

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

Variant 1: Right upper quadrant pain. Suspected biliary disease. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	○
CT abdomen with IV contrast	May Be Appropriate	⊕⊕⊕
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	○
MRI abdomen without IV contrast with MRCP	May Be Appropriate	○
Nuclear medicine scan gallbladder	May Be Appropriate	⊕⊕
CT abdomen without IV contrast	May Be Appropriate	⊕⊕⊕
CT abdomen without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

Variant 2: Right upper quadrant pain. No fever or high white blood cell (WBC) count. Suspected biliary disease. Negative or equivocal ultrasound.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	○
CT abdomen with IV contrast	Usually Appropriate	⊕⊕⊕
MRI abdomen without IV contrast with MRCP	Usually Appropriate	○
Nuclear medicine scan gallbladder	May Be Appropriate	⊕⊕
CT abdomen without IV contrast	May Be Appropriate	⊕⊕⊕
CT abdomen without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

Variant 3: Right upper quadrant pain. Fever, elevated WBC count. Suspected biliary disease. Negative or equivocal ultrasound.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	○
CT abdomen with IV contrast	Usually Appropriate	⊕⊕⊕
Nuclear medicine scan gallbladder	Usually Appropriate	⊕⊕
MRI abdomen without IV contrast with MRCP	May Be Appropriate	○
CT abdomen without IV contrast	May Be Appropriate	⊕⊕⊕
CT abdomen without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

Variant 4: Right upper quadrant pain. Suspected acalculous cholecystitis. Negative or equivocal ultrasound.

Procedure	Appropriateness Category	Relative Radiation Level
Nuclear medicine scan gallbladder	Usually Appropriate	☼☼
CT abdomen with IV contrast	May Be Appropriate	☼☼☼
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	○
Percutaneous cholecystostomy	May Be Appropriate	Varies
MRI abdomen without IV contrast with MRCP	May Be Appropriate	○
CT abdomen without IV contrast	May Be Appropriate	☼☼☼
CT abdomen without and with IV contrast	Usually Not Appropriate	☼☼☼☼

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, the primary diagnostic concern in the setting of acute right upper quadrant pain. Jaundice is an important clinical finding that suggests a different subset of conditions. Please see the ACR Appropriateness Criteria[®] topic on “[Jaundice](#)” [1] that pertains specifically to this clinical scenario.

Acute cholecystitis is the most frequent complication of gallstone disease, a common entity [2], and may be life-threatening; therefore, timely diagnosis is essential for proper treatment. Although most patients with acute cholecystitis experience right upper quadrant abdominal pain, nausea, vomiting, anorexia, and fever [2], 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 acute cholecystitis. Also, this information does not yield sufficient diagnostic certainty for making management decisions. Therefore, imaging studies play a major role in establishing a diagnosis of acute cholecystitis and assessing possible alternate diagnoses if acute cholecystitis is not present [3].

Unless otherwise stated, the ratings and recommendations for this document specifically relate to the adult nonpregnant patient.

Discussion of Procedures by Variant

Variant 1: Right upper quadrant pain. Suspected biliary disease. Initial imaging.

US Abdomen

Ultrasound (US) is the first choice of investigation for biliary symptoms or right upper quadrant abdominal pain. It is very accurate at diagnosing or excluding gallstones with reported accuracy of 96% for detection of gallstones [2], and may differentiate cholelithiasis from gallbladder sludge, polyps, or masses. The diagnosis of chronic cholecystitis is difficult on anatomic imaging. The gallbladder may appear contracted or distended, and pericholecystic fluid is usually absent.

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 differentiating acute cholecystitis from gallstones alone and chronic cholecystitis with gallstones [4]. Unfortunately, the sonographic Murphy sign has a relatively low specificity for acute cholecystitis [5] and its absence is unreliable as a negative predictor of acute cholecystitis 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. A meta-analysis by Shea et al [6] reviewed 22 studies evaluating cholescintigraphy and 5 studies evaluating US published between 1978 and 1990. The authors concluded that cholescintigraphy demonstrated the best sensitivity of 97% (95% CI: 96%-98%) and specificity of 90% (95% CI: 86%-95%) in

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detecting acute cholecystitis, whereas US had a sensitivity of 88% (95% CI: 74%-100%) and specificity of 80% (95% CI: 62%-98%).

Other studies performed since then have shown similar findings. Although cholescintigraphy is recognized to have a higher sensitivity and specificity, US remains the initial test of choice for imaging patients with suspected acute cholecystitis for a variety of reasons, including shorter study time, morphologic evaluation, confirmation of the presence or absence of gallstones, evaluation of intrahepatic and extrahepatic bile ducts, gallbladder wall edema, pericholecystic fluid, and identification or exclusion of alternative diagnoses [4,7-9].

However, the usefulness of US is limited in critically ill patients where gallbladder abnormalities are common in the absence of acute cholecystitis [10,11].

If complicated cholecystitis (emphysematous, hemorrhagic, gangrenous, or perforated, among others) is suspected, US remains the first choice of investigation for biliary symptoms or right upper quadrant abdominal pain. It is important to note, however, that some patients with complicated cholecystitis may present just like those with noncomplicated disease [2]. Depending on the complication, one may detect intraluminal hyperechoic blood products, intraluminal gas or gas in the gallbladder wall, intraluminal debris or membranes, or discontinuity of the gallbladder wall [2,12,13]. The gallbladder may appear contracted or distended, and pericholecystic fluid is variably present.

Although its sensitivity to some complications of cholecystitis is often limited, a normal appearance of the gallbladder, especially the wall, makes acute gallbladder pathology very unlikely. Thus, US remains the first imaging choice if complications of cholecystitis are suspected.

Nuclear Medicine Scan Gallbladder

Despite providing information limited to the hepatobiliary tract, cholescintigraphy has been advocated as a useful modality in this setting. Specifically, gallbladder nonvisualization with delayed imaging or morphine-augmented cholescintigraphy is highly accurate for evaluating the presence or absence of acute cholecystitis. One study states that gallbladder ejection fraction <30% may be useful in predicting the severity of cholecystitis and is associated with a higher complication rate in the setting of laparoscopic cholecystectomy [14]. However, although cholescintigraphy has a higher sensitivity and specificity for the evaluation of acute cholecystitis, US remains the initial test of choice for imaging patients with right upper quadrant pain for a variety of reasons, including shorter study time, morphologic evaluation, confirmation of the presence or absence of gallstones, evaluation of intrahepatic and extrahepatic bile ducts, and identification or exclusion of alternative diagnoses [4,7-9].

CT Abdomen

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 acute cholecystitis in equivocal cases based on US or scintigraphy, with a negative predictive value approaching 90% [12]. It is usually most appropriate to perform this examination after a US and/or cholescintigraphy. CT may reveal such complications as gangrene, gas formation, intraluminal hemorrhage, and perforation [7-9,12,15-19]. Furthermore, CT has been advocated as a useful modality in preoperative planning, with the absence of gallbladder wall enhancement or presence of a stone within the infundibulum associated with a higher rate of conversion from laparoscopic to open cholecystectomy. The CT findings in acute cholecystitis are similar to those encountered by US [2] with the exception of gallstones, which may not be detected by CT. Other potential findings include adjacent liver parenchymal hyperemia, which can only be assessed if intravenous (IV) contrast is administered. Abnormal gallbladder wall enhancement can be seen in more advanced cases, also if IV contrast is employed [2].

Of note, the sensitivity for detection of gallstones on CT is only approximately 75% and is dependent on differing density of the stone relative to bile [2].

CT is usually preferred over MRI, largely because of its speed [12].

CT without IV contrast can detect some features and complications of acute cholecystitis, such as gallbladder wall thickening, pericholecystic inflammation, gas formation, and hemorrhage, although some important features, such as wall enhancement and adjacent liver parenchymal hyperemia, cannot be detected without IV contrast. Adjacent liver hyperemia is actually one of the earlier findings in acute cholecystitis and can be a very useful problem-solving tool [2].

CT without and with IV contrast is not often viewed as helpful in assessing patients admitted with right upper quadrant abdominal pain. Little additional information is gained by the routine addition of a noncontrast phase to a contrast-enhanced phase in this clinical setting, without prior chronic disease or neoplasia [20].

MRI Abdomen with MRCP

The presence of acute cholecystitis can be further explored using abdominal MRI, which often includes the use of an IV gadolinium-based contrast agent in cases where other imaging tests are equivocal [2]. 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]. It can perform superiorly to US in cases of gallstones in the gallbladder neck, the cystic duct, or the common bile duct [2].

As with CT without IV contrast, noncontrast MRI will not be able to detect all the imaging features or potential complications of acute cholecystitis. However, noncontrast MRI with MR cholangiopancreatography (MRCP) has excellent accuracy for detection of biliary stone disease and, therefore, a noncontrast MRI is generally preferred over a noncontrast CT.

Variant 2: Right upper quadrant pain. No fever or high white blood cell (WBC) count. Suspected biliary disease. Negative or equivocal ultrasound.

The symptom of right upper quadrant pain is nonspecific, and a number of entities can present similarly, including biliary infection, liver mass with capsular involvement, pancreatic inflammation, intestinal disorders, and referred pain from elsewhere in the abdomen or pelvis or even in the right lung. However, acute cholecystitis is a fairly common disease that presents with right upper quadrant pain and is often the initial diagnosis to exclude.

CT Abdomen

CT is not the first-line imaging test for suspected biliary causes of right upper quadrant abdominal pain. However, if US is negative for acute cholecystitis and there is no alternative diagnosis, CT, preferably with IV contrast, is the next preferred imaging examination for identifying those additional causes of right upper quadrant abdominal pain. When a diagnosis of acute cholecystitis is not prospectively suspected, CT may also be used to demonstrate acute cholecystitis in patients who have nonspecific abdominal pain. CT may also be valuable for further clarification of sonographic findings.

It is important to select the proper imaging protocol based on clinical information and other imaging. For example, evaluation for nephrolithiasis is best performed with a noncontrast-enhanced CT, whereas characterization of a liver lesion may be more accurate with a multiphasic CT or MRI, which may include precontrast and postcontrast images.

Detection of gallstones on CT with IV contrast depends on differing density of the stone relative to bile. Reported sensitivity for gallstone detection by CT is approximately 75%. Calcified gallstones are readily apparent. Cholesterol stones may also be seen as less dense than bile. Nitrogen gas may collect within degenerating gallstones, creating central fissures that may also be seen as different attenuation from bile [2].

The diagnosis of chronic cholecystitis is difficult to make at imaging. Chronic cholecystitis is associated with gallstones in 95% of cases and may result from a single or multiple recurrent episodes of acute cholecystitis. Chronic inflammation causes the gallbladder to become thickened and fibrotic. On CT, there may be absence of adjacent liver parenchymal hyperemia and pericholecystic inflammatory change, with nonvisualization of gallstones [2].

Noncontrast abdominal CT has very limited value in the assessment of suspected biliary sources of right upper quadrant abdominal pain. Unenhanced abdominal CT may or may not demonstrate cholelithiasis, depending on the density of the stones. Pericholecystic inflammatory fat stranding may be seen in acute cholecystitis. Evaluation of biliary ductal dilatation is limited.

CT without and with IV contrast is not often viewed as helpful in assessing patients admitted with right upper quadrant abdominal pain. Little additional information is gained by the routine addition of a noncontrast phase to a contrast-enhanced phase in this clinical setting, without prior chronic disease or neoplasia [20].

MRI Abdomen with MRCP

MRCP is excellent for detection of cholelithiasis/choledocholithiasis with reported sensitivity of 85% to 100%, specificity of 90%, and accuracy of 89% to 90% [2]. MRCP is superior to US in the evaluation of cystic duct and

common bile duct calculi and calculi impacted in the gallbladder neck. Visualization of the common bile duct and even the cystic duct is a significant advantage of MRI over US in the evaluation of right upper quadrant pain [23].

MRI may also demonstrate findings to help distinguish acute from chronic cholecystitis. In chronic cholecystitis, gallbladder wall thickening related to chronic inflammation shows low signal intensity, as opposed to acute cholecystitis, which is associated with edema and T2 signal hyperintensity. Abdominal MRI with IV contrast may show perihepatic contrast enhancement in the setting of acute inflammation, helpful for differentiating acute cholecystitis from chronic cholecystitis [2].

Although contrast-enhanced examinations are preferred, MRI of the abdomen without IV contrast is also useful. It often provides improved characterization of incidental sonographic liver findings as compared to noncontrast CT. Standard T2-weighted MRI generally allows visualization of both normal caliber and dilated bile ducts. Noncontrast MRI with MRCP is very helpful in the follow-up of known hepatobiliary stone disease.

Abdominal MRI with, and sometimes without, IV contrast in combination with MRCP provides comprehensive evaluation of the hepatobiliary system. In addition to evaluating for cholelithiasis and choledocholithiasis, additional pathologies may be identified. Sources of biliary ductal dilatation, such as masses and lymph nodes, may be identified.

Nuclear Medicine Scan Gallbladder

Low-grade, partial or intermittent biliary obstruction may present with symptoms of recurrent right upper quadrant abdominal pain, mimicking chronic cholecystitis and numerous nonbiliary causes of abdominal pain. Nuclear medicine hepatobiliary imaging also aids in the diagnosis of partial biliary obstruction that is due to stones, biliary stricture, and sphincter of Oddi obstruction. Sphincter of Oddi evaluation with cholecystokinin cholescintigraphy does not carry the risk of pancreatitis, which may be seen with manometric evaluation. The use of cholecystokinin-augmented nuclear medicine hepatobiliary imaging in patients with pain of biliary origin is an acceptable practice under current Society of Gastrointestinal and Laparoscopic Surgeons clinical guidelines [24].

Nuclear medicine hepatobiliary imaging with calculation of the gallbladder ejection fraction after cholecystokinin infusion may be used to diagnose chronic gallbladder disease, partial biliary obstruction, and biliary dyskinesia as a cause of right upper quadrant pain. However, this test may be less useful in patients with atypical symptoms.

Variant 3: Right upper quadrant pain. Fever, elevated WBC count. Suspected biliary disease. Negative or equivocal ultrasound.

Nuclear Medicine Scan Gallbladder

A 2012 meta-analysis by Kiewiet et al [25] included 40 studies evaluating cholescintigraphy and 26 studies evaluating US published between 1978 and 2010. This analysis confirmed the sensitivity and specificity values for acute cholecystitis noted by Shea et al [6], with respect to cholescintigraphy at 96% (95% CI: 94%-97%) and 90% (95% CI: 86%-93%), respectively. However, Kiewiet et al [25] reported a slightly lower sensitivity for US at 81% (95% CI: 75%-87%) and slightly higher specificity at 83% (95% CI: 74%-89%) compared with Shea's US findings. Similarly, direct comparisons of the diagnostic accuracy of US and cholescintigraphy performed in multiple studies have confirmed the superior accuracy of cholescintigraphy for acute cholecystitis. Despite providing information limited to the hepatobiliary tract, cholescintigraphy has been advocated as a useful diagnostic modality. In the setting of suspected acute cholecystitis, cholescintigraphy should be considered a first-line examination.

CT Abdomen

Although it has not been advocated as a primary imaging examination for acute right upper quadrant pain, CT with IV contrast can confirm or refute the diagnosis of acute cholecystitis in equivocal cases based on US or scintigraphy, with a negative predictive value approaching 90% [12]. CT may reveal such complications as gangrene, gas formation, intraluminal hemorrhage, and perforation [7-9,12,15-19]. Furthermore, CT has been advocated as a useful modality in preoperative planning, with the absence of gallbladder wall enhancement or presence of a stone within the infundibulum associated with conversion from laparoscopic to open cholecystectomy. Prior knowledge of these imaging findings may help guide appropriate surgical approach [26].

Clinical conditions that can mimic acute cholecystitis, in terms of presentation with acute right upper quadrant pain, include chronic cholecystitis, peptic ulcer, pancreatitis, gastroenteritis, ascending cholangitis, and bowel obstruction, among others. However, acute cholecystitis is a fairly common disease that presents with right upper

quadrant pain and is often the initial diagnosis to exclude. If US or scintigraphy are negative for acute cholecystitis and there is no alternative diagnosis, CT, preferably with IV contrast, is the next preferred imaging examination for identifying those disorders. When a diagnosis of acute cholecystitis is not prospectively suspected, CT may also be used to demonstrate acute cholecystitis in patients who have nonspecific abdominal pain.

The CT findings in acute cholecystitis are similar to those encountered by US [2] with the exception of gallstones, which may not be seen with CT. Other potential findings include adjacent liver parenchymal hyperemia, which cannot be detected without IV contrast. Abnormal gallbladder wall enhancement can be seen in more advanced cases [2].

CT without IV contrast can detect some features and complications of acute cholecystitis, such as gallbladder wall thickening, pericholecystic inflammation, gas formation, and hemorrhage, although some important features, such as wall enhancement and adjacent liver parenchymal hyperemia, cannot be detected without IV contrast. Adjacent liver hyperemia is actually one of the earlier findings in acute cholecystitis and can be a very useful problem-solving tool [2].

CT without and with IV contrast is not often viewed as helpful in assessing patients admitted with right upper quadrant abdominal pain. Little additional information is gained by the routine addition of a noncontrast phase to a contrast-enhanced phase in this clinical setting, without prior chronic disease or neoplasia [20].

MRI Abdomen with MRCP

The presence of acute cholecystitis can be further explored using abdominal MRI, which often includes the use of an IV gadolinium-based contrast agent, in cases where other imaging tests are equivocal [2]. 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, more consistent visualization of the extrahepatic biliary tree is an important advantage of its use [27,28].

MRI is considered the best modality for evaluating hepatic and biliary abnormalities that are not characterized by US. It can perform superiorly to US in cases of gallstones in the gallbladder neck, the cystic duct, or the common bile duct [2].

Few studies have examined the role of MRI in evaluating acute cholecystitis. 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%) [23,25,27,28], similar to those of US. A study by Byott and Harris [29] advocated for the use of limited MRI (rapid acquisition HASTE [Half Fourier Acquisition Single Shot Turbo Spin Echo] coronal and axial sequences, without IV contrast) for evaluation of acute cholecystitis, especially in younger patients.

As with CT without IV contrast, noncontrast MRI will not be able to detect all the imaging features or potential complications of acute cholecystitis. However, noncontrast MRI with MRCP has excellent accuracy for visualization of normal and dilated bile ducts and detection of stone disease compared to noncontrast CT. Standard T2-weighted imaging can better demonstrate gallbladder wall edema and pericholecystic fluid than noncontrast CT.

Variant 4: Right upper quadrant pain. Suspected acalculous cholecystitis. Negative or equivocal ultrasound.

Nuclear Medicine Scan Gallbladder

Cholescintigraphy is a very sensitive diagnostic test because most cases of acalculous cholecystitis are associated with cystic duct obstruction, similar to the calculous form of the disease. Some cases of acalculous cholecystitis, however, are related to direct inflammation of the gallbladder, leading to false-negative studies when using cholescintigraphy [30]. It should also be noted that the specificity of cholescintigraphy may be limited in the critically ill patient where nonvisualization of the gallbladder may occur in the absence of inflammation despite preimaging cholecystokinin administration. However, cholescintigraphy remains the imaging examination of choice when acalculous cholecystitis is suspected.

CT Abdomen

Patients with suspected acalculous cholecystitis are typically critically ill and CT has a role in evaluating these patients [15]; although, as with US, the frequent prevalence of nonspecific abnormal imaging findings in the gallbladders of critically ill patients limit 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].

CT without IV contrast can detect some features and complications of acalculous cholecystitis, such as gallbladder wall thickening, pericholecystic inflammation, gas formation, and hemorrhage. Although, some important features, such as wall enhancement and adjacent liver parenchymal hyperemia, cannot be detected on noncontrast CT and so IV contrast is preferred. Adjacent liver hyperemia is actually one of the earlier findings in acalculous cholecystitis and can be a very useful problem-solving tool [2].

CT without and with IV contrast is not often viewed as helpful in assessing patients admitted with right upper quadrant abdominal pain. Little additional information is gained by the routine addition of a noncontrast phase to a contrast-enhanced phase in this clinical setting, without prior chronic disease or neoplasia [20].

MRI Abdomen with MRCP

MRI has not been evaluated sufficiently in acalculous cholecystitis and is often impractical, given patient comorbidity. Therefore, its usefulness in the setting of suspected acalculous cholecystitis is limited. However, MRI may play a role in cases where other imaging tests are equivocal [2]. 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]. MRI can be the next best imaging modality when acalculous cholecystitis is excluded, and MRI with MRCP is considered the best modality for evaluating hepatic and biliary abnormalities that are not characterized by US. It can perform superiorly to US in cases of gallstones in the gallbladder neck, the cystic duct, or the common bile duct [2].

Percutaneous Cholecystostomy

Percutaneous cholecystostomy, can be both diagnostic and therapeutic, and it is usually considered safe in hospitalized patients suspected of having acalculous cholecystitis [32,33]. Some of the diagnostic criteria by which a diagnosis of cholecystitis is made with percutaneous cholecystostomy include obstruction of the cystic duct in the clinical setting of suspected acute cholecystitis and improvement in symptoms of acute cholecystitis after placement of the cholecystostomy [34].

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 [35-37]. Definitive cholecystectomy is then sometimes performed [32]. It is more often used as a therapeutic option rather than solely for diagnosis.

Summary of Recommendations

- **Variante 1:** US abdomen is usually appropriate for the initial evaluation for right upper quadrant pain with suspected biliary disease.
- **Variante 2:** In the setting of right upper quadrant pain with suspected biliary disease with no fever or high WBC count and a negative or equivocal US, the following procedures are usually appropriate and equivalent alternatives: (a) MRI abdomen without and with IV contrast with MRCP, (b) CT abdomen with IV contrast, and (c) MRI abdomen without IV contrast with MRCP.
- **Variante 3:** Nuclear medicine scan gallbladder is usually appropriate for right upper quadrant pain with fever and elevated WBC count with suspected biliary disease and an equivocal US. MRI abdomen without and with IV contrast with MRCP or CT abdomen with IV contrast is also usually appropriate and provides additional diagnostic information.
- **Variante 4:** Nuclear medicine scan gallbladder is usually appropriate for right upper quadrant pain with suspected acalculous cholecystitis and a negative or equivocal US.

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 [38].

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".

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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.