

**American College of Radiology  
ACR Appropriateness Criteria®**

**Clinical Condition:** Right Upper Quadrant Pain

**Variant 1:** Fever, elevated white blood cell count (WBC), positive Murphy sign.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	9		O
MRI abdomen without and with IV contrast	6		O
Cholescintigraphy	6	Based on US findings, this generally should follow US of the right upper quadrant.	☼☼
CT abdomen with IV contrast	6		☼☼☼
MRI abdomen without IV contrast	4		O
CT abdomen without IV contrast	4		☼☼☼
CT abdomen without and with IV contrast	3		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 2:** Suspected acalculous cholecystitis.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	8	If gallbladder dilation, wall thickening, or fluid are present, proceed with percutaneous cholecystostomy, as clinically indicated.	O
MRI abdomen without and with IV contrast	6		O
Cholescintigraphy	6	This procedure is used for hospitalized patients, following an equivocal US.	☼☼
CT abdomen with IV contrast	6		☼☼☼
Percutaneous cholecystostomy	6	This can be both diagnostic and therapeutic, particularly with ICU patients. Consider using this procedure for the nonoperative patient or if other causes of sepsis have been excluded. This usually requires imaging first. It is performed only in certain patients (elderly, immunocompromised, etc.).	Varies
MRI abdomen without IV contrast	4		O
CT abdomen without IV contrast	4		☼☼☼
CT abdomen without and with IV contrast	3		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Right Upper Quadrant Pain

**Variant 3:** No fever, normal WBC.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	9	This is performed to exclude a diagnosis of stones and bile duct obstruction.	O
MRI abdomen without and with IV contrast	6		O
Cholescintigraphy	6	This is performed if US is equivocal.	☼☼
CT abdomen with IV contrast	6		☼☼☼
MRI abdomen without IV contrast	5		O
CT abdomen without IV contrast	3		☼☼☼
CT abdomen without and with IV contrast	3		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 4:** No fever, normal WBC, ultrasound shows only gallstones.

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with IV contrast	7		☼☼☼
MRI abdomen without IV contrast	6		O
MRI abdomen without and with IV contrast	6		O
Cholescintigraphy	6	This is performed to exclude other sources of pain from the diagnosis.	☼☼
CT abdomen without IV contrast	3		☼☼☼
CT abdomen without and with IV contrast	3		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Right Upper Quadrant Pain

**Variant 5:** Hospitalized patient with fever, elevated WBC, and positive Murphy sign.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	9		O
CT abdomen with IV contrast	7		☼ ☼ ☼
MRI abdomen without and with IV contrast	6		O
Cholescintigraphy	6	This is performed if US is inconclusive.	☼ ☼
Percutaneous cholecystostomy	6	This can be both diagnostic and therapeutic, particularly with ICU patients. Consider using this for the nonoperative patient or if other causes of sepsis have been excluded. This usually requires imaging first. It is performed only in certain patients (elderly, immunocompromised, etc.).	Varies
MRI abdomen without IV contrast	5		O
CT abdomen without IV contrast	4		☼ ☼ ☼
CT abdomen without and with IV contrast	3		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 6:** Fever, leukocytosis, pregnant patient.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	9		O
MRI abdomen without IV contrast	8		O
MRI abdomen without and with IV contrast	3		O
Cholescintigraphy	3		☼ ☼
CT abdomen without IV contrast	3		☼ ☼ ☼
CT abdomen with IV contrast	3		☼ ☼ ☼
CT abdomen without and with IV contrast	1		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

## RIGHT UPPER QUADRANT PAIN

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### **Summary of Literature Review**

#### **Introduction/Background**

Acute right upper quadrant pain is very common as a presenting symptom in hospital emergency departments and occasionally in patients hospitalized initially for unrelated conditions. This review will focus largely on the diagnostic accuracy of imaging studies performed to evaluate acute cholecystitis (AC), the primary diagnostic concern in the setting of acute right upper quadrant pain.

AC may be life-threatening; therefore, correct, timely diagnosis is essential for proper treatment. However, information derived only from clinical history, physical examination, and routine laboratory tests has not yielded acceptable likelihood ratios sufficient to predict the presence or absence of AC. Also, this information does not yield sufficient diagnostic certainty for making management decisions. Imaging studies, therefore, play a major role in establishing a diagnosis of AC and assessing possible alternate diagnoses, if AC is not present [1].

Radiography of the abdomen is of limited value for evaluating right upper quadrant pain. Although abdominal radiographs performed for initial evaluation may identify gallstones, they are not sufficient for establishing diagnoses of AC. Ultrasound (US) and cholescintigraphy are the imaging studies most often used to diagnose AC. Computed tomography (CT), however, may confirm or refute the diagnosis and reveal complications that are less clearly identified using other imaging modalities. Several studies support the diagnostic potential for magnetic resonance imaging (MRI) in patients with suspected AC; however, its use has yet to be fully assessed.

#### **Ultrasound and Cholescintigraphy**

An initial study from 1981 defined the sonographic Murphy sign as focal tenderness corresponding to a sonographically localized gallbladder, which, along with stones, sludge, and gallbladder wall thickening, allowed for separating AC from gallstones alone and chronic cholecystitis with gallstones [2]. Unfortunately, the sonographic Murphy sign has a relatively low specificity for AC [3], and its absence is unreliable as a negative predictor of AC if the patient has received pain medication prior to imaging. Since that initial study, many subsequent studies have been conducted to assess the accuracy of US and cholescintigraphy. The meta-analysis of Shea et al [4] reviewed 22 studies evaluating cholescintigraphy and 5 studies evaluating US published between 1978 and 1990. The authors concluded that cholescintigraphy demonstrated the best sensitivity (97%; 95% confidence interval [CI]: 96%, 98%) and specificity (90%; 95% CI: 86%, 95%) in detecting AC, whereas US had a sensitivity of 88% (95% CI: 74%, 100%) and specificity of 80% (95% CI: 62%, 98%).

A 2012 meta-analysis by Kiewiet et al [5] built on the results of Shea et al [4] and included 40 studies evaluating cholescintigraphy and 26 studies evaluating US published between 1978 and 2010. This analysis confirmed the sensitivity and specificity values noted by Shea et al, with cholescintigraphy at 96% (95% CI: 94%, 97%) and 90% (95% CI: 86%, 93%), respectively. However, Kiewiet et al [5] reported a slightly lower sensitivity for US at 81% (95% CI: 75%, 87%) and slightly higher specificity at 83% (95% CI: 74%, 89%). Similarly, direct comparisons of the diagnostic accuracy of US and cholescintigraphy performed in 11 studies confirmed the superior accuracy of cholescintigraphy.

Although cholescintigraphy is recognized to have a higher sensitivity and specificity, US remains the initial test of choice for imaging patients with suspected AC for a variety of reasons, including greater availability, shorter

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study time, lack of ionizing radiation, morphologic evaluation, confirmation of the presence or absence of gallstones, evaluation of intrahepatic and extrahepatic bile ducts, and identification or exclusion of alternative diagnoses [2,6-8] .

Despite providing information limited to the hepatobiliary tract, cholescintigraphy has been advocated as a useful preoperative modality. Specifically, findings of gallbladder nonvisualization or gallbladder ejection fraction <30% are noted to be useful in predicting the severity of cholecystitis and are associated with a higher complication rate in the setting of laparoscopic cholecystectomy [9]. Ideally, the surgeon or emergency physician, in consultation with the radiologist, should determine the role of scintigraphy in each case [10-14].

### **Computed Tomography**

Although it has not been advocated as a primary imaging examination for acute right upper quadrant pain, CT can confirm or refute the diagnosis of AC in equivocal cases based on US and/or scintigraphy and reveal such complications as gangrene, gas formation, intraluminal hemorrhage, and perforation [6-8,15-19]. Furthermore, CT has been advocated as a useful modality in preoperative planning, with the absence of gallbladder wall enhancement and/or presence of a stone within the infundibulum associated with conversion from laparoscopic to open cholecystectomy. Prior knowledge of these imaging findings may therefore help guide appropriate surgical approach [20].

Clinical conditions that can mimic AC, in terms of presentation with acute right upper quadrant pain, include chronic cholecystitis, peptic ulcer, pancreatitis, gastroenteritis, and bowel obstruction, among others. If US and/or scintigraphy are negative for AC and there is no alternative diagnosis, CT, preferably with intravenous contrast, is the next preferred imaging examination for identifying those disorders. When a diagnosis of AC is not prospectively suspected, CT may also be used to demonstrate AC in patients who have nonspecific abdominal pain.

### **Magnetic Resonance Imaging**

AC can be confirmed or excluded by an abdominal MRI using various protocols, which often include the use of an intravenous gadolinium-based contrast agent. As with CT, MRI is not advocated as a primary imaging examination to evaluate acute right upper quadrant pain; however, several studies have suggested that abdominal MRI is a reliable alternative and can be particularly helpful in the patient who is difficult to examine with US [21-23]. Although factors such as longer acquisition times limit its use in the emergency setting, less interpreter variability and more consistent visualization of the extrahepatic biliary tree are important advantages of its use [24,25]. MRI can be the next best imaging modality when AC is excluded, and it is considered the best modality for evaluating hepatic and biliary abnormalities that are not characterized by US.

Few studies have examined the role of MRI in evaluating AC. Based on the available literature encompassing several small studies, MRI sensitivity estimates range from 50% to 91%, with specificities ranging from 79% to 89%. According to the meta-analysis by Kiewiet et al, the summary sensitivity is 85% (95% CI: 66%, 95%) and specificity is 81% (95% CI: 69%, 90%) [5,23-25], similar to those of US. Additional studies with larger sample sizes are needed to better clarify the role of abdominal MRI in evaluating AC.

### **Pregnant Patients**

As in the general population, US is the imaging test of choice for evaluating AC in pregnant patients. MRI is the preferred test to follow an inconclusive US, as it can be used to evaluate the entire biliary system and diagnose other causes of acute abdominal pain without exposing the patient to ionizing radiation. Magnetic resonance cholangiopancreatography is helpful in identifying patients who require immediate intervention for pancreatic or biliary pathology. It also helps guard against unnecessary endoscopic retrograde cholangiopancreatography by excluding a biliary abnormality, when US findings are equivocal. Note that during pregnancy, intravenous gadolinium is generally not administered, as it is a class III agent in pregnancy [26,27].

### **Acalculous Cholecystitis**

The diagnosis of acute acalculous cholecystitis (AAC) is more problematic than calculous AC. AAC is a serious and potentially lethal condition that mainly affects critically ill patients who frequently have significant comorbidity. It often presents with clinical, radiologic, and laboratory features that are complex and nonspecific. Diagnosis of acalculous cholecystitis, in both hospitalized patients and emergency room patients, is often one of exclusion.

The use of US and/or scintigraphy has been advocated for AAC. The usefulness of US is limited, however, as gallbladder abnormalities are common with US in critically ill patients, with no apparent correlation to clinical or biochemical parameters related to AAC [28,29]. Cholescintigraphy may be a more sensitive diagnostic test, because most cases of AAC are associated with cystic duct obstruction, similar to the calculous form of the disease. Some cases of AAC, however, are related to direct inflammation of the gallbladder, leading to false-negative studies when using cholescintigraphy [30]. It should also be noted that diagnostic specificity is limited with cholescintigraphy, as nonvisualization of the gallbladder is a common imaging finding when no inflammation is present, despite preimaging cholecystokinin administration. CT also has a role in evaluating these critically ill patients [15], although, as with US, the frequent prevalence of nonspecific abnormal imaging findings in the gallbladders of critically ill patients limits its diagnostic value. Nevertheless, when the gallbladder appears completely normal on CT, there is a low probability of any surgical finding in the gallbladder [31]. MRI has not been evaluated sufficiently in AAC and is often impractical, given patient comorbidity.

Laparoscopic cholecystectomy is the definitive treatment for patients with AC [32-34], as its operative mortality is as low as 0.8% in patients who have major risk factors [35]. However, significant morbidity and mortality have been reported among patients who have a high surgical risk [36-40]. Percutaneous cholecystostomy, which can be both diagnostic and therapeutic, is often a safe approach in hospitalized patients suspected of having AAC [41]. Following aspiration of the bile, gallbladder drainage catheter placement may be accomplished immediately, if indicated. This can frequently bridge patients to cholecystectomy at a subsequent time [33,42,43].

### Summary

- When AC is suspected in patients who have right upper quadrant pain, the diagnosis should be confirmed or excluded using US and/or cholescintigraphy.
- US is preferred as the initial imaging test, with supplemental cholescintigraphy used in problematic cases, if the latter could potentially alter patient management.
- CT or MRI may be helpful in equivocal cases and used to identify complications of AC.
- If AC is excluded by US and/or scintigraphy, CT or MRI may be appropriate, depending on the clinical scenario.
- MRI is the preferred test for pregnant patients with right upper quadrant pain when US is inconclusive.
- Percutaneous cholecystostomy may be both diagnostic and therapeutic in patients with acalculous cholecystitis.
- These guidelines should allow the radiologist, emergency physician, and surgeon to be confident when choosing an expedient modality or combination of modalities to establish or exclude this important diagnosis.

### Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- [ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#)
- [ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound](#)
- [ACR Manual on Contrast Media](#)
- [ACR Guidance Document for Safe MR Practices](#)

### 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, both because of 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 to 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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies”.

### Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

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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.