37]. There is no literature on the usefulness of PET/CT as an initial imaging modality in the acute setting.

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**E. MRI abdomen without and with IV contrast**

Although there are limited studies on the usefulness of MRI specifically for LUQ pain, rapid MRI studies have been introduced and optimized for the evaluation of acute abdominal and pelvic pain. In a systematic review paper of 33 studies in 2,044 patients, MRI achieved a 96% sensitivity

and 93% specificity for the diagnosis of appendicitis and its complications [38]. In a study of abbreviated rapid MRI without IV contrast in acute abdominal pain in 468 patients, MRI achieved an overall diagnostic accuracy of 99% [39]. In a subgroup of patients who underwent surgery or endoscopy (n = 90), the sensitivity was 98% and the specificity was 92%. The most common etiologies were appendicitis, bowel obstruction, intussusception, inflammatory bowel disease, diverticulitis, abscess, ovarian torsion, and pelvic inflammatory disease [39]. MRI can be a useful tool in pregnant patients and children. In addition, MRI has been well studied and concluded to be a useful tool for evaluation of splenic size, mass, micronodularity, and infiltrative process [40,41]. Splenic hematoma, infarct, and perisplenic collections can also be evaluated by MRI.

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**F. MRI abdomen without IV contrast**

There are no large, published studies that investigate the value of contrast administration and compared with MRI without IV contrast in the workup of acute LUQ pain with suspected splenomegaly. However, the addition of IV contrast can improve the evaluation of the splenic parenchyma, masses, infarcts, and the vasculature, and therefore, it is recommended to be considered for the initial workup.

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**G. Radiography abdomen**

Radiographs achieve a sensitivity of 90% for identifying foreign bodies and a moderate sensitivity of 49% for detecting bowel obstruction [42]. Radiography has historically been used in the evaluation of splenomegaly [43]; however, low-dose CT demonstrates superior diagnostic accuracy in comparison. It is now concluded that there is a limited role for radiography in the assessment of acute LUQ pain and splenomegaly.

**Variant 1: Adult. Acute left upper quadrant pain. Suspected splenomegaly. Initial imaging.**  
**H. US abdomen**

Ultrasound (US) has a lower diagnostic accuracy compared with cross-sectional modalities such as CT and MRI. A retrospective study reported an US sensitivity of 18% in the detection of splenic infarcts that were diagnosed by CT over a 10-year period at a single center [30]. Similarly, US has inferior sensitivity in the detection of splenic lesions and infiltrative processes. However, it can be useful in screening and assessing splenic size and perisplenic collections and enables serial imaging to monitor for complications. Two decades ago, patients with sickle cell disease were expected to have autosplenectomy by age 5, which is now a rare observation, primarily due to advances in supportive care and transfusion therapy. US provides an excellent noninvasive tool for accurate assessment of spleen size as well as evaluation of echogenicity and heterogeneity, which varies with disease severity [44,45]. US has also been reported in the evaluation of splenomegaly and guidance for safe return to contact sports after infectious mononucleosis [46,47].

Color and spectral Doppler US can aid in the evaluation of vasculature. Portal flow parameters and the splenic artery resistive index provide useful tools in differentiating between splenomegaly of portal hypertension or hematologic origins [48]. US can also aid in the evaluation of portal and splenic vein thrombosis, which is a common cause of portal hypertension and splenomegaly, with a high morbidity from gastrointestinal bleeding [49,50]. Therefore, US provides an appropriate tool for initial imaging of the LUQ in the emergency, inpatient, or outpatient settings. In this document, US refers to formal sonographic examination. Comparison with Focused Assessment with Sonography in Trauma examination or point-of-care US is beyond the scope of this document and

will be investigated and addressed in future publications by the ACR.

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

Localized LUQ pain and fever raise concern for an infectious process with possible abscess, especially with a known systemic infection, malignancy, immunocompromised state, recent surgery, or significant trauma. Infection in the LUQ may involve superinfection of a splenic lesion or hematoma or be the result of hematogenous spread from a systemic infection such as endocarditis or direct extension from subjacent infection such as pancreatitis or diverticulitis [8]. Timely diagnosis of an abscess is critical for source control and to avoid rupture and peritonitis.

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**A. CT abdomen and pelvis with IV contrast**

CT provides a rapid and high-resolution cross-sectional imaging tool for the evaluation of acute abdominal pain and fever [23-25]. Administration of IV contrast increases the diagnostic yield through the better characterization of visceral parenchyma, intraorgan abscesses, and intraperitoneal or retroperitoneal fluid collections. IV contrast improves visualization of the gastrointestinal tract and the presence of inflammatory, infectious, or ischemic colitis, which may present with LUQ pain [8]. Positive oral contrast can assist in the evaluation of potential leak and fistula, but it introduces logistical challenges including prolonged scan time without a significant diagnostic yield in the setting of intra-abdominal infection. CT was reported to have a 69% sensitivity to detect an acute abnormality in a retrospective study of patients with LUQ pain presenting in the emergency department [25]. CT achieved an excellent specificity, with only 12% of patients with negative CT diagnosed clinically with a pathology that was undetectable on imaging. The remaining patients with negative CT also had an unremarkable clinical evaluation [25]. Although there is no study in the current literature assessing the diagnostic accuracy of CT specifically in acute LUQ pain and fever, there is sufficient evidence on the usefulness of CT with IV contrast to properly diagnose and guide the workup of acute abdominal pain and fever. In a retrospective study of 584 patients, emergency department clinicians were surveyed before and after a CT of the abdomen [51]. CT altered the leading diagnosis in 49% of patients, increased mean physician diagnostic certainty ranging from 70% to 92%, and led to changes in management in 42% of patients. Among etiologies associated with fever and infection, including abscess, diverticulitis, colitis, cholecystitis, cholangitis, and appendicitis, CT increased diagnostic certainty in >30% of cases [51]. CT also provides a safe modality for diagnosis and percutaneous drainage of abscesses. Specifically for splenic abscesses, CT-guided drainage has shown to be an effective alternative to splenectomy in select cases to preserve immunity [36].

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**B. CT abdomen and pelvis without and with IV contrast**

In select postoperative patients with ambiguity about surgical history or concern for retained surgical material, noncontrast CT may assist in the differentiation of foreign bodies from abnormal enhancement. However, in the setting of acute LUQ pain and fever, the addition of noncontrast CT to routine CT with IV contrast does not increase the diagnostic yield or add information.

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**C. CT abdomen and pelvis without IV contrast**

Although CT with IV contrast is superior, most notably for the assessment of vasculature and gastrointestinal lining in colitis and gastroenteritis, CT without IV contrast can be used as a substitute for evaluation of fluid collections and abscesses as a potential source for fever. In

patients at increased risk of microabscesses such as in immunocompromised patients, IV contrast is more sensitive for the detection of numerous small lesions in the spleen and should be considered as the initial imaging modality [8].

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**D. FDG-PET/CT skull base to mid-thigh**

FDG-PET/CT with large anatomical coverage and high sensitivity to inflammatory, infectious, and neoplastic etiologies is useful in the workup of fever of unknown origin, especially if prior cross-sectional imaging did not identify a source [37]. However, there is no current literature to support the use of this modality for the initial workup of LUQ pain and fever.

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**E. MRI abdomen without and with IV contrast**

MRI has been used for the evaluation of acute pain and specifically for the detection of abdominopelvic abscesses [39,52]. Rapid protocols with T2 and diffusion-weighted imaging sequences without IV contrast have been optimized and validated with an overall diagnostic accuracy of 99% in a range of etiologies including enterocolitis, pyelonephritis, appendicitis, diverticulitis, and associated abscess [39]. MRI also allows for the differentiation of an abscess from other fluid collections such as hematomas or postoperative collections. More advanced protocols such as MR enterography can be considered in patients with suspected inflammatory bowel disease, which preferably should be performed with IV contrast to increase the sensitivity for detection of mild inflammatory changes, fistula tracts, and small abscesses [53]. However, these examinations require a bowel preparation and advanced planning, potentially leading to delays in the emergency setting. Additionally, MRI requires patient cooperation and the ability to perform repeated breath-holds and lie flat for an extended period, which may not be a realistic goal for critically ill patients, resulting in incomplete examinations.

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**F. MRI abdomen without IV contrast**

MRI without IV contrast allows for the detection of inflammatory changes, abscesses, and lymphadenopathy and provides adequate anatomical information [39,52,53]. However, IV contrast enhances the visualization and detection of mild inflammation, fistula tracts, and masses, as well as evaluation of vasculature and potential complications such as pseudoaneurysms or venous thrombus. Although diffusion-weighted imaging sequences may be adequate for evaluation of abscesses in patients with LUQ pain and fever, they are highly susceptible to artifacts, most notably in the presence of metallic implants or foreign bodies. Addition of IV contrast can address these instances and it is recommended to be included.

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**G. Radiography abdomen**

The current literature does not include any recent studies on the use of radiography in the evaluation of LUQ pain and fever or its role in detection of the underlying cause. If there is concern for foreign body or surgical material causing fever and pain, radiography can be considered, because it has been shown to achieve a sensitivity of 90% in the detection of intraabdominal foreign bodies [42].

**Variant 2: Adult. Acute left upper quadrant pain. Fever. Initial imaging.**

**H. US abdomen**

US provides a fast tool for the visualization of anatomic landmarks in the LUQ such as the spleen,

pancreatic tail, or left kidney and evaluation of vasculature, with the assistance of color and spectral Doppler US. It also allows for the detection of intrasplenic lesions, perisplenic collections, and ascites. However, US sensitivity drops at earlier stages of disease and performs inferiorly compared with CT. In a retrospective study of 240 patients with colonic diverticulitis, the sensitivity of US for diagnosing complicated diverticulitis in comparison with CT as the reference standard was 84%, with a specificity of 95.8% [54]. Similarly, in a study of 85 patients with suspected intraabdominal sepsis after abdominal surgery, the likelihood ratio of a positive test was 1.33 for US and 2.53 for CT [55]. Corresponding posttest probabilities were 0.57 for US and 0.71 for CT. The likelihood ratio of a negative result was 0.6 for US and 0.18 for CT. Corresponding posttest probabilities were 0.37 for US and 0.15 for CT. The authors concluded that because of the low discriminatory power, US should not be performed as an initial test in the detection of intraabdominal infections [55]. Nonetheless, US can be a useful modality for targeted interventions and drainage of associated abscesses following initial diagnosis.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

Localized LUQ pain in the absence of splenomegaly or fever has a broad differential including peptic ulcer disease, gastric outlet obstruction, pancreatitis and its complications, infectious or ischemic enterocolitis, diverticulitis, bowel obstruction, adrenal hemorrhage, renal etiologies, neoplasm, hernias, postoperative complications, and pulmonary etiologies such as pneumonia or pericarditis. In the absence of ancillary findings to suggest a specific diagnosis, many of which are individually addressed by other ACR Appropriateness Criteria<sup>®</sup> as noted in the introduction of this document, the initial imaging study needs to be broad. CT is often the modality of choice and the first to be performed.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**  
**A. CT abdomen and pelvis with IV contrast**

The workhorse of abdominal imaging, CT abdomen and pelvis, is the preferred choice for the evaluation of abdominal pain in the presence or absence of other ancillary symptoms [16]. It is rapid, and it provides a large field of view with adequate anatomical coverage and high spatial resolution. IV contrast increases soft tissue contrast and allows for the evaluation of vasculature or acute bleeding in suspect cases. Positive oral contrast is beneficial in the evaluation for suspected leaks, fistulas, and postoperative complications; however, it is not routinely required. It may create the appearance of pseudotumors in the stomach or cause streak artifacts in the bowel [28,29]. Neutral oral contrast, such as water, allows for better distention and evaluation of stomach and bowel lumen, without significant delay in throughput.

In a retrospective study of 1,280 patients by 245 physicians, CT led to a change in the leading diagnosis in 51% of patients with abdominal pain, 42% of patients with chest pain and/or dyspnea, and 24% of patients with headache [24]. Pre-CT diagnostic confidence was inversely associated with the likelihood of a diagnostic change. CT helped confirm or exclude >95% of alternative diagnoses and led to changes in admission decisions for 25% of patients with abdominal pain [24]. This unparalleled impact on the confirmation of a final diagnosis, alleviation of uncertainty, and selection of appropriate clinical management has led to a robust and growing use of CT in the emergency and outpatient setting. Although there are limited studies on nonspecific LUQ pain, there is evidence that CT will outperform other modalities and should be considered as the initial imaging modality. In a study of 100 patients who presented to the emergency department with acute LUQ pain, the sensitivity of CT was 69% for 39 patients who were eventually diagnosed with an acute abdominal abnormality [25]. Of these, 27 patients had an abnormal finding that was



detected on CT. Of the remaining patients with negative CT, 12 patients were diagnosed clinically without detectable image findings. The remaining patients with negative CT were not found to have a significant pathology by clinical evaluation. It is concluded that CT is a useful tool for patients with LUQ pain in the emergency setting with moderate sensitivity and excellent specificity.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

**B. CT abdomen and pelvis without and with IV contrast**

In select patients with a complex past surgical history and no prior in-house imaging, the addition of a noncontrast CT may reduce ambiguity about surgical material versus abnormal enhancement. However, noncontrast CT does not significantly increase the diagnostic yield in nearly all other patients presenting with nonspecific LUQ pain, and therefore it is not useful on a routine basis.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

**C. CT abdomen and pelvis without IV contrast**

Hematoma, fluid collections, ascites, bowel obstruction, lymphadenopathy, hepatosplenomegaly, and renal stones are common etiologies that do not require the administration of IV contrast. However, inflammatory and infectious processes, such as gastroenteritis, pancreatitis, pyelonephritis, inflammatory bowel disease, colitis, venous thrombus, or neoplasms, can be missed on noncontrast examination.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

**D. FDG-PET/CT skull base to mid-thigh**

FDG-PET/CT may be used for the workup of malignancy and select nonmalignant etiologies such as fever of unknown origin, suspected infection of instrumentation and prostheses, or paraneoplastic syndromes, but it is not a useful initial imaging study for evaluation of pain, localized to LUQ or otherwise.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

**E. MRI abdomen without and with IV contrast**

With the advent of rapid sequences, MRI achieves high diagnostic accuracy for the workup of abdominal pain. However, absence of IV contrast lowers diagnostic yield in many circumstances. Examples include mild inflammatory changes, infarcts, fistula tracts, vasculature, and their complications such as pseudoaneurysms or thrombus. For this reason, MRI without IV contrast is not recommended for patients with LUQ pain that is otherwise nonspecific and who require an imaging examination that encompasses a wide range of etiologies.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

**F. MRI abdomen without IV contrast**

MRI achieves high diagnostic accuracy for the workup of abdominal pain, specifically in appendicitis, inflammatory bowel disease, pancreatitis, biliary, and ovarian etiologies, and has been well studied in pregnant patients and children. Therefore, it may be an appropriate initial imaging modality for LUQ pain workup.

**Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging.**

**G. Radiography abdomen**

Radiographs with or without serial imaging were traditionally used for the evaluation of bowel obstruction, ileus, and constipation, with moderate sensitivity ranging from 30% to 70% [56]. Bowel obstruction, however, infrequently presents as a localized pain. For nonobstructive etiologies, radiography is also inferior to CT. In a study of >800 patients in the emergency department,

abdominal radiography contributed to clinical management in 4% of patients [57]. As a result, radiography may lead to a delay in care and invariably requires subsequent imaging and is thus not recommended.

### **Variant 3: Adult. Acute left upper quadrant pain. Not otherwise specified. Initial imaging. H. US abdomen**

US provides a rapid tool for the evaluation of splenic size, splenic vasculature, and the preliminary screening of the LUQ for a mass or abscess [46,58]. However, it is of vital importance to consider the inferior sensitivity of US to cross-sectional modalities for patients with nonspecific LUQ pain. US abdomen may be appropriate in a select group of patients in whom US is not deemed to cause a delay in care. Additionally, it should not be planned as a complementary procedure to cross-sectional modalities.

## **Summary of Highlights**

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1:** In the setting of LUQ pain with suspected splenomegaly, CT abdomen and pelvis with IV contrast is usually appropriate to evaluate the spleen. US abdomen is also usually appropriate to evaluate splenic size and parenchyma, as well as splenic and portal vasculature. These procedures should be viewed as alternate initial procedures, although in certain circumstances, they may be ordered in sequence. It is not recommended that these procedures be ordered simultaneously.
- **Variant 2:** In the setting of LUQ pain with fever, CT abdomen and pelvis with IV contrast is usually appropriate to evaluate for an infectious process with or without abscess involving spleen or adjacent organs.
- **Variant 3:** In the setting of LUQ pain, not otherwise specified, CT abdomen and pelvis with IV contrast is usually appropriate to evaluate a wide range of pathologies and is the modality of choice.

## **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, please go to the ACR website at <https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria>.

## **Gender Equality and Inclusivity Clause**

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

## 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.

## 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 (e.g., 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. Yew KS, George MK, Allred HB. Acute Abdominal Pain in Adults: Evaluation and Diagnosis. *American Family Physician*. 107(6):585-596, 2023 Jun.
2. Nagurney JT, Brown DF, Chang Y, Sane S, Wang AC, Weiner JB. Use of diagnostic testing in the emergency department for patients presenting with non-traumatic abdominal pain. *J Emerg Med* 2003;25:363-71.
3. Amari K, Fukumori N, Anzai K, Yamashita SI. The Diagnostic Process for the Evaluation of Acute Abdominal Pain by Resident Trainees in Japan: A Cross-sectional Study. *Internal Medicine*. 59(10):1257-1265, 2020.
4. Pines J, Uscher Pines L, Hall A, Hunter J, Srinivasan R, Ghaemmaghmi C. The interrater variation of ED abdominal examination findings in patients with acute abdominal pain. *Am J Emerg Med* 2005;23:483-7.
5. Samaras N, Chevalley T, Samaras D, Gold G. Older patients in the emergency department: a review. *Ann Emerg Med* 2010;56:261-9.
6. Cartwright SL, Knudson MP. Evaluation of acute abdominal pain in adults. *Am Fam Physician* 2008;77:971-8.
7. Cervellin G, Mora R, Ticinesi A, et al. Epidemiology and outcomes of acute abdominal pain in a large urban Emergency Department: retrospective analysis of 5,340 cases. *Ann Transl Med* 2016;4:362.
8. Ecanow JS, Gore RM. Evaluating Patients with Left Upper Quadrant Pain. [Review]. *Radiologic Clinics of North America*. 53(6):1131-57, 2015 Nov.
9. Vij A, Zaheer A, Kamel IR, et al. ACR Appropriateness Criteria® Epigastric Pain. *J Am Coll Radiol* 2021;18:S330-S39.
10. Porter KK, Zaheer A, Kamel IR, et al. ACR Appropriateness Criteria® Acute Pancreatitis. *J Am Coll Radiol* 2019;16:S316-S30.
11. Gupta RT, Kalisz K, Khatri G, et al. ACR Appropriateness Criteria® Acute Onset Flank Pain-Suspicion of Stone Disease (Urolithiasis). *J Am Coll Radiol* 2023;20:S315-S28.
12. Smith AD, Nikolaidis P, et al. ACR Appropriateness Criteria® Acute Pyelonephritis: 2022 Update. *J Am Coll Radiol*. 2022 Nov;19(11S):S1546-1440(22)00651-2.
13. Beache GM, Mohammed TH, Hurwitz Kowek LM, et al. ACR Appropriateness Criteria R Acute Nonspecific Chest Pain-Low Probability of Coronary Artery Disease. *Journal of the American College of Radiology*. 17(11S):S346-S354, 2020 Nov.J. Am. Coll. Radiol.. 17(11S):S346-S354, 2020 Nov.
14. Jokerst C, Chung JH, et al. ACR Appropriateness Criteria® Acute Respiratory Illness in Immunocompetent Patients. *J Am Coll Radiol*. 2018 Nov;15(11S):S1546-1440(18)31154-2.
15. Shah VN, Parsons MS, Boulter DJ, et al. ACR Appropriateness Criteria R Thoracic Back Pain. *Journal of the American College of Radiology*. 21(11S):S504-S517, 2024 Nov.J. Am. Coll. Radiol.. 21(11S):S504-S517, 2024 Nov.
16. Scheirey CD, Fowler KJ, Therrien JA, et al. ACR Appropriateness Criteria® Acute Nonlocalized Abdominal Pain. *J Am Coll Radiol* 2018;15:S217-S31.

- 17.** Cox M, Li Z, Desai V, et al. Acute nontraumatic splenic infarctions at a tertiary-care center: causes and predisposing factors in 123 patients. *Emergency Radiology*. 23(2):155-60, 2016 Apr.
- 18.** Pozo AL, Godfrey EM, Bowles KM. Splenomegaly: investigation, diagnosis and management. *Blood Rev* 2009;23:105-11.
- 19.** Pachter HL, Hofstetter SR, Elkowitz A, Harris L, Liang HG. Traumatic cysts of the spleen--the role of cystectomy and splenic preservation: experience with seven consecutive patients. [Review] [58 refs]. *Journal of Trauma-Injury Infection & Critical Care*. 35(3):430-6, 1993 Sep.
- 20.** Esterson YB, Sheth S, Kawamoto S. Splenic sequestration in the adult: cross sectional imaging appearance of an uncommon diagnosis. *Clin Imaging* 2021;69:369-73.
- 21.** Sheth S, Ruzal-Shapiro C, Piomelli S, Berdon WE. CT imaging of splenic sequestration in sickle cell disease. *Pediatric Radiology*. 30(12):830-3, 2000 Dec.
- 22.** Al-Habbal Y, Christophi C, Muralidharan V. Aneurysms of the splenic artery - a review. [Review]. *Surgeon Journal of the Royal Colleges of Surgeons of Edinburgh & Ireland*. 8(4):223-31, 2010 Aug. *Surg.* 8(4):223-31, 2010 Aug.
- 23.** Ham H, McInnes MD, Woo M, Lemonde S. Negative predictive value of intravenous contrast-enhanced CT of the abdomen for patients presenting to the emergency department with undifferentiated upper abdominal pain. *Emergency Radiology*. 19(1):19-26, 2012 Jan.
- 24.** Pandharipande PV, Reisner AT, Binder WD, et al. CT in the Emergency Department: A Real-Time Study of Changes in Physician Decision Making. *Radiology* 2016;278:812-21.
- 25.** Tirkes T, Ballenger Z, Steenburg SD, Altman DJ, Sandrasegaran K. Computerized tomography of the acute left upper quadrant pain. *Emergency Radiology*. 23(4):353-6, 2016 Aug.
- 26.** Ishihara K, Ishida R, Saito T, Teramoto K, Hosomura Y, Shibuya H. Computed tomography features of portal hypertensive gastropathy. *Journal of Computer Assisted Tomography*. 28(6):832-5, 2004 Nov-Dec. *J Comput Assist Tomogr*. 28(6):832-5, 2004 Nov-Dec.
- 27.** McCormick PA, Malone DE, Docherty JR, Kiat C, Christopher BT, Chin JL. Patterns of splenic arterial enhancement on computed tomography are related to changes in portal venous pressure. *European Journal of Gastroenterology & Hepatology*. 31(3):352-356, 2019 03.
- 28.** Razavi SA, Johnson JO, Kassin MT, Applegate KE. The impact of introducing a no oral contrast abdominopelvic CT examination (NOCAPE) pathway on radiology turn around times, emergency department length of stay, and patient safety. *Emerg Radiol* 2014;21:605-13.
- 29.** Uyeda JW, Yu H, Ramalingam V, Devalapalli AP, Soto JA, Anderson SW. Evaluation of Acute Abdominal Pain in the Emergency Setting Using Computed Tomography Without Oral Contrast in Patients With Body Mass Index Greater Than 25. *J Comput Assist Tomogr* 2015;39:681-6.
- 30.** Antopolsky M, Hiller N, Salameh S, Goldshtein B, Stalnikowicz R. Splenic infarction: 10 years of experience. *Am J Emerg Med* 2009;27:262-5.
- 31.** Lee MW, Yeon SH, Ryu H, et al. Volumetric splenomegaly in patients with essential thrombocythemia and prefibrotic/early primary myelofibrosis. *International Journal of*

Hematology. 114(1):35-43, 2021 Jul.

- 32.** Luther M, Henes FO, Zabelina T, et al. Spleen volume and length determined by computed tomography impact outcome after allogeneic stem cell transplantation for myelofibrosis. *Bone Marrow Transplantation*. 58(7):755-761, 2023 Jul.
- 33.** Shen S, DeNardo GL, Yuan A, Hartmann-Siantar C, O'Donnell RT, DeNardo SJ. Splenic volume change and nodal tumor response in non-Hodgkin's lymphoma patients after radioimmunotherapy using radiolabeled Lym-1 antibody. *Cancer Biotherapy & Radiopharmaceuticals*. 20(6):662-70, 2005 Dec.
- 34.** Warshauer DM, Molina PL, Worawattanakul S. The spotted spleen: CT and clinical correlation in a tertiary care center. *Journal of Computer Assisted Tomography*. 22(5):694-702, 1998 Sep-Oct.
- 35.** Ozturk O, Eldem G, Peynircioglu B, et al. Outcomes of partial splenic embolization in patients with massive splenomegaly due to idiopathic portal hypertension. *World Journal of Gastroenterology*. 22(43):9623-9630, 2016 Nov 21.
- 36.** Tasar M, Ugurel MS, Kocaoglu M, Saglam M, Somuncu I. Computed tomography-guided percutaneous drainage of splenic abscesses. *Clinical Imaging*. 28(1):44-8, 2004 Jan-Feb.
- 37.** Jain L, Mackenzie S, Bomanji JB, et al. 18F-Fluorodeoxyglucose positron emission tomography-computed tomography imaging in HIV-infected patients with lymphadenopathy, with or without fever and/or splenomegaly. *International Journal of STD & AIDS*. 29(7):691-694, 2018 06.
- 38.** Kim D, Woodham BL, Chen K, Kuganathan V, Edye MB. Rapid MRI Abdomen for Assessment of Clinically Suspected Acute Appendicitis in the General Adult Population: a Systematic Review. *J Gastrointest Surg* 2023;27:1473-85.
- 39.** Byott S, Harris I. Rapid acquisition axial and coronal T2 HASTE MR in the evaluation of acute abdominal pain. *Eur J Radiol*. 85(1):286-290, 2016 Jan.
- 40.** Kaplan KR, Mitchell DG, Steiner RM, et al. Polycythemia vera and myelofibrosis: correlation of MR imaging, clinical, and laboratory findings. *Radiology*. 183(2):329-34, 1992 May.
- 41.** Zafar F, Lubert AM, Trout AT, et al. Abdominal CT and MRI Findings of Portal Hypertension in Children and Adults with Fontan Circulation. *Radiology*. 303(3):557-565, 2022 06.
- 42.** Ahn SH, Mayo-Smith WW, Murphy BL, Reinert SE, Cronan JJ. Acute nontraumatic abdominal pain in adult patients: abdominal radiography compared with CT evaluation. *Radiology*. 2002 Oct;225(1):159-64.
- 43.** Zambetti EF, Haramati LB, Jenny-Avital ER, Borczuk AC. Detection and significance of splenomegaly on chest radiographs of HIV-infected outpatients. *Clinical Radiology*. 54(1):34-7, 1999 Jan.
- 44.** Gale HI, Bobbitt CA, Setty BN, et al. Expected Sonographic Appearance of the Spleen in Children and Young Adults With Sickle Cell Disease: An Update. *Journal of Ultrasound in Medicine*. 35(8):1735-45, 2016 Aug.
- 45.** Walker TM, Hambleton IR, Mason KP, Serjeant G. Spleen size in homozygous sickle cell disease: trends in a birth cohort using ultrasound. *British Journal of Radiology*. 95(1140):20220634, 2022 Dec 01.
- 46.** Hosey RG, Mattacola CG, Kriss V, Armsey T, Quarles JD, Jagger J. Ultrasound assessment of

- spleen size in collegiate athletes. *British Journal of Sports Medicine*. 40(3):251-4; discussion 251-4, 2006 Mar.
47. McCorkle R, Thomas B, Suffaletto H, Jehle D. Normative spleen size in tall healthy athletes: implications for safe return to contact sports after infectious mononucleosis. *Clinical Journal of Sport Medicine*. 20(6):413-5, 2010 Nov.
  48. Piscaglia F, Donati G, Cecilioni L, et al. Influence of the spleen on portal haemodynamics: a non-invasive study with Doppler ultrasound in chronic liver disease and haematological disorders. *Scand J Gastroenterol*. 37(10):1220-7, 2002 Oct.
  49. Berzigotti A, Zappoli P, Magalotti D, Tiani C, Rossi V, Zoli M. Spleen enlargement on follow-up evaluation: a noninvasive predictor of complications of portal hypertension in cirrhosis. *Clinical Gastroenterology & Hepatology*. 6(10):1129-34, 2008 Oct.
  50. Ferri PM, Ferreira AR, Fagundes ED, Liu SM, Roquete ML, Penna FJ. Portal vein thrombosis in children and adolescents: 20 years experience of a pediatric hepatology reference center. *Arquivos de Gastroenterologia*. 49(1):69-76, 2012 Jan-Mar. *Arq Gastroenterol*. 49(1):69-76, 2012 Jan-Mar.
  51. Abujudeh HH, Kaewlai R, McMahon PM, et al. Abdominopelvic CT increases diagnostic certainty and guides management decisions: a prospective investigation of 584 patients in a large academic medical center. *AJR*. 2011;196(2):238-243.
  52. Oto A, Schmid-Tannwald C, Agrawal G, et al. Diffusion-weighted MR imaging of abdominopelvic abscesses. *Emerg Radiol* 2011;18:515-24.
  53. Guglielmo FF, Anupindi SA, Fletcher JG, et al. Small Bowel Crohn Disease at CT and MR Enterography: Imaging Atlas and Glossary of Terms. [Review]. *Radiographics*. 40(2):354-375, 2020 Mar-Apr.
  54. Ripolles T, Sebastian-Tomas JC, Martinez-Perez MJ, Manrique A, Gomez-Abril SA, Torres-Sanchez T. Ultrasound can differentiate complicated and noncomplicated acute colonic diverticulitis: a prospective comparative study with computed tomography. *Abdom Radiol (NY)* 2021;46:3826-34.
  55. Go HL, Baarslag HJ, Vermeulen H, Lameris JS, Legemate DA. A comparative study to validate the use of ultrasonography and computed tomography in patients with post-operative intra-abdominal sepsis. *Eur J Radiol* 2005;54:383-7.
  56. Chang KJ, Marin D, Kim DH, et al. ACR Appropriateness Criteria® Suspected Small-Bowel Obstruction. *J Am Coll Radiol* 2020;17:S305-S14.
  57. Kellow ZS, MacInnes M, Kurzencwyg D, et al. The role of abdominal radiography in the evaluation of the nontrauma emergency patient. *Radiology*. 2008;248(3):887-893.
  58. Jarvis L, Cook PG, James CM, Rose M, Prentice AG, Dubbins PA. Duplex sonography in splenomegaly. *British Journal of Radiology*. 64(762):485-8, 1991 Jun.
  59. Measuring Sex, Gender Identity, and Sexual Orientation.
  60. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf>.

## Disclaimer

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.

<sup>a</sup>University of Colorado Denver Anschutz Medical Campus, Aurora, Colorado. <sup>b</sup>Research Author, Johns Hopkins Hospital, Baltimore, Maryland. <sup>c</sup>Panel Chair, Boston University Medical Center, Boston, Massachusetts. <sup>d</sup>Global Advanced Imaging, PLLC, Little Rock, Arkansas; Commission on Nuclear Medicine and Molecular Imaging. <sup>e</sup>The University of Texas MD Anderson Cancer Center, Houston, Texas. <sup>f</sup>University of Texas Health Science Center at Houston and McGovern Medical School, Houston, Texas; American Gastroenterological Association. <sup>g</sup>Columbia University Irving Medical Center, New York, New York. <sup>h</sup>Medstar Georgetown University Hospital, Washington, District of Columbia, Primary care physician. <sup>i</sup>Emory University School of Medicine, Atlanta, Georgia. <sup>j</sup>UMass Memorial Health and UMass Chan Medical School, Worcester, Massachusetts; Committee on Emergency Radiology-GSER. <sup>k</sup>NorthShore University HealthSystem, Evanston, Illinois. <sup>l</sup>Schmidt College of Medicine, Florida Atlantic University, Boca Raton, Florida; American College of Emergency Physicians. <sup>m</sup>Loyola University of Chicago, Chicago, Illinois. <sup>n</sup>Specialty Chair, University of California San Diego, San Diego, California.