

**Right Upper Quadrant Pain
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Trowbridge RL, Rutkowski NK, Shojania KG. Does this patient have acute cholecystitis? <i>JAMA</i> 2003; 289(1):80-86.	Review/Other-Dx	17 studies	To determine role of clinical or laboratory testing in identifying patients who require diagnostic imaging tests to rule in or rule out the diagnosis of AC.	No clinical criteria had high or low likelihood ratio for AC except Murphy sign (positive likelihood ratio 2.8) and right upper quadrant tenderness (positive likelihood ratio 0.4).	4
2. Laing FC, Federle MP, Jeffrey RB, Brown TW. Ultrasonic evaluation of patients with acute right upper quadrant pain. <i>Radiology</i> 1981; 140(2):449-455.	Observational-Dx	52 patients	Prospective study to define the role of US in acute right upper quadrant pain.	SMS plus stones was most sensitive for AC; 33% had no stones or SMS and were normal.	3
3. Bree RL. Further observations on the usefulness of the sonographic Murphy sign in the evaluation of suspected acute cholecystitis. <i>J Clin Ultrasound</i> 1995; 23(3):169-172.	Observational-Dx	200 patients	To determine accuracy of SMS in AC.	Sensitivity of SMS 86%, specificity 35%, PPV 43%, NPV 82%. Combination of stones and SMS specificity of 77%. SMS has many false positives.	3
4. Shea JA, Berlin JA, Escarce JJ, et al. Revised estimates of diagnostic test sensitivity and specificity in suspected biliary tract disease. <i>Arch Intern Med</i> 1994; 154(22):2573-2581.	Review/Other-Dx	30 articles	To estimate the sensitivity and specificity of diagnostic tests for gallstones and AC.	US has the best unadjusted sensitivity (0.97; 95% CI, 0.95 to 0.99) and specificity (0.95; 95% CI, 0.88 to 1.00) for evaluating patients with suspected gallstones. Adjusted values are 0.84 (0.76 to 0.92) and 0.99 (0.97 to 1.00), respectively. Adjusted and unadjusted results for oral cholecystogram were lower. Radionuclide scanning has the best sensitivity (0.97; 95% CI, 0.96 to 0.98) and specificity (0.90; 95% CI, 0.86 to 0.95) for evaluating patients with suspected AC; test performance is unaffected by delayed imaging. Unadjusted sensitivity and specificity of US in evaluating patients with suspected AC are 0.94 (0.92 to 0.96) and 0.78 (0.61 to 0.96); adjusted values are 0.88 (0.74 to 1.00) and 0.80 (0.62 to 0.98).	4
5. Kiewiet JJ, Leeuwenburgh MM, Bipat S, Bossuyt PM, Stoker J, Boermeester MA. A systematic review and meta-analysis of diagnostic performance of imaging in acute cholecystitis. <i>Radiology</i> 2012; 264(3):708-720.	Review/Other-Dx	57 studies, 5859 patients	To update previously summarized estimates of diagnostic accuracy for AC and to obtain summary estimates for more recently introduced modalities.	Sensitivity of cholescintigraphy (96%; 95% CI: 94%, 97%) was significantly higher than sensitivity of US (81%; 95% CI: 75%, 87%) and MRI (85%; 95% CI: 66%, 95%). There were no significant differences in specificity among cholescintigraphy (90%; 95% CI: 86%, 93%), US (83%; 95% CI: 74%, 89%) and MRI (81%; 95% CI: 69%, 90%). Only one study about evaluation of CT met the inclusion criteria; the reported sensitivity was 94% (95% CI: 73%, 99%) at a specificity of 59% (95% CI: 42%, 74%).	4

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6. Bennett GL, Balthazar EJ. Ultrasound and CT evaluation of emergent gallbladder pathology. <i>Radiol Clin North Am</i> 2003; 41(6):1203-1216.	Review/Other-Dx	N/A	Review US and CT evaluation of emergent gallbladder pathology.	US is the initial imaging modality of choice for the evaluation of suspected acute gallbladder disorders. CT also plays an important role in the evaluation of acute gallbladder pathology and is useful where US findings are equivocal. CT is also extremely valuable in the assessment of suspected complications of AC, particularly emphysematous cholecystitis, hemorrhagic cholecystitis, and gallbladder perforation, which are often very difficult diagnoses to establish at US.	4
7. Hanbidge AE, Buckler PM, O'Malley ME, Wilson SR. From the RSNA refresher courses: imaging evaluation for acute pain in the right upper quadrant. <i>Radiographics</i> 2004; 24(4):1117-1135.	Review/Other-Dx	N/A	To review imaging features of AC.	US is the main imaging modality for assessment of acute right upper quadrant pain. US is sensitive and specific in demonstrating gallstones, biliary dilatation, and features that suggest acute inflammatory disease.	4
8. Smith EA, Dillman JR, Elsayes KM, Menias CO, Bude RO. Cross-sectional imaging of acute and chronic gallbladder inflammatory disease. <i>AJR</i> 2009; 192(1):188-196.	Review/Other-Dx	N/A	Comprehensive review of the clinical and cross-sectional imaging features of different acute and chronic gallbladder inflammatory diseases.	Inflammatory gallbladder diseases are a common source of abdominal pain and cause considerable morbidity and mortality. Numerous other gallbladder inflammatory conditions may also occur that can be readily diagnosed by cross-sectional imaging.	4

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9. Cho JY, Han HS, Yoon YS, Ahn KS, Lee SH, Hwang JH. Hepatobiliary scan for assessing disease severity in patients with cholelithiasis. <i>Arch Surg</i> 2011; 146(2):169-174.	Observational-Dx	941 patients	To evaluate the role of a hepatobiliary scan for predicting the severity of cholecystitis and the difficulty of laparoscopic cholecystectomy.	The overall predictive value of the gallbladder ejection fraction for predicting AC was 82.9% ($P<.001$), and the sensitivity and specificity of the gallbladder ejection fraction at a set point of 30.0% were 92.1% and 61.6%, respectively. The mean severity of the cholecystitis score and the difficulty in performing laparoscopic cholecystectomy scores in the patients with gallbladder nonvisualization or a gallbladder ejection fraction less than 30.0% (2.9 [2.5] and 0.5 [0.9], respectively) were significantly higher than those for the patients with a gallbladder ejection fraction of 30.0% or higher (0.5 [1.1] and 0.3 [0.6]; $P<.001$ and $P=.01$, respectively). Moreover, the patients with gallbladder nonvisualization or a gallbladder ejection fraction $>30.0\%$ experienced higher rates of complication after laparoscopic cholecystectomy than did the patients with a gallbladder ejection fraction of 30.0% or higher (6.3% vs 2.6%; $P=.006$).	3
10. Alobaidi M, Gupta R, Jafri SZ, Fink-Bennet DM. Current trends in imaging evaluation of acute cholecystitis. <i>Emerg Radiol</i> 2004; 10(5):256-258.	Observational-Dx	117 patients	To compare roles of US to HIDA in the diagnosis of AC.	Patients had combinations of US, HIDA, both or no imaging. The best results were HIDA imaging with sensitivity of 91% and US has sensitivity of 62%.	2
11. Kalimi R, Gecelter GR, Caplin D, et al. Diagnosis of acute cholecystitis: sensitivity of sonography, cholescintigraphy, and combined sonography-cholescintigraphy. <i>J Am Coll Surg</i> 2001; 193(6):609-613.	Observational-Dx	132 patients	Retrospective study of patients with AC who had US, HIDA or both.	Sensitivity of US 48%. Sensitivity of HIDA 86%. Sensitivity of US plus HIDA 90%. Recommend HIDA as first test.	3
12. Ralls PW, Colletti PM, Halls JM, Siemsen JK. Prospective evaluation of 99mTc-IDA cholescintigraphy and gray-scale ultrasound in the diagnosis of acute cholecystitis. <i>Radiology</i> 1982; 144(2):369-371.	Observational-Dx	91 patients	To assess sensitivity, specificity and accuracy of US and scintigraphy for AC.	US; sensitivity 86%, specificity 90%, accuracy 88%. Scintigraphy; sensitivity. 86%, specificity 84%, accuracy 85%.	2
13. Ralls PW, Colletti PM, Lapin SA, et al. Real-time sonography in suspected acute cholecystitis. Prospective evaluation of primary and secondary signs. <i>Radiology</i> 1985; 155(3):767-771.	Observational-Dx	497 patients	Prospective analysis primary and secondary US signs to determine the accuracy of US for AC.	Stones accurate and sensitive but less specific. SMS and wall thickening less accurate and specific but more sensitive.	3

* See Last Page for Key

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14. Samuels BI, Freitas JE, Bree RL, Schwab RE, Heller ST. A comparison of radionuclide hepatobiliary imaging and real-time ultrasound for the detection of acute cholecystitis. <i>Radiology</i> 1983; 147(1):207-210.	Observational-Dx	194 patients	To compare scintigraphy and US in detection of AC.	Radionuclide scintigraphy: sensitivity 97%, specificity 93% PPV 77%. US sensitivity: 97%, specificity 64%, PPV 40%. Presence of stones was positive; strict pathologic criteria.	3
15. Bennett GL, Rusinek H, Lisi V, et al. CT findings in acute gangrenous cholecystitis. <i>AJR</i> 2002; 178(2):275-281.	Observational-Dx	75 patients; 4 observers	Retrospective review of CT scans to determine value of CT for gangrenous cholecystitis.	Best criteria for gangrenous cholecystitis were air in wall or lumen, intraluminal membranes, irregular or absent wall, and abscess. Absence of wall enhancement, pericholecystic fluid and gall bladder distention. Overall accuracy of CT, 87%.	3
16. De Vargas Macciucca M, Lanciotti S, De Cicco ML, Coniglio M, Gualdi GF. Ultrasonographic and spiral CT evaluation of simple and complicated acute cholecystitis: diagnostic protocol assessment based on personal experience and review of the literature. <i>Radiol Med</i> 2006; 111(2):167-180.	Observational-Dx	35 patients	Retrospective review to identify and classify the US and CT signs of simple and complicated AC and to define the correct diagnostic protocol. Gold standard used was histological findings.	US had accuracy of 66.6%, sensitivity of 37.5%, specificity of 70%, PPV of 100%, and an NPV of 58.3%. CT had 100% accuracy, sensitivity, and specificity. If more than two major signs associated with one minor sign or at least one sign of complication are present at US, CT is mandatory to recognize and evaluate the type of complication and indicate appropriate treatment.	3
17. Kim YK, Kwak HS, Kim CS, et al. CT findings of mild forms or early manifestations of acute cholecystitis. <i>Clin Imaging</i> 2009; 33(4):274-280.	Observational-Dx	34 patients with mild or early AC and 34 control	To determine the most predictive CT feature of the mild forms or early manifestations of AC. Two radiologists analyzed CT of patients.	Most significant predictor of mild or early AC on CT was the presence of pericholecystic increased attenuation on the arterial phase (sensitivity, 82.4%), followed by indistinctness of the interface between the gall bladder and liver (sensitivity, 38.0%), which were identified by both observers with good agreement.	2
18. Shakespear JS, Shaaban AM, Rezvani M. CT findings of acute cholecystitis and its complications. <i>AJR</i> 2010; 194(6):1523-1529.	Review/Other-Dx	N/A	To describe and illustrate the CT findings of AC and its complications.	CT findings suggesting AC should be interpreted with caution and should probably serve as justification for further investigation with abdominal US. CT has a relatively high NPV, and AC is unlikely in the setting of a negative CT. Complications of AC have a characteristic CT appearance and include necrosis, perforation, abscess formation, intraluminal hemorrhage, and wall emphysema.	4

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19. Tsai MJ, Chen JD, Tiu CM, Chou YH, Hu SC, Chang CY. Can acute cholecystitis with gallbladder perforation be detected preoperatively by computed tomography in ED? Correlation with clinical data and computed tomography features. <i>Am J Emerg Med</i> 2009; 27(5):574-581.	Observational-Dx	75 patients	Retrospective review to determine which CT findings and clinical data can help diagnose gallbladder perforation in AC. Medical records and CT findings were compared between 2 groups with and without gallbladder perforation.	16 patients had gallbladder perforation. Higher mortality rate was found in the perforation group (18.8% vs 1.7%; P=.029). Older age (>70 years; P=.004) and higher percentage of segmented neutrophil (>80%; P=.027) were significant clinical factors for predicting gallbladder perforation in AC. In multivariate analysis, visualized gallbladder wall defect was the most significant predicting CT feature for diagnosing gallbladder perforation in AC.	3
20. Fuks D, Mouly C, Robert B, Hajji H, Yzet T, Regimbeau JM. Acute cholecystitis: preoperative CT can help the surgeon consider conversion from laparoscopic to open cholecystectomy. <i>Radiology</i> 2012; 263(1):128-138.	Observational-Dx	108 patients	To establish whether preoperative CT findings in patients with AC were associated with conversion from laparoscopic to open cholecystectomy in patients with calculous AC.	Conversion occurred in 24 (22%) cases. On preoperative CT images, the absence of gallbladder wall enhancement was associated with the presence of gangrenous AC (sensitivity, 73%). The absence of gallbladder wall enhancement (58% and 40% for conversion and nonconversion, respectively; P=.02) and the presence of a gallstone in the gallbladder infundibulum (78% and 22% for conversion and nonconversion, respectively; P=.04) were associated with AC-related conversion in a multivariate analysis. Interobserver agreement for CT study interpretation was very good (median k value, 0.92; range, 0.76-1.00).	2
21. Akpınar E, Turkbey B, Karcaaltincaba M, et al. Initial experience on utility of gadobenate dimeglumine (Gd-BOPTA) enhanced T1-weighted MR cholangiography in diagnosis of acute cholecystitis. <i>J Magn Reson Imaging</i> 2009; 30(3):578-585.	Review/Other-Dx	11 consecutive patients with acute right upper quadrant pain; 15 controls	Prospective study to examine the feasibility of the use of Gd-BOPTA-enhanced T1-weighted MR cholangiography in diagnosis of AC.	In the control group, Gd-BOPTA was visualized within the gallbladder in all subjects. For the study group, gallstones were present in 9 patients on MR cholangiography. In addition to anatomical assessment, Gd-BOPTA-enhanced MR cholangiography can provide functional evaluation similar to scintigraphy in diagnosing AC in patients with acute right upper quadrant pain and equivocal findings.	4

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22. Altun E, Semelka RC, Elias J, Jr., et al. Acute cholecystitis: MR findings and differentiation from chronic cholecystitis. <i>Radiology</i> 2007; 244(1):174-183.	Observational-Dx	32 patients; 4 blinded reviewers	To retrospectively determine the sensitivity and specificity of MRI for differentiation between acute and chronic cholecystitis, with histopathologic analysis as the reference standard.	MRI sensitivity and specificity were 95% (18/19 patients) and 69% (9/13 patients), respectively. Sensitivities of increased gallbladder wall enhancement and increased transient pericholecystic hepatic enhancement were 74% (14/19 patients) and 62% (10/16 patients), respectively. Both findings had 92% (12/13 patients) specificity. Sensitivities of increased wall thickness, pericholecystic fluid, and adjacent fat signal intensity changes were 100% (19/19 patients), 95% (18/19 patients), and 95% (18/19 patients), respectively; specificities were 54% (7/13 patients), 38% (5/13 patients), and 54% (7/13 patients), respectively. Pericholecystic abscess, intraluminal membranes, and wall irregularity or defect each had 100% (13/13 patients) specificity; sensitivities were 11% (2/19 patients), 26% (five of 19 patients), and 21% (4/19 patients), respectively. Increased gallbladder wall enhancement (P<.001) and increased transient pericholecystic hepatic enhancement (P=.003) were the most significantly different between acute and chronic cholecystitis.	3
23. Oh KY, Gilfeather M, Kennedy A, et al. Limited abdominal MRI in the evaluation of acute right upper quadrant pain. <i>Abdom Imaging</i> 2003; 28(5):643-651.	Observational-Dx	24 patients	To investigate whether limited abdominal MRI is as effective as transabdominal US in evaluating patients presenting with acute right upper quadrant pain.	MRI and US demonstrated no statistically significant difference in the diagnosis of gallbladder wall thickening, the presence of gallstones or pericholecystic fluid, or the diagnosis of AC (P>0.05). The sensitivity of both for AC was 50%, with specificities of 89% and 86% for US and MRI, respectively. US readers more frequently requested additional tests and displayed more variability in whether they could adequately see the common bile duct.	2
24. Hakansson K, Leander P, Ekberg O, Hakansson HO. MR imaging in clinically suspected acute cholecystitis. A comparison with ultrasonography. <i>Acta Radiol</i> 2000; 41(4):322-328.	Observational-Dx	94 patients	To compare the diagnostic value of fast pulse sequences in MRI with US in patients with clinically suspected AC.	MR diagnoses were AC in 23, gallbladder and common bile duct stones in 3, and other pathologic conditions of the abdomen in 7 and normal in 2 patients. US diagnoses were AC in 17, gallbladder stones in 8, other pathologic conditions of the abdomen in 2, normal in 5 and non-conclusive in 3 patients.	2

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25. Regan F, Schaefer DC, Smith DP, Petronis JD, Bohlman ME, Magnuson TH. The diagnostic utility of HASTE MRI in the evaluation of acute cholecystitis. Half-Fourier acquisition single-shot turbo SE. <i>J Comput Assist Tomogr</i> 1998; 22(4):638-642.	Observational-Dx	72 patients	To (a) determine the significance of high signal intensity surrounding the gallbladder as seen on T2-weighted HASTE MRIs in patients with AC and (b) to determine the sensitivity of T2-weighted HASTE MRIs in detecting gallbladder and common bile duct calculi in patients with AC.	Of the 72 patients imaged with HASTE MRI, 55 had cholecystitis based on clinical, sonographic, and/or surgical findings. Of these, 45 had acute and 10 had chronic cholecystitis. HASTE MRI demonstrated MR pericholecystic high signal in 41/45 (91%) of the patients with AC. The sensitivity of HASTE MRI in diagnosing AC was 91%. The specificity was 79%. The PPV was 87%, the NPV was 85%, and the overall accuracy of the test was 89%. Gallbladder stones were seen by HASTE MRI in 38/41 (93%) of patients with acute calculus cholecystitis demonstrated at sonography. Common bile duct stones were demonstrated by HASTE MRI in 7/9 (78%) patients and by sonography in 5/9 (56%) patients with documented choledocholithiasis on conventional cholangiography.	2
26. Oto A, Ernst R, Ghulmiyyah L, Hughes D, Saade G, Chaljub G. The role of MR cholangiopancreatography in the evaluation of pregnant patients with acute pancreaticobiliary disease. <i>Br J Radiol</i> 2009; 82(976):279-285.	Review/Other-Dx	18 pregnant patients had MRCP; 15 patients evaluated with US	Retrospective review of MRIs and patient charts to determine the usefulness of MRCP in the evaluation of pregnant patients with acute pancreaticobiliary disease and its additional value over US.	Biliary dilatation was detected in 8 patients by US. MRCP demonstrated the etiology in 4 of these patients (choledocholithiasis (n=1), Mirizzi syndrome (n=1), choledochal cyst (n=1) and intrahepatic biliary stones (n=1)) and excluded obstructive pathology in the other 4 patients. MRCP appears to be a valuable and safe technique for the evaluation of pregnant patients with acute pancreaticobiliary disease.	4
27. Oto A, Ernst RD, Ghulmiyyah LM, et al. MR imaging in the triage of pregnant patients with acute abdominal and pelvic pain. <i>Abdom Imaging</i> 2009; 34(2):243-250.	Observational-Dx	118 pregnant patients	To determine the usefulness of MRCP in the evaluation of pregnant patients with acute pancreaticobiliary disease and its additional value over US.	The sensitivity, specificity, accuracy, PPVs, and NPVs of MRI for acute appendicitis, and surgical/interventional diagnoses were 90.0% vs 88.9%, 98.1% vs 95.0%, 97.5% vs 94.1%, 81.8% vs 76.2%, 99.1% vs 97.9%, respectively.	3

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28. Boland GW, Slater G, Lu DS, Eisenberg P, Lee MJ, Mueller PR. Prevalence and significance of gallbladder abnormalities seen on sonography in intensive care unit patients. <i>AJR</i> 2000; 174(4):973-977.	Observational-Dx	55 patients	To evaluate sonographic abnormalities of the gallbladder other than acalculous cholecystitis across a broad range of intensive care unit patients.	11/55 patients were found to have gallbladder calculi and were excluded from the study. 37 (84%) of the remaining 44 patients had at least one sonographic abnormality while in the intensive care unit. 25 (57%) of the 44 patients had as many as three abnormalities found on sonography, and 6 (14%) of 44 patients had 4 or 5 sonographic findings of gallbladder abnormalities while in the intensive care unit. No statistically significant correlation was found among any of these sonographic abnormalities and the clinical and laboratory parameters.	2
29. Puc MM, Tran HS, Wry PW, Ross SE. Ultrasound is not a useful screening tool for acute acalculous cholecystitis in critically ill trauma patients. <i>Am Surg</i> 2002; 68(1):65-69.	Observational-Dx	62 patients	A retrospective study to assess the utility of US in the diagnosis of acute acalculous cholecystitis.	The data revealed a sensitivity of 30% (6/20) and a specificity of 93% (39/42) for US evaluation. 20 patients had subsequent HIDA with a sensitivity of 100% (12/12) and specificity of 88% (7/8). The data do not support US as a reliable routine screening tool for acute acalculous cholecystitis. Despite its convenience as a bedside procedure US has insufficient sensitivity to justify its use and a more sensitive diagnostic tool should be used.	3
30. Ziessman HA. Nuclear medicine hepatobiliary imaging. <i>Clin Gastroenterol Hepatol</i> 2010; 8(2):111-116.	Review/Other-Dx	N/A	To review the most common clinical indications of nuclear medicine hepatobiliary imaging (cholescintigraphy).	HIDA can detect high grade biliary obstruction prior to ductal dilatation; images reveal a persistent hepatogram without biliary clearance due to the high backpressure. HIDA also aids in the diagnosis of partial biliary obstruction due to stones, biliary stricture, and sphincter of Oddi obstruction. It can confirm biliary leakage postcholecystectomy and hepatic transplantation. Calculation of a gallbladder ejection fraction after cholecystokinin infusion is commonly used to diagnose chronic acalculous gallbladder disease.	4

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31. Ahvenjarvi L, Koivukangas V, Jartti A, et al. Diagnostic accuracy of computed tomography imaging of surgically treated acute acalculous cholecystitis in critically ill patients. <i>J Trauma</i> 2011; 70(1):183-188.	Observational-Dx	127 patients	To determine the usefulness of CT findings in predicting necrotic acute AC in intensive care unit patients.	Abnormal CT findings were present in 96% of all the intensive care unit patients. Higher bile density in the gallbladder body and subserosal edema was associated with an edematous gallbladder (specificity, 93.6%; sensitivity, 23.1%). The most specific findings predicting necrotic acute AC were gas in the gallbladder wall or lumen, lack of gallbladder wall enhancement, and edema around the gallbladder (specificity, 99.2%, 94.9%, and 92.4%, respectively; and sensitivity, 11.1%, 37.5%, and 22.2%, respectively).	3
32. Khan MN, Nordon I, Ghauri AS, Ranaboldo C, Carty N. Urgent cholecystectomy for acute cholecystitis in a district general hospital - is it feasible? <i>Ann R Coll Surg Engl</i> 2009; 91(1):30-34.	Review/Other-Dx	64 patients	To determine the conversion rate and the risk of major complications with laparoscopic cholecystectomy for AC and to compare the results with the published data from specialist centers.	All patients underwent laparoscopic cholecystectomy during the index admission. 11 patients had preoperative ERCP and 12 patients had on-table cholangiogram. There were no conversions. Postoperative ERCP was required in 6 patients. The median time interval between admission and operation was 3 days (range, 2-7 days). There were two bile leaks but no common bile duct injury. There were two cases of superficial wound infection. One patient required re-operation for small bowel obstruction secondary to a port site hernia.	4

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33. Melloul E, Denys A, Demartines N, Calmes JM, Schafer M. Percutaneous drainage versus emergency cholecystectomy for the treatment of acute cholecystitis in critically ill patients: does it matter? <i>World J Surg</i> 2011; 35(4):826-833.	Observational-Tx	42 patients	To compare percutaneous drainage of the gallbladder to emergency cholecystectomy in a well-defined patient group with sepsis related to acute calculous/acalculous cholecystitis.	42 patients [median age = 65.5 years (range = 32-94)] were included; 45% underwent emergency cholecystectomy (10 laparoscopic, 9 open) and 55% percutaneous drainage (n=23). Both patient groups had similar preoperative characteristics. Percutaneous drainage and emergency cholecystectomy were successful in 91% and 100% of patients, respectively. Organ dysfunctions were similarly improved by the third postoperative/postdrainage days. Despite undergoing percutaneous drainage, 2 patients required emergency cholecystectomy due to gangrenous cholecystitis. The conversion rate after laparoscopy was 20%. Overall morbidity was 8.7% after percutaneous drainage and 47% after emergency cholecystectomy (P=0.011). Major morbidity was 0% after percutaneous drainage and 21% after emergency cholecystectomy (P=0.034). The mortality rate was not different (13% after percutaneous drainage and 16% after emergency cholecystectomy, P=1.0) and the deaths were all related to the patients' preexisting disease. Hospital and intensive care unit stays were not different. Recurrent symptoms (17%) occurred only after AC in the percutaneous drainage group.	2
34. Popkharitov AI. Laparoscopic cholecystectomy for acute cholecystitis. <i>Langenbecks Arch Surg</i> 2008; 393(6):935-941.	Observational-Tx	225 patients	To examine use of laparoscopic cholecystectomy in AC, evaluating the effect of timing of surgery and the influence of the various types of gallbladder inflammation on patient outcome.	Laparoscopic cholecystectomy can be done safely in most patients with AC. The timing of surgery has no clinical relevant effect on conversion rates, operative times, morbidity, and postoperative hospital stay.	3

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35. Steiner CA, Bass EB, Talamini MA, Pitt HA, Steinberg EP. Surgical rates and operative mortality for open and laparoscopic cholecystectomy in Maryland. <i>N Engl J Med</i> 1994; 330(6):403-408.	Review/Other-Dx	54 acute care hospitals; 29,851 patients	To analyze the association between the introduction of this procedure and three variables: the rate at which cholecystectomy was performed in Maryland, the characteristics of patients undergoing cholecystectomy in routine clinical practice, and operative mortality.	The annual rate of cholecystectomy, adjusted for age, rose from 1.69 per 1,000 state residents in 1987-1989 to 2.17 per 1,000 residents in 1992, an increase of 28% ($P<0.001$). As compared with patients undergoing open cholecystectomy, patients undergoing laparoscopic cholecystectomy tended to be younger, less likely to have AC or a common-duct stone, and more likely to be white and have private health insurance or belong to a health maintenance organization ($P<0.001$). Although the operative mortality associated with laparoscopic cholecystectomy was less than that with open cholecystectomy (adjusted odds ratio, 0.22; 95% CI, 0.13 to 0.37) and the overall mortality rate for all cholecystectomies declined from 0.84% in 1989 to 0.56% in 1992, there was no significant change in the total number of cholecystectomy-related operative deaths because of the increase in the cholecystectomy rate.	4
36. Bingener J, Richards ML, Schwesinger WH, Strodel WE, Sirinek KR. Laparoscopic cholecystectomy for elderly patients: gold standard for golden years? <i>Arch Surg</i> 2003; 138(5):531-535; discussion 535-536.	Observational-Tx	5,884 patients	To evaluate the outcomes in an elderly population at a time when laparoscopic cholecystectomy has become the gold standard for patients with symptomatic gallstone disease.	Elderly patients were predominantly male (64%). Septuagenarians had a 40% incidence of complicated gallstone disease, such as AC, choledocholithiasis, or biliary pancreatitis, and octogenarians had a 55% incidence. Overall mortality was 1.4%. The conversion rate was 17% for the first 5 years of the study period and 7% for the second half. The conversion rate was 22% for patients with complicated disease and 2.5% for patients with chronic cholecystitis. Average hospital stay decreased from 10.2 days to 4.6 days during the first and second half of the study period, respectively.	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Brunt LM, Quasebarth MA, Dunnegan DL, Soper NJ. Outcomes analysis of laparoscopic cholecystectomy in the extremely elderly. <i>Surg Endosc</i> 2001; 15(7):700-705.	Observational-Tx	421 patients	To determine whether extremely elderly patients, age 80 years or older, were at higher risk for adverse outcomes from laparoscopic cholecystectomy than patients younger than 80 years.	Advanced age (group 2) was associated with a higher mean American Society of Anesthesiology (ASA) class (2.7 vs 2.3; $P<0.001$) and a greater incidence of common bile duct stones (43% vs 26%; $P<0.01$), as compared with those of younger age (group 1). Mean operative times in group 2 were 106 +/- 45 min as compared with 96 +/- 38 min in group 1, a difference that is not significant. The extremely elderly (group 2) had a four-fold higher rate of conversion to open cholecystectomy (16% vs 4%) and a longer mean postoperative hospital stay (2.1 vs 1.4 days). Grades 1 and 2 complications also were more common in group 2: grade 1: group 1, 8.8% vs group 2, 17% and grade 2: group 1, 4.3% vs group 2, 7.1% ($P<0.05$). One patient in group 1 had a myocardial infarction 13 days postoperatively, and two deaths occurred in the extremely elderly group within 30 days postoperatively.	2
38. Kirshtein B, Bayme M, Bolotin A, Mizrahi S, Lantsberg L. Laparoscopic cholecystectomy for acute cholecystitis in the elderly: is it safe? <i>Surg Laparosc Endosc Percutan Tech</i> 2008; 18(4):334-339.	Observational-Tx	225 patients	To evaluate the outcome of laparoscopic cholecystectomy in patients with AC aged 75 years and older.	There was no difference in mean duration of symptoms before admission and length of hospital stay before surgery (3.8 days in elderly vs 3.1 in younger patients, and 2.8 vs 2.3 days, respectively). In all, 21% of the elderly patients had American Society of Anesthesiologists score III and IV. Mean operative time and conversion rate to open surgery were similar in both groups. Postoperative stay was longer in elderly (3.9 vs 2.8). The postoperative complications rate and mortality were significantly higher in the elderly group (31% vs 15%, and 4.8% vs 0.5%, respectively).	3

**Right Upper Quadrant Pain
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
39. Pessaix P, Regenet N, Tuech JJ, Rouge C, Bergamaschi R, Arnaud JP. Laparoscopic versus open cholecystectomy: a prospective comparative study in the elderly with acute cholecystitis. <i>Surg Laparosc Endosc Percutan Tech</i> 2001; 11(4):252-255.	Observational-Tx	139 patients	To determine the feasibility and the efficacy of laparoscopic cholecystectomy for AC in patients older than 75 years of age and to compare the results with those of open cholecystectomy.	The two groups of patients with cholecystolithiasis included 50 patients who underwent laparoscopic cholecystectomy (group 1) and 89 patients who underwent open cholecystectomy (group 2). Group 1 consisted of 30 women and 20 men, with a mean age of 81.9 years (range, 75-98). Group 2 consisted of 51 women and 38 men, with a mean age of 81.9 years (range, 75-93). There was no difference in the American Society of Anesthesiologists classification in both groups. The length of the surgery (103.3 vs 149.7 minutes), postoperative length of stay (7.7 vs 12.7 days), and inpatient rehabilitation (15 vs 42 patients) were significantly shorter in group 1 than in group 2. The postoperative morbidity rate was not different between the groups. There was no mortality in group 1, but four patients died in group 2 (P=0.29). The conversion rate was 32% (n = 16) in group 1. Laparoscopic cholecystectomy in elderly patients with AC is safe and effective.	2
40. Winbladh A, Gullstrand P, Svanvik J, Sandstrom P. Systematic review of cholecystostomy as a treatment option in acute cholecystitis. <i>HPB (Oxford)</i> 2009; 11(3):183-193.	Review/Other-Dx	53 studies, 1,918 patients	To determine if there is any evidence in the literature to recommend percutaneous cholecystostomy rather than cholecystectomy for AC in the elderly population.	Successful intervention was seen in 85.6% of patients with AC. A total of 40% of patients treated with percutaneous cholecystostomy were later cholecystectomized, with a mortality rate of 1.96%. Procedure mortality was 0.36%, but 30-day mortality rates were 15.4% in patients treated with percutaneous cholecystostomy and 4.5% in those treated with acute cholecystectomy (P<0.001).	4
41. Chung YH, Choi ER, Kim KM, et al. Can percutaneous cholecystostomy be a definitive management for acute acalculous cholecystitis? <i>J Clin Gastroenterol</i> 2012; 46(3):216-219.	Observational-Tx	57 patients	To evaluate the safety, efficacy, and long-term outcome of percutaneous cholecystostomy without additional cholecystectomy as a definitive treatment for acute acalculous cholecystitis.	Percutaneous cholecystostomy was technically successful in all patients, and no major complications relating to the procedure were encountered. Symptoms resolved within 4 days in 53/57 (93%) patients. The in-hospital mortality rate was 21% (11/57) and elective cholecystectomy was performed in 18/57 (31%). 28 patients were managed non-operatively and cholecystostomy tubes were subsequently removed. These 28 patients were follow-up over a median 32 months and recurrent cholecystitis occurred in 2 (7%).	2

**Right Upper Quadrant Pain
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Cherng N, Witkowski ET, Sneider EB, et al. Use of cholecystostomy tubes in the management of patients with primary diagnosis of acute cholecystitis. <i>J Am Coll Surg</i> 2012; 214(2):196-201.	Observational-Tx	185 patients	To review both surgical cholecystostomy tubes and percutaneous cholecystostomy tubes used to treat patients with AC at a tertiary care center and determine whether there was a benefit to these patients compared with conventional therapy of open conversion or open cholecystectomy.	Mean patient age was 71 years and 80% had ≥ 1 comorbidity (mean 2.6). 78% of cholecystostomy tubes were percutaneous cholecystostomy tube placement and 22% were surgical cholecystostomy tube placement. Median length of stay from cholecystostomy tube insertion to discharge was 4 days. The majority (57%) of patients eventually underwent cholecystectomy performed by 20 different surgeons in a median of 63 days post-cholecystostomy tube (range 3 to 1,055 days); of these, 86% underwent laparoscopic cholecystectomy and 13% underwent open conversion or open cholecystectomy. In the radiology and surgical group, 50% and 80% underwent subsequent cholecystectomy, respectively, at a median of 63 and 60 days post-cholecystostomy tube. Whether surgical or percutaneous cholecystostomy tube placement, approximately the same proportion of patients (85% to 86%) underwent laparoscopic cholecystectomy as definitive treatment.	2

**Right Upper Quadrant Pain
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
43. Joseph T, Unver K, Hwang GL, et al. Percutaneous cholecystostomy for acute cholecystitis: ten-year experience. <i>J Vasc Interv Radiol</i> 2012; 23(1):83-88 e81.	Observational-Tx	106 patients	To review the clinical course of patients with AC treated by percutaneous cholecystostomy, and to identify risk factors retrospectively that predict outcome.	Overall, 72 patients (68%) showed an improvement clinically, whereas 34 (32%) showed no improvement or a clinically worsened condition after cholecystostomy. Patients who presented to the emergency department primarily with AC fared better (84% of patients showed improvement) than inpatients (34% showed improvement; $P<.0001$). Gallstones were identified in 54% of patients who presented to the emergency department, whereas acalculous cholecystitis was more commonly diagnosed in inpatients (54%). Patients with sepsis had worse outcomes overall ($P<.0001$). Bacterial bile cultures were analyzed in 95% of patients and showed positive results in 52%, with no overall effect on outcome. There was no correlation between the time of onset of symptoms until antibiotic therapy or cholecystostomy in either group. Long-term outcomes for both groups were better for those who later underwent cholecystectomy ($P<.0001$).	2
44. American College of Radiology. <i>Manual on Contrast Media</i> . Available at: http://www.acr.org/~link.aspx?_id=29C40D1FE0EC4E5EAB6861BD213793E5&_z=z .	Review/Other-Dx	N/A	Guidance document on contrast media to assist radiologists in recognizing and managing risks associated with the use of contrast media.	N/A	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
 - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
 - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
 - c) the study is an expert opinion or consensus document.

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

AC = Acute cholecystitis

CI = Confidence interval

CT = Computed tomography

ERCP = Endoscopic retrograde cholangiopancreatography

Gd-BOPTA = Gadobenate dimeglumine

HASTE = Half-Fourier acquisition single-shot turbo spin-echo

HIDA = Hepatobiliary 99mTc-iminodiacetic acid

MRCP = Magnetic resonance cholangiopancreatography

MRI = Magnetic resonance imaging

NPV = Negative predictive value

PPV = Positive predictive value

SMS = Sonographic Murphy sign

US = Ultrasound