Published in final edited form as:
J Am Coll Radiol. 2014 March ; 11(3): 316–322. doi:10.1016/j.jacr.2013.11.017.

ACR Appropriateness Criteria Right Upper Quadrant Pain

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Abstract

Acute right upper quadrant pain is a common presenting symptom in patients with acute cholecystitis. When acute cholecystitis is suspected in patients with right upper quadrant pain, in most clinical scenarios, the initial imaging modality of choice is ultrasound. Although cholescintigraphy has been shown to have slightly higher sensitivity and specificity for diagnosis, ultrasound is preferred as the initial study for a variety of reasons, including greater availability, shorter examination time, lack of ionizing radiation, morphologic evaluation, confirmation of the presence or absence of gallstones, evaluation of bile ducts, and identification or exclusion of alternative diagnoses. CT or MRI may be helpful in equivocal cases and may identify complications of acute cholecystitis. When ultrasound findings are inconclusive, MRI is the preferred imaging test in pregnant patients who present with right upper quadrant pain.

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Dr Rosen is a stockholder in Anvita Health. Dr Baker has a research agreement with Siemens Healthcare and receives monetary support for forthcoming research. Dr Nelson is a consultant for GE Healthcare and receives research support from Bracco Wemoto International and Becton Dickinson. Dr Qayyum's spouse works for Philips Medical Systems. Dr Smith: Bayer - Role as an independent contractor for contracted research. Bracco Diagnostics - Role as an independent contractor for contracted research. GE Healthcare - Role as an independent contractor for contracted research. Pfizer - My wife has a relationship of ownership interest (stock). Boston Scientific - My wife has a relationship of ownership interest (stock).

The ACR Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed every 2 years by a multidisciplinary expert panel. The guideline development and review include an extensive analysis of current medical literature from peer-reviewed journals and the application of a well-established consensus methodology (modified Delphi) to rate the appropriateness of imaging and treatment procedures by the panel. In those instances in which evidence is lacking or not definitive, expert opinion may be used to recommend imaging or treatment.

Keywords

Appropriateness Criteria; cholescintigraphy; ultrasound; cholecystitis; abdominal pain; comparative studies

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 focuses 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, so 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 alternative diagnoses if AC is not present [1].

Radiography of the abdomen is of limited value for evaluating right upper quadrant pain. Although abdominal radiography performed for initial evaluation may identify gallstones, they are not sufficient for establishing diagnoses of AC. Ultrasound and cholescintigraphy are the imaging studies most often used to diagnose AC. 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 MRI in patients with suspected AC; however, its use has yet to be fully assessed (see Variants 1–4).

Ultrasound and Cholescintigraphy

An initial study in 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 the separation of AC from gallstones alone and chronic cholecystitis with gallstones [2]. Unfortunately, the sonographic Murphy sign has relatively low specificity for AC [3], and its absence is unreliable as a negative predictor of AC if the patient has received pain medication before imaging. Since that initial study, many subsequent studies have been conducted to assess the accuracy of ultrasound and

cholescintigraphy. In a meta-analysis, Shea et al [4] reviewed 22 studies evaluating cholescintigraphy and 5 studies evaluating ultrasound 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 ultrasound had 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 ultrasound 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 reported slightly lower sensitivity of ultrasound at 81% (95% CI: 75%, 87%) and slightly higher specificity at 83% (95% CI: 74%, 89%). Similarly, direct comparisons of the diagnostic accuracy of ultrasound and cholescintigraphy performed in 11 studies confirmed the superior accuracy of cholescintigraphy.

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

CT

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 on the basis of ultrasound and/or scintigraphic findings 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 the 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 the 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 ultrasound and/or scintigraphic results 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.

MRI

AC can be confirmed or excluded by 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 patients who are difficult to examine with ultrasound [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 ultrasound.

Few studies have examined the role of MRI in evaluating AC. On the basis of 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 [5], the summary sensitivity is 85% (95% CI: 66%, 95%), and specificity is 81% (95% CI: 69%, 90%) [23–25], similar to those of ultrasound. 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, ultrasound is the imaging test of choice for evaluating AC in pregnant patients (see Variant 5). MRI is the preferred test to follow inconclusive ultrasound, 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. MR 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 ultrasound 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 that of calculous AC (see Variant 6). 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 ultrasound and/or scintigraphy has been advocated for AAC. The usefulness of ultrasound is limited, however, because gallbladder abnormalities are common on ultrasound 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 results 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 ultrasound, the high prevalence of nonspecific abnormal imaging findings in the gallbladders of critically ill patients limits its diagnostic value. Nevertheless, when the gallbladder seems 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 at 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]. After 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 ultrasound and/or cholescintigraphy.
- Ultrasound 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 can be used to identify complications of AC.
- If AC is excluded by ultrasound 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 the results of ultrasound are inconclusive.
- Percutaneous cholecystostomy may be both diagnostic and therapeutic in patients with acalculous cholecystitis.
- These guidelines should allow radiologists, emergency physicians, and surgeons 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 pregnant patients can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- *ACR-SPR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation* [44],
- *ACR-ACOG-AIUM-SRU Practice Guideline for the Performance of Obstetrical Ultrasound* [45],
- *ACR Manual on Contrast Media* [46], and
- "ACR Guidance Document on Safe MR Practices: 2013" [47].

ANTICIPATED EXCEPTIONS

Nephrogenic systemic fibrosis is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It seems to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rates (ie, <30 mL/min/1.73 m^2), and almost never in other patients. There is growing literature regarding nephrogenic systemic fibrosis. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk and to limit the type and amount in patients with estimated glomerular filtration rates <30 mL/min/1.73 m^2. For more information, please see the *ACR Manual on Contrast Media* [46].

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 indication has been included for each imaging examination. The relative radiation levels 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 seems to accompany radiation exposure). For these reasons, the relative radiation level dose estimate ranges for pediatric examinations are lower compared with those specified for adults (see Table 1). Additional information regarding radiation dose assessment for imaging examinations can be found in *ACR Appropriateness Criteria®: Radiation Dose Assessment Introduction* [48].

For additional information on ACR Appropriateness Criteria, refer to www.acr.org/ac.

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Table 1

Relative radiation level designations

Relative Radiation Level	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
☢	<0.1	<0.03
☢☢	0.1–1	0.03–0.3
☢☢☢	1–10	0.3–3
☢☢☢☢	10–30	3–10
☢☢☢☢☢	30–100	10–30

Note: Relative radiation level 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 relative radiation levels for these examinations are designated as “Varies.”

Variant 1

Fever, elevated white blood cell count, positive Murphy sign

Radiologic Procedure	Rating	Comments	Relative Radiation Level
Ultrasound abdomen	9		○
MRI abdomen without and with contrast	6	See statement regarding contrast in text under “Anticipated Exceptions.”	○
Cholescintigraphy	6	Based on ultrasound findings, this generally should follow ultrasound of the right upper quadrant.	☢☢
CT abdomen with contrast	6		☢☢☢
MRI abdomen without contrast	4		○
CT abdomen without contrast	4		☢☢☢
CT abdomen without and with contrast	3		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Variant 2

No fever, normal white blood cell count

Radiologic Procedure	Rating	Comments	Relative Radiation Level
Ultrasound abdomen	9	This is performed to exclude a diagnosis of stones and bile duct obstruction.	○
MRI abdomen without and with contrast	6	See statement regarding contrast in text under “Anticipated Exceptions.”	○
Cholescintigraphy	6	This is performed if ultrasound is equivocal.	☢☢
CT abdomen with contrast	6		☢☢☢
MRI abdomen without contrast	5		○
CT abdomen without contrast	3		☢☢☢
CT abdomen without and with contrast	3		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Variant 3

No fever, normal white blood cell count, ultrasound shows only gallstones

Radiologic Procedure	Rating	Comments	Relative Radiation Level
CT abdomen with contrast	7		☢☢☢
MRI abdomen without contrast	6		○
MRI abdomen without and with contrast	6	See statement regarding contrast in text under “Anticipated Exceptions.”	○
Cholescintigraphy	6	This is performed to exclude other sources of pain from the diagnosis.	☢☢
CT abdomen without contrast	3		☢☢☢
CT abdomen without and with contrast	3		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, 9 = usually appropriate.

Variant 4

Hospitalized patient with fever, elevated white blood cell count, and positive Murphy sign

Radiologic Procedure	Rating	Comments	Relative Radiation Level
Ultrasound abdomen	9		○
CT abdomen with contrast	7		☢☢☢
MRI abdomen without and with contrast	6	See statement regarding contrast in text under “Anticipated Exceptions.”	○
Cholescintigraphy	6	This is performed if ultrasound is inconclusive.	☢☢
Percutaneous cholecystostomy	6	This can be both diagnostic and therapeutic, particularly with intensive care unit 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 contrast	5		○
CT abdomen without contrast	4		☢☢☢
CT abdomen without and with contrast	3		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Variant 5

Fever, leukocytosis, pregnant patient

Radiologic Procedure	Rating	Comments	Relative Radiation Level
Ultrasound abdomen	9		○
MRI abdomen without contrast	8		○
MRI abdomen without and with contrast	3	See statement regarding contrast in text under “Anticipated Exceptions.”	○
Cholescintigraphy	3		☢☢
CT abdomen without contrast	3		☢☢☢
CT abdomen with contrast	3		☢☢☢
CT abdomen without and with contrast	1		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Variant 6

Suspected acalculous cholecystitis

Radiologic Procedure	Rating	Comments	Relative Radiation Level
Ultrasound abdomen	8	If gallbladder dilation, wall thickening, or fluid are present, proceed with percutaneous cholecystostomy, as clinically indicated.	○
MRI abdomen without and with contrast	6	See statement regarding contrast in text under “Anticipated Exceptions.”	○
Cholescintigraphy	6	This procedure is used for hospitalized patients, following equivocal results on ultrasound.	☢☢
CT abdomen with contrast	6		☢☢☢
Percutaneous cholecystostomy	6	This can be both diagnostic and therapeutic, particularly with intensive care unit 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 contrast	4		○
CT abdomen without contrast	4		☢☢☢
CT abdomen without and with contrast	3		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.