

The role of endoscopy in the evaluation of suspected choledocholithiasis

This is one of a series of statements discussing the use of GI endoscopy in common clinical situations. The Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy prepared this text. In preparing this guideline, a search of the medical literature was performed by using PubMed. Additional references were obtained from the bibliographies of the identified articles and from recommendations of expert consultants. When few or no data exist from well-designed prospective trials, emphasis is given to results of large series and reports from recognized experts. Guidelines for appropriate use of endoscopy are based on a critical review of the available data and expert consensus at the time that the guidelines are drafted. Further controlled clinical studies may be needed to clarify aspects of this guideline. This guideline may be revised as necessary to account for changes in technology, new data, or other aspects of clinical practice. The recommendations were based on reviewed studies and were graded on the strength of the supporting evidence (Table 1).¹

This guideline is intended to be an educational device to provide information that may assist endoscopists in providing care to patients. This guideline is not a rule and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment. Clinical decisions in any particular case involve a complex analysis of the patient's condition and available courses of action. Therefore, clinical considerations may lead an endoscopist to take a course of action that varies from these guidelines.

Gallstone disease affects more than 20 million American adults² at an annual cost of \$6.2 billion.³ A subset of these patients will also have choledocholithiasis, including 5% to 10% of those undergoing laparoscopic cholecystectomy for symptomatic cholelithiasis⁴⁻⁷ and 18% to 33% of patients with acute biliary pancreatitis.⁸⁻¹¹ The approach to patients with suspected choledocholithiasis requires careful consideration because missed common bile duct (CBD) stones pose a risk of recurrent symptoms, pancreatitis, and cholangitis. However, the morbidity and cost

from indiscriminant and/or invasive biliary evaluation should also be minimized. This guideline addresses the role of endoscopy in patients with suspected choledocholithiasis.

INITIAL EVALUATION

Choledocholithiasis is most commonly suspected in the scenarios of symptomatic cholelithiasis and acute biliary pancreatitis (ABP), with other presentations such as de novo bile duct stones in the postcholecystectomy patient occurring less often. The initial evaluation of suspected choledocholithiasis should include serum liver biochemical tests (eg, alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and total bilirubin) and a transabdominal ultrasound (US) of the right upper quadrant. Fractionation of bilirubin can be considered in clinical scenarios in which isolated indirect hyperbilirubinemia (eg, Gilbert syndrome) may be present.

Liver biochemical tests may have the most utility in excluding the presence of CBD stones; the negative predictive value of completely normal liver biochemical test results in a series of more than 1000 patients undergoing laparoscopic cholecystectomy was more than 97%, whereas the positive predictive value of any abnormal liver biochemical test result was only 15%.¹² Although other series have reported modestly better positive predictive values for CBD stones for abnormal bilirubin, alkaline phosphatase, or γ -glutamyl transpeptidase, these still generally range from 25% to 50%.¹²⁻¹⁵ These latter cholestatic liver biochemical tests generally progressively increase with the duration and severity of biliary obstruction. As such, more abnormally elevated values will result in an increased likelihood of CBD stones.^{13,14} For example, in one study, a bilirubin level of 1.7 mg/dL or higher portended a specificity of 60% for choledocholithiasis, whereas the specificity increased to approximately 75% at a cutoff of 4 mg/dL.¹³ However, the mean bilirubin level in series of patients with choledocholithiasis has been reported at 1.5 to 1.9 mg/dL,^{14,15} and only a minority (one third or less) of patients with choledocholithiasis will have a bilirubin level of 4 mg/dL or higher.^{13,14}

Transabdominal US has a relatively poor sensitivity (22%-55%) for detecting CBD stones.¹⁶⁻¹⁹ However, US more reliably detects dilation of the CBD (sensitivity 77%-87%), a finding often associated with choledocholithiasis.²⁰⁻²³

TABLE 1. GRADE system for rating the quality of evidence for guidelines

Quality of evidence	Definition	Symbol
High quality	Further research is very unlikely to change our confidence in the estimate of effect.	⊕ ⊕ ⊕ ⊕
Moderate quality	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.	⊕ ⊕ ⊕ ○
Low quality	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.	⊕ ⊕ ○ ○
Very low quality	Any estimate of effect is very uncertain.	⊕ ⊕ ○ ○

Weaker recommendations are indicated by phrases such as "we suggest," whereas stronger recommendations are typically stated as "we recommend."
Adapted from Guyatt et al.¹

TABLE 2. A proposed strategy to assign risk of choledocholithiasis in patients with symptomatic cholelithiasis based on clinical predictors

Predictors of choledocholithiasis^{13,14,29,31,32}

Very strong

- CBD stone on transabdominal US
- Clinical ascending cholangitis
- Bilirubin > 4 mg/dL

Strong

- Dilated CBD on US (> 6 mm with gallbladder in situ)
- Bilirubin level 1.8-4 mg/dL

Moderate

- Abnormal liver biochemical test other than bilirubin
- Age older than 55 y
- Clinical gallstone pancreatitis

Assigning a likelihood of choledocholithiasis based on clinical predictors^{12-14,28,29,31,32}

Presence of any very strong predictor	High
Presence of both strong predictors	High
No predictors present	Low
All other patients	Intermediate

CBD, Common bile duct.

The normal bile duct diameter is 3 to 6 mm,²⁴⁻²⁶ and mild dilation related to advancing age has been reported.²⁶ Biliary dilation greater than 8 mm in a patient with an intact gallbladder is usually indicative of biliary obstruction.²¹ Also, the sonographic characterization of gallbladder stones harbors some predictive value for choledocholithiasis, with multiple small (<5 mm) stones posing a 4-fold higher risk of migration into the duct as opposed to larger and/or solitary stones.²⁷ Given the relatively low prevalence (5%-10%) of choledocholithiasis in patients with symptomatic cholelithiasis, a normal bile duct US has a 95% to 96% negative predictive value.^{12,28}

Thus, although no single variable consistently strongly predicts choledocholithiasis in patients with symptomatic cholelithiasis, many investigators have noted that the probability of a CBD stone is higher in the presence of multiple abnormal prognostic signs.^{13,29,30} As a result, a number of different prognostic scores, formulas, and algorithms have been devised to help predict the probability of choledocholithiasis.^{13,14,29,31,32} Although there is no single accepted scoring system, by using factors such as age, liver test results, and US findings, patients can generally be categorized into low (<10%), intermediate (10%-50%), and high (>50%) probability of choledocholithiasis (Table 2). A CBD stone seen on US is the most reliable predictor of choledocholithiasis at subsequent endoscopic retrograde cholangiography (ERC) or surgery.^{13,31} The

specificity of US for CBD stones is very high, with occasional discrepancies attributed to interval stone migration or falsely positive US findings. Otherwise, the most predictive variables seem to be cholangitis, a bilirubin level higher than 1.7 mg/dL, and a dilated CBD on US. The presence of 2 or more of these variables results in a high probability of a CBD stone.^{13,31} Advanced age (older than 55 years), elevation of a liver biochemical test result other than bilirubin, and pancreatitis are less robust predictors for choledocholithiasis.^{13,31} Conversely, nonjaundiced patients with a normal bile duct on US have a low probability (<5%) of choledocholithiasis.^{12,28}

A RISK-STRATIFIED DIAGNOSTIC APPROACH TO PATIENTS WITH SYMPTOMATIC CHOLELITHIASIS

A proposed strategy to assign risk of choledocholithiasis based on clinical predictors evident after initial diagnostic evaluation is presented in Table 2. This table summarizes the relative importance of common clinical predictors for choledocholithiasis based on the available

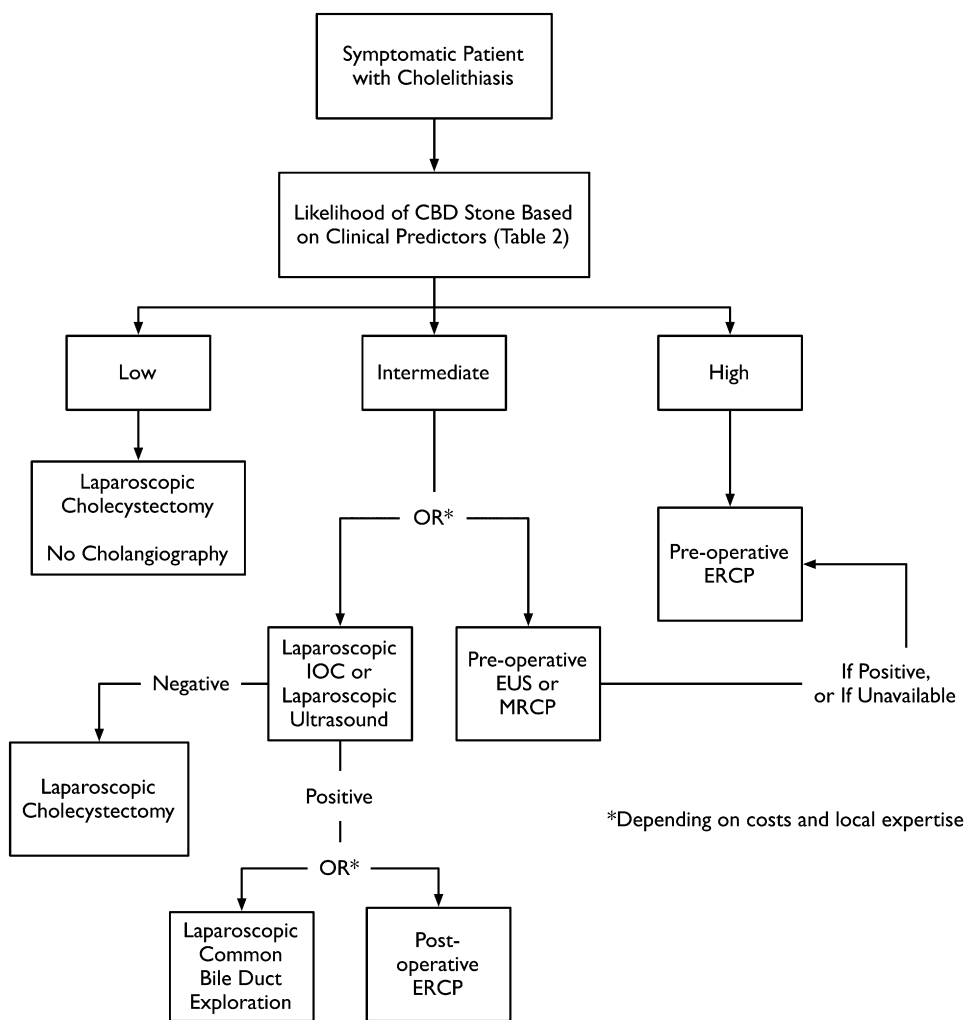


Figure 1. A suggested management algorithm for patients with symptomatic cholelithiasis based on the degree of probability for choledocholithiasis. Modified from Tse et al.³²

literature; however, it is not a validated clinical decision aid. A suggested management algorithm for patients with symptomatic cholelithiasis, based on whether they are at low, intermediate, or high probability of choledocholithiasis, is presented in Figure 1.

Low risk of choledocholithiasis

Patients with symptomatic cholelithiasis who are candidates for surgery and have a low probability of choledocholithiasis (<10%) should undergo cholecystectomy; no further evaluation is recommended because the cost and risks of additional preoperative biliary evaluation are not justified by the low probability of a CBD stone.^{12,28} Whether routine intraoperative cholangiography (IOC) or laparoscopic US should be performed at laparoscopic cholecystectomy, for purposes of both defining the biliary anatomy and for screening for CBD stones, is an area of controversy in the surgical literature.³³⁻³⁶

Intermediate risk of choledocholithiasis

Patients at intermediate probability of choledocholithiasis (10%-50%) after initial evaluation benefit from additional biliary imaging to further triage the need for ductal stone clearance.^{28,37,38} Failure to identify CBD stones can result in recurrent symptoms, cholangitis, and ABP.^{39,40} Options for evaluation of these patients include endoscopic ultrasound (EUS), magnetic resonance cholangiography (MRC), preoperative ERC, and IOC or laparoscopic US to facilitate either removal at surgery or postoperative ERC.

High risk of choledocholithiasis

Patients at high probability of CBD stones (>50%) require further evaluation of the bile duct; because of the frequent need for therapy, typically preoperative ERC or operative cholangiography are undertaken. In the era of open cholecystectomy, there was no advantage found for preoperative ERC over operative cholangiography and common duct exploration in randomized, controlled trials.⁴¹

However, open cholecystectomy is now infrequently performed given the attenuated morbidity and shorter hospital stays associated with laparoscopic cholecystectomy. Two randomized, controlled trials compared 2-stage management (preoperative ERC followed by laparoscopic cholecystectomy) with an all-surgical approach of laparoscopic IOC and transcystic stone removal or laparoscopic choledochotomy for patients at high risk of choledocholithiasis.^{42,43} In these studies, there was no difference in morbidity, mortality, or primary ductal clearance rates (88%) between the 2 arms. Other potential options include intraoperative or postoperative ERC for patients with positive IOC findings; laparoscopic antegrade placement of a transpapillary stent to ensure biliary access at postoperative ERC may also be considered.⁴⁴ A more robust discussion of operative versus endoscopic management of choledocholithiasis in patients undergoing cholecystectomy is beyond the scope of this guideline. However, CBD stone detection and subsequent management are inseparably linked, and many of the techniques used for biliary evaluation and CBD stone removal are considerably operator dependent. Thus, the best strategies for the evaluation and management of choledocholithiasis in patients with symptomatic cholelithiasis will be heavily predicated on local expertise and available technology.

Nonendoscopic biliary imaging modalities

CT: Conventional (nonhelical) CT has historically demonstrated better sensitivity for choledocholithiasis than transabdominal US when composite diagnostic criteria are used (eg, the inclusion of indirect signs such as ductal dilation), although direct visualization of stones has not exceeded 75%.⁴⁵ Helical CT has shown improved performance over conventional CT for choledocholithiasis, with 65% to 88% sensitivity and 73% to 97% specificity.⁴⁶⁻⁴⁹ Expense and radiation exposure have limited the use of CT as a first-line diagnostic test for choledocholithiasis, but in many instances, abdominal CT scans are ordered in the emergency department setting to evaluate and exclude competing potential diagnoses that may have similar presentations.

MRC: MRC has 85% to 92% sensitivity and 93% to 97% specificity for choledocholithiasis detection, as assessed in 2 recent systematic reviews.^{50,51} However, the sensitivity of MRC seems to diminish in the setting of small (<6 mm) stones and has been reported as 33% to 71% in this clinical subset.⁵²⁻⁵⁴

CT cholangiography: CT cholangiography is performed by using helical CT in conjunction with a dedicated cholegraphic iodinated contrast agent that is taken up by the liver and excreted into the bile. Although its performance characteristics for choledocholithiasis detection are similar to those of MRC,^{46,55,56} concerns regarding the toxicity of available cholegraphic agents and significant radiation dose have limited the clinical adoption of this imaging modality.

IOC: Intraoperative fluorocholangiography may be performed by insertion of small catheter into a cystic ductotomy or via the gallbladder (cholecystocholangiography) and injection of iodinated contrast dye with real-time fluoroscopic interpretation by the surgeon. IOC can be successfully completed in 88% to 100% of patients, has a reported sensitivity of 59% to 100% and specificity of 93% to 100% for choledocholithiasis, and typically requires between 10 and 17 minutes to complete during a laparoscopic cholecystectomy.⁵⁷

Laparoscopic US: Laparoscopic US transducers are available in a variety of viewing arrays, may be rigid or flexible, and fit through a conventional laparoscopic trocar. Laparoscopic US of the extrahepatic bile duct can be successfully completed in 88% to 100% of patients and can be performed in 4 to 10 minutes, with a reported sensitivity of 71% to 100% and specificity of 96% to 100%.⁵⁷ Laparoscopic US has a reportedly longer learning curve than does IOC.

Endoscopic biliary imaging modalities

EUS: EUS combines endoscopic visualization with 2-dimensional US and is well suited for biliary imaging given the close proximity of the extrahepatic bile duct to the proximal duodenum. Radial array echoendoscopes more frequently allow elongated views of the bile duct and are thus preferred by many endosonographers; however, the performance of linear array instruments for choledocholithiasis is also excellent, with series reporting a sensitivity of 93% to 97%.^{58,59} Two meta-analyses, each composed of more than 25 trials and more than 2500 patients, reported an 89% to 94% sensitivity and 94% to 95% specificity of EUS for detecting choledocholithiasis, with ERC, IOC, or surgical exploration used as criterion standards.^{60,61} EUS remains highly sensitive for stones smaller than 5 mm, and its performance does not seem adversely affected by decreasing stone size.⁶²⁻⁶⁴ Excluding examinations for esophageal cancer staging, complications with diagnostic EUS are rare (0.1%-0.3%).⁶⁵⁻⁶⁷

ERC: Because the risk of adverse events is higher with ERC than with noninvasive biliary imaging studies or EUS, the use of ERC as a diagnostic modality is best suited for those patients at high risk of choledocholithiasis because they are most likely to benefit from the therapeutic capability of ERC. ERC has traditionally served as a criterion standard for choledocholithiasis detection; thus, data regarding its operating characteristics are limited. However, the sensitivity of ERC with cholangiography alone has been reported as 89% to 93% with a specificity of 100% in studies that used subsequent biliary sphincterotomy and duct sweeping with balloons/baskets as the criterion standard.^{68,69} False-negative ERC findings for choledocholithiasis typically occur in the setting of small stones in a dilated duct.

The risks of ERC include pancreatitis (1.3%-6.7%), infection (0.6%-5.0%), hemorrhage (0.3%-2.0%), and

perforation (0.1%-1.1%) in prospective series of unselected patients.⁷⁰⁻⁷⁶ However, several patient variables (eg, young age, female sex) have been identified that serve as risk factors for pancreatitis; similarly, coagulopathy increases bleeding risk and immunosuppression increases the risk of infection at ERC.⁷² Thus, risk estimates must be individualized to the patient.

ERC-associated technologies: Small-caliber, high-frequency (12-30 MHz) wire-guided intraductal US (IDUS) probes can be passed through the instrument channel of a duodenoscope and into the bile duct without a previous sphincterotomy in nearly 100% of cases.^{69,77} IDUS has demonstrated excellent sensitivity (97%-100%) for choledocholithiasis,^{69,77} and some studies have shown modestly improved accuracy of ERC with IDUS for stone detection compared with cholangiography alone.⁷⁷ However, the clinical impact of the high sensitivity of IDUS for choledocholithiasis is uncertain because stones missed by ERC that are detected by IDUS tend to be small (<4 mm) and of unclear significance.⁶⁹

Conventional "mother-daughter" or newer single-operator cholangioscopy systems are most often used in the diagnosis of indeterminate biliary strictures and as an adjunct in the management of complicated stone disease, but may have a role in biliary stone detection in limited settings. Adherent or impacted stones may be difficult to differentiate from complex strictures or biliary polyps, and direct visualization has been valuable in characterizing these indeterminate filling defects.⁷⁸ Others have reported a potential role for cholangioscopy in confirming ductal clearance in patients after stone extraction.^{79,80} Although they are potentially useful in specific clinical settings, given the additional time and expense incurred by IDUS and cholangioscopy, their overall role in the diagnosis of choledocholithiasis remains limited.

EUS-directed ERC

Given the higher morbidity of ERC compared with EUS, several investigators recently evaluated sequential EUS and ERC in patients with suspected choledocholithiasis in an effort to better triage patients in need of treatment.⁸¹⁻⁸⁴ These 4 trials randomized patients at intermediate to high risk for choledocholithiasis to an EUS-first strategy versus an ERC-first strategy. Patients found to have CBD stones at EUS underwent subsequent therapeutic ERC, which was performed in the same setting in 3 of the 4 trials.^{81,83,84} Across the trials, 27% to 40% of patients randomized to EUS were found to have CBD stones, and the negative predictive value of EUS seemed to be robust, with only 0% to 4% of patients with normal EUS findings returning with pancreaticobiliary symptoms in 1 to 2 years of follow-up. Thus, this sequential approach in these studies eliminated the need for 60% to 73% of ERC and its attendant risk. There was either less morbidity or a trend toward less morbidity associated with the EUS-first strategy across all studies.

An EUS-guided diagnostic strategy also seems to be cost-effective for many patients with suspected choledocholithiasis. In a cost analysis associated with a prospective trial of EUS for suspected choledocholithiasis in more than 450 patients, an EUS-first strategy was cost-effective for patients with an estimated likelihood of CBD stones of less than 61%, with the ERC-first strategy proving the dominant strategy for patients at higher risk.⁸⁵ Similarly, a decision analysis assessing the roles of IOC, ERC, and EUS in patients undergoing laparoscopic cholecystectomy found EUS to be cost-effective when the estimated risk of CBD stones was 11% to 55%.³⁷ In both of these cost analyses, EUS and subsequent therapeutic ERC were performed on separate days; procedures performed in tandem with a single sedation may yield even greater savings.

The role of endoscopy for suspected choledocholithiasis in the postcholecystectomy patient

Choledocholithiasis after cholecystectomy may result from either a migrated gallbladder stone not detected in the perioperative period or a stone forming de novo in the common bile duct. Diagnostic considerations are slightly different in these patients than in those with a gallbladder in situ. Although patients presenting with pain, abnormal liver biochemical tests, jaundice, or fever may have choledocholithiasis, alternative processes such as bile leak, iatrogenic biliary stricture, and biliary-type sphincter of Oddi dysfunction are additional possibilities in the postcholecystectomy patient.

Generally, the initial evaluation of these patients should include serum liver biochemical tests and a transabdominal US, mirroring the approach to the precholecystectomy patient with symptomatic cholelithiasis. However, dilation of the common bile duct after cholecystectomy has been reported,^{86,87} so using a 6-mm cutoff for normal is likely not appropriate for this population. Also, some patients reporting postcholecystectomy pain may have chronic abdominal pain unrelated to their biliary tree, and thus unresolved by cholecystectomy. In these patients, use of narcotic analgesics is not uncommon, and biliary dilation related to narcotic use has also been reported.^{88,89}

Data regarding the evaluation for choledocholithiasis in patients who have undergone cholecystectomy are limited. However, postcholecystectomy patients with normal liver biochemical test results and normal US findings are very unlikely to have choledocholithiasis.⁹⁰ In postcholecystectomy patients referred for ERC because of suspected choledocholithiasis after initial evaluation, the incidence of choledocholithiasis is 33% to 43%.^{90,91} Both EUS⁹¹ and MRC⁹⁰ have been shown to be highly accurate for detecting choledocholithiasis in this patient subset, as well as providing alternative diagnoses in many cases. As such, ERC, EUS, and MRC may all be considered in the diagnostic evaluation of postcholecystectomy patients when initial

laboratory and US data are abnormal yet nondiagnostic. However, given that the ultimate incidence of choledocholithiasis is still less than 50% in this population, EUS and MRC may be preferable to ERC in this setting, particularly given their attenuated morbidity compared with ERC.

The role of endoscopy for suspected choledocholithiasis in patients with gallstone pancreatitis

The approach to suspected choledocholithiasis in patients with ABP may differ from patients with symptomatic cholelithiasis alone. Clinical investigations have demonstrated a correlation between the presence of persistent CBD stones and the severity of ABP, particularly when biliopancreatic obstruction is present.⁹²⁻⁹⁴ Identifying patients most likely to benefit from early detection and treatment of retained CBD stones in ABP has been an area of controversy, however.

ERC: Three randomized, controlled trials found a trend toward benefit in patients with suspected ABP who were randomized to early ERC (within 24-72 hours from presentation) with biliary sphincterotomy versus conservative management.⁹⁵⁻⁹⁷ In these trials, the subgroups with pancreatitis predicted to be severe (by Ranson⁹⁸ or Glasgow⁹⁹ scoring) who underwent early ERC had significant reductions in morbidity and mortality. These studies included patients with clinical evidence of biliary obstruction and cholangitis, and an alternative interpretation of these data is that patients with persistent biliopancreatic obstruction, rather than those with predicted severe ABP, benefit from early endoscopic assessment and intervention. Accordingly, a randomized, controlled trial of early ERC versus conservative management in ABP that excluded patients with a bilirubin level greater than 5 mg/dL found no benefit in morbidity and mortality in patients with predicted severe ABP who underwent early ERC.¹⁰⁰ A recent meta-analysis of early ERC versus conservative care in patients with ABP that excluded patients with cholangitis also found no benefit in morbidity and mortality in patients with predicted severe ABP who underwent early ERC.¹⁰¹ Two randomized, controlled trials that sought to select patients with ABP with persistent biliary obstruction, but not cholangitis, for early ERC versus conservative care were conflicting in their outcomes, although trial protocols differed.^{102,103} In summary, in the absence of clear evidence of a retained stone, there does not seem to be a role for early ERC in the evaluation and management of patients with mild ABP. Conversely, in patients with ABP and concomitant cholangitis, early ERC is strongly recommended given the observed benefits in morbidity and mortality. Data are conflicting as to the benefit of early ERC in patients with predicted severe ABP or in ABP with clinical evidence of biliary obstruction when acute cholangitis is absent.

EUS: Acute pancreatitis may cause duodenal and pancreatic edema that could theoretically hinder EUS and impair sonographic visualization of small stones in the distal CBD. However, in several studies of acute pancreatitis, EUS provided an assessment of the bile duct in almost all patients while maintaining a high level of accuracy for CBD stones (97%-100%).^{9,10,104} Given the risks and uncertain benefit associated with ERC in patients with ABP and the modest prevalence of choledocholithiasis in ABP (18%-33%),⁸⁻¹¹ investigators have also targeted this scenario for EUS-directed triage to ERC.^{83,105}

In 2 series of patients with acute pancreatitis of suspected biliary etiology, all subjects underwent sequential EUS and ERC (conducted by separate, blinded examiners). EUS had a sensitivity of 91% to 97% and accuracy of 97% to 98% for choledocholithiasis detection, similar to or better than the performance of ERC in these studies.^{9,10} In a trial that randomized 140 patients with acute pancreatitis of suspected biliary etiology to EUS versus ERC, the bile duct was successfully evaluated more frequently with EUS, and EUS was associated with a trend toward less morbidity.⁸³ No patients with a negative biliary EUS finding experienced the development of recurrent symptoms in more than a 2-year median follow-up, and EUS identified cholelithiasis in 6 of 48 patients initially labeled idiopathic after unrevealing transabdominal US and ERC. A Monte Carlo decision analysis recently compared selective ERC (for severe ABP, with supportive care for mild ABP) with the EUS-first and MRC-first approaches.¹⁰⁶ The EUS-first strategy was preferable for severe ABP in this analysis, with reduced costs, fewer ERCs, and fewer complications.

RECOMMENDATIONS

1. We recommend that the initial evaluation of suspected choledocholithiasis should include serum liver biochemical tests and a transabdominal US of the right upper quadrant. ⊕⊕⊕○ These tests should be used to risk-stratify patients to guide further evaluation and management.
2. We recommend that patients with symptomatic cholelithiasis who are surgical candidates and have a low probability of choledocholithiasis proceed to cholecystectomy without additional biliary evaluation (Fig. 1). ⊕⊕⊕○
3. We recommend that patients with an intermediate probability of choledocholithiasis undergo further evaluation with preoperative EUS or MRC or an IOC (Fig. 1). ⊕⊕⊕○ In this group of patients, we suggest that ERC be deferred unless EUS, MRC, and IOC are unavailable, given the less favorable risk profile of ERC. ⊕⊕⊕○
4. We recommend that patients with a high probability of choledocholithiasis undergo an evaluation of the bile

- duct with therapeutic capability, generally preoperative ERC (Fig. 1). ⊕ ⊕ ⊕ ○ When available, laparoscopic bile duct exploration can serve as an alternative to ERC.
5. We suggest that EUS or MRC be considered in the diagnostic evaluation of postcholecystectomy patients suspected of having choledocholithiasis when initial laboratory and US data are abnormal yet nondiagnostic. ⊕ ⊕ ○ ○
 6. We recommend against early ERC in the evaluation and management of patients with mild ABP in the absence of clear evidence of a retained stone. ⊕ ⊕ ⊕ ○
 7. We recommend early ERC in patients with acute biliary pancreatitis and concomitant cholangitis, given the observed benefits in morbidity and mortality. ⊕ ⊕ ⊕ ⊕
 8. We suggest that patients with acute biliary pancreatitis and clinical evidence of biliary obstruction be considered for early ERC. ⊕ ⊕ ○ ○ We cannot recommend for or against early ERC in patients with predicted severe acute biliary pancreatitis in the absence of overt biliary obstruction or cholangitis, given the lack of consensus in the available data. ⊕ ⊕ ○ ○
 9. As patients with acute biliary pancreatitis are at least at intermediate risk for choledocholithiasis, we suggest pre-operative EUS or IOC be considered for these patients when cholangitis or biliary obstruction are absent. ⊕ ⊕ ○ ○

Abbreviations: ABP, acute biliary pancreatitis; CBD, common bile duct; ERC, endoscopic retrograde cholangiography; IDUS, intraductal US; IOC, intraoperative cholangiography; MRC, magnetic resonance cholangiography.

REFERENCES

1. Guyatt GH, Oxman AD, Vist GE, et al; GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;336:924-6.
2. Everhart JE, Khare M, Hill M, et al. Prevalence and ethnic differences in gallbladder disease in the United States. *Gastroenterology* 1999; 117:632-9.
3. Everhart JE, Ruhl CE. Burden of digestive diseases in the United States I: Overall and upper gastrointestinal diseases. *Gastroenterology* 2009; 136:376-86.
4. Hunter JG. Laparoscopic transcystic bile duct exploration. *Am J Surg* 1992;163:53-6.
5. Robinson BL, Donohue JH, Gunes S, et al. Selective operative cholangiography: appropriate management for laparoscopic cholecystectomy. *Arch Surg* 1995;130:625-30.
6. Petelin JB. Laparoscopic common bile duct exploration. *Surg Endosc* 2003;17:1705-15.
7. O'Neill CJ, Gillies DM, Gani JS. Choledocholithiasis: overdiagnosed endoscopically and undertreated laparoscopically. *ANZ J Surg* 2008;78: 487-91.
8. Chang L, Lo SK, Stabile BE, et al. Gallstone pancreatitis: a prospective study on the incidence of cholangitis and clinical predictors of retained common bile duct stones. *Am J Gastroenterol* 1998;93:527-31.
9. Chak A, Hawes RH, Cooper GS, et al. Prospective assessment of the utility of EUS in the evaluation of gallstone pancreatitis. *Gastrointest Endosc* 1999;49:599-604.
10. Liu CL, Lo CM, Chan JKF, et al. Detection of choledocholithiasis by EUS in acute pancreatitis: a prospective evaluation in 100 consecutive patients. *Gastrointest Endosc* 2001;54:325-30.
11. Cohen ME, Slezak L, Wells CK, et al. Prediction of bile duct stones and complications in gallstone pancreatitis using early laboratory trends. *Am J Gastroenterol* 2001;96:3305-11.
12. Yang MH, Chen TH, Wang SE, et al. Biochemical predictors for absence of common bile duct stones in patients undergoing laparoscopic cholecystectomy. *Surg Endosc* 2008;22:1620-4.
13. Barkun AN, Barkun JS, Fried GM, et al. Useful predictors of bile duct stones in patients undergoing laparoscopic cholecystectomy. *Ann Surg* 1994;220:32-9.
14. Onken JE, Brazer SR, Eisen GM, et al. Predicting the presence of choledocholithiasis in patients with symptomatic cholelithiasis. *Am J Gastroenterol* 1996;91:762-7.
15. Peng WK, Sheikh Z, Paterson-Brown S, et al. Role of liver function tests in predicting common bile duct stones in patients with acute calculous cholecystitis. *Br J Surg* 2005;92:1241-7.
16. Einstein DM, Lapin SA, Ralls PW, et al. The insensitivity of sonography in the detection of choledocholithiasis. *AJR Am J Roentgenol* 1984; 142:725-8.
17. Vallon AG, Lees WR, Cotton PB. Grey-scale ultrasonography in cholestatic jaundice. *Gut* 1979;20:51-4.
18. Cronan JJ. US diagnosis of choledocholithiasis: a reappraisal. *Radiology* 1986;161:133-4.
19. O'Connor HJ, Hamilton I, Ellis WR, et al. Ultrasound detection of choledocholithiasis: prospective comparison with ERCP in the postcholecystectomy patient. *Gastrointest Radiol* 1986;11:161-4.
20. Lapis JL, Orlando RC, Mittelstaedt CA, et al. Ultrasonography in the diagnosis of obstructive jaundice. *Ann Intern Med* 1978;89:61-3.
21. Baron RL, Stanley RJ, Lee JKT, et al. A prospective comparison of the evaluation of biliary obstruction using computed tomography and ultrasonography. *Radiology* 1982;145:91-8.
22. Mitchell SE, Clark RA. A comparison of computed tomography and sonography in choledocholithiasis. *AJR Am J Roentgenol* 1984;142: 729-33.
23. Pedersen OM, Nordgard K, Kvinnsland S. Value of sonography in obstructive jaundice. Limitations of bile duct caliber as an index of obstruction. *Scand J Gastroenterol* 1987;22:975-81.
24. Parulekar SG. Ultrasound evaluation of bile duct size. *Radiology* 1979; 133:703-7.
25. Bruneton JN, Roux P, Fenart D, et al. Ultrasound evaluation of common bile duct size in normal adult patients and following cholecystectomy: a report of 750 cases. *Eur J Radiol* 1981;1:171-2.
26. Bachar GN, Cohen M, Belenky A, et al. Effect of aging on the adult extrahepatic bile duct: a sonographic study. *J Ultrasound Med* 2003;22:879-82.
27. Costi R, Sarli L, Caruso G, et al. Preoperative ultrasonographic assessment of the number and size of gallbladder stones: is it a useful predictor of asymptomatic choledochal lithiasis. *J Ultrasound Med* 2002; 21:971-6.
28. Liu TH, Consorti ET, Kawashima A, et al. Patient evaluation and management with selective use of magnetic resonance cholangiography and endoscopic retrograde cholangiopancreatography before laparoscopic cholecystectomy. *Ann Surg* 2001;234:33-40.
29. Prat F, Meduri B, Ducot B, et al. Prediction of common bile duct stones by noninvasive tests. *Ann Surg* 1999;229:362-8.
30. Bose SM, Mazumdar A, Prakash VS, et al. Evaluation of the predictors of choledocholithiasis: comparative analysis of clinical, biochemical, radiological, radionuclear, and intraoperative parameters. *Surg Today* 2001;31:117-22.
31. Abboud PAC, Malet PF, Berlin JA, et al. Predictors of common bile duct stones prior to cholecystectomy: a meta-analysis. *Gastrointest Endosc* 1996;44:450-9.
32. Tse F, Barkun JS, Barkun AN. The elective evaluation of patients with suspected choledocholithiasis undergoing laparoscopic cholecystectomy. *Gastrointest Endosc* 2004;60:437-48.

33. Nassarweh NN, Flum DR. Role of intraoperative cholangiography in avoiding bile duct injury. *J Am Coll Surg* 2007;656-64.
34. Metcalfe MS, Ong T, Bruening MH, et al. Is laparoscopic intraoperative cholangiogram a matter of routine? *Am J Surg* 2004;187:475-81.
35. Byrne MF, McLoughlin MT, Mitchell RM, et al. For patients with predicted low risk for choledocholithiasis undergoing laparoscopic cholecystectomy, selective intraoperative cholangiography and postoperative endoscopic retrograde cholangiopancreatography is an effective strategy to limit unnecessary procedures. *Surg Endosc* 2009;23:1933-7.
36. Nickolgh A, Soltaniyekta S, Kalbasi H. Routine versus selective intraoperative cholangiography during laparoscopic cholecystectomy: a survey of 2,130 patients undergoing laparoscopic cholecystectomy. *Surg Endosc* 2006;20:868-74.
37. Sahai AV, Mauldin PD, Marsi V, et al. Bile duct stones and laparoscopic cholecystectomy: a decision analysis to assess the roles of intraoperative cholangiography, EUS, and ERCP. *Gastrointest Endosc* 1999;49:334-43.
38. Urbach DR, Khajanchee YS, Jobe BA, et al. Cost-effective management of common bile duct stones: a decision analysis of the use of endoscopic retrograde cholangiopancreatography (ERCP), intraoperative cholangiography, and laparoscopic bile duct exploration. *Surg Endosc* 2001;15:4-13.
39. Frossard JL, Hadengue A, Amouyal G, et al. Choledocholithiasis: a prospective study of spontaneous common bile duct stone migration. *Gastrointest Endosc* 2000;51:175-9.
40. Oria A, Alvarez J, Chiapetta L, et al. Risk factors for acute pancreatitis in patients with migrating gallstones. *Arch Surg* 1989;124:1295-6.
41. Martin DJ, Vernon D, Tooouli J. Surgical versus endoscopic treatment of bile duct stones. *Cochrane Database Syst Rev* 2006;19: CD003327.
42. Cuschieri A, Lezoche E, Moreno M, et al. E.A.E.S. multicenter prospective randomized controlled trial comparing two-stage versus single-stage management of patients with gallstone disease and ductal calculi. *Surg Endosc* 1999;13:952-7.
43. Sgourakis G, Karaliotis K. Laparoscopic common bile duct exploration and cholecystectomy versus endoscopic stone extraction and laparoscopic cholecystectomy for choledocholithiasis: a prospective randomized study. *Minerva Chir* 2002;57:467-74.
44. Fanelli RD, Gersin KS. Laparoscopic endobiliary stenting: a simplified approach to the management of occult common bile duct stones. *J Gastrointest Surg* 2001;5:74-80.
45. Miller FH, Hwang CM, Gabriel H, et al. Contrast-enhanced helical CT of choledocholithiasis. *AJR Am J Roentgenol* 2003;181:125-30.
46. Soto JA, Alvarez O, Munera F, et al. Diagnosing bile duct stones: comparison of unenhanced helical CT, oral-contrast enhanced CT cholangiography, and MR cholangiography. *AJR Am J Roentgenol* 2000;175:1127-34.
47. Neitlich JD, Topazian M, Smith RC, et al. Detection of choledocholithiasis: comparison of unenhanced helical CT and endoscopic retrograde cholangiopancreatography. *Radiology* 1997;203:753-7.
48. Tseng CW, Chen CC, Chen TS, et al. Can computed tomography with coronal reconstruction improve the diagnosis of choledocholithiasis? *J Gastroenterol Hepatol* 2008;23:1586-9.
49. Anderson SW, Rho E, Soto JA. Detection of biliary duct narrowing and choledocholithiasis: accuracy of portal venous phase multidetector CT. *Radiology* 2008;247:418-27.
50. Romagnuolo J, Bardou M, Rahme E, et al. Magnetic resonance cholangiopancreatography: a meta-analysis of test performance in suspected biliary disease. *Ann Intern Med* 2003;139:547-57.
51. Verma D, Kapadia A, Eisen GM, et al. EUS vs MRCP for detection of choledocholithiasis. *Gastrointest Endosc* 2006;64:248-54.
52. Zidi SH, Prat F, Le Guen O, et al. Use of magnetic resonance cholangiography in the diagnosis of choledocholithiasis: prospective comparison with a reference imaging method. *Gut* 1999;44:118-22.
53. Sugiyama M, Atomi Y, Hachiya J. Magnetic resonance cholangiography using half-Fourier acquisition for diagnosing choledocholithiasis. *Am J Gastroenterol* 1998;93:1886-90.
54. Boraschi P, Neri E, Braccini G, et al. Choledocholithiasis: diagnostic accuracy of MR cholangiopancreatography—3 year experience. *MRI* 1999;17:1245-53.
55. Polkowski M, Palucki J, Regula J, et al. Helical computed tomographic cholangiography versus endosonography for suspected bile duct stones: a prospective blinded study in non-jaundiced patients. *Gut* 1999;45:744-9.
56. Cabada Giadis T, Sarria Octavio de Toledo L, Martinez-Berganza Asensio MT, et al. Helical CT cholangiography in the evaluation of the biliary tract: application to the diagnosis of choledocholithiasis. *Abdom Imaging* 2002;27:61-70.
57. Machi J, Tateishi T, Oishi AJ, et al. Laparoscopic ultrasonography versus operative cholangiography during laparoscopic cholecystectomy: review of the literature and a comparison with open intraoperative ultrasonography. *J Am Coll Surg* 1999;188:361-7.
58. Kohut M, Nowakowska-Dulawa E, Marek T, et al. Accuracy of linear ultrasonography in the evaluation of patients with suspected common bile duct stones. *Endoscopy* 2002;34:299-303.
59. Lachter J, Rubin A, Shiller M, et al. Linear EUS for bile duct stones. *Gastrointest Endosc* 2000;51:51-4.
60. Tse F, Liu L, Barkun AN, et al. EUS: a meta-analysis of test performance in suspected choledocholithiasis. *Gastrointest Endosc* 2008;67:235-44.
61. Garrow D, Miller S, Sinha D, et al. Endoscopic ultrasound: a meta-analysis of test performance in suspected biliary obstruction. *Clin Gastroenterol Hepatol* 2007;5:616-23.
62. Kondo S, Isayama H, Akahane M, et al. Detection of common bile duct stones: comparison between endoscopic ultrasonography, magnetic resonance cholangiography, and helical-computed-tomographic cholangiography. *Eur J Radiol* 2005;54:271-5.
63. Aube C, Delorme B, Yzet T, et al. MR cholangiopancreatography versus endoscopic sonography in suspected common bile duct lithiasis: a prospective, comparative study. *AJR Am J Roentgenol* 2005;184:55-62.
64. Sugiyama M, Atomi Y. Endoscopic ultrasonography for diagnosing choledocholithiasis: a prospective comparative study with ultrasonography and computed tomography. *Gastrointest Endosc* 1997;45:143-6.
65. Bournet B, Miguieres I, Delacroix M, et al. Early morbidity of endoscopic ultrasound: 13 years' experience at a referral center. *Endoscopy* 2006;38:349-54.
66. Mortensen MB, Frstrup C, Holm FS, et al. Prospective evaluation of patient tolerability, satisfaction with patient information, and complications in endoscopic ultrasonography. *Endoscopy* 2005;37:146-53.
67. Rosch T, Dittler HJ, Fockens P, et al. Major complications of endoscopic ultrasonography: results of a survey of 42,105 cases [abstract]. *Gastrointest Endosc* 1993;39:341.
68. Prat F, Amouyal G, Amouyal P, et al. Prospective controlled study of endoscopic ultrasonography and endoscopic retrograde cholangiography in patients with suspected common bile duct lithiasis. *Lancet* 1996;347:75-9.
69. Tseng LJ, Jao YT, Mo LR, et al. Over-the-wire US catheter probe as an adjunct to ERCP in the detection of choledocholithiasis. *Gastrointest Endosc* 2001;54:720-3.
70. Freeman ML, Nelson DB, Sherman S, et al. Complications of endoscopic biliary sphincterotomy. *N Engl J Med* 1996;335:909-18.
71. Loperfido S, Angelini G, Benedetti G, et al. Major early complications from diagnostic and therapeutic ERCP: a prospective multicenter study. *Gastrointest Endosc* 1998;48:1-10.
72. Freeman ML, DiSario JA, Nelson DB, et al. Risk factors for post-ERCP pancreatitis: a prospective, multicenter study. *Gastrointest Endosc* 2001;54:425-34.
73. Masci E, Toti G, Mariani A, et al. Complications of diagnostic and therapeutic ERCP: a prospective, multicenter study. *Am J Gastroenterol* 2001;96:417-23.
74. Christensen M, Matzen P, Schulze S, et al. Complications of ERCP: a prospective study. *Gastrointest Endosc* 2004;60:721-31.

75. Williams EJ, Taylor S, Fairclough P, et al. Risk factors for complication following ERCP: results of a large-scale, prospective multi-center study. *Endoscopy* 2007;39:793-801.
76. Cotton PB, Garrow DA, Gallagher J, et al. Risk factors for complications after ERCP: a multivariate analysis of 11,497 procedures over 12 years. *Gastrointest Endosc* 2009 [Epub ahead of print].
77. Das A, Isenberg G, Wong RCK, et al. Wire-guided intraductal US: an adjunct to ERCP in the management of bile duct stones. *Gastrointest Endosc* 2001;54:31-6.
78. Chen YK, Pleskow DK. SpyGlass single operator peroral cholangiopancreatography system for the diagnosis and therapy of bile duct disorders: a clinical feasibility study. *Gastrointest Endosc* 2007;65: 832-41.
79. Weickert U, Jakobs R, Hahne M, et al. Cholangioscopy after successful treatment of complicated choledocholithiasis: is stone free really stone free? [in German]. *Dtsch Med Wochenschr* 2003;128:481-4.
80. Larghi A, Waxman I. Endoscopic direct cholangioscopy by using an ultra-slim upper endoscope: a feasibility study. *Gastrointest Endosc* 2006;63:853-7.
81. Lee YT, Chan FKL, Leung WK, et al. Comparison of EUS and ERCP in the investigation with suspected biliary obstruction caused by choledocholithiasis: a randomized study. *Gastrointest Endosc* 2008;67: 660-8.
82. Polkowski M, Regula J, Tilszer A, et al. Endoscopic ultrasound versus endoscopic retrograde cholangiography for patients with intermediate probability of bile duct stones: a randomized trial comparing two management strategies. *Endoscopy* 2007;39:296-303.
83. Liu CL, Fan ST, Lo CM, et al. Comparison of early endoscopic ultrasonography and endoscopic retrograde cholangiopancreatography in the management of acute biliary pancreatitis: a prospective randomized study. *Clin Gastroenterol Hepatol* 2005;3:1238-44.
84. Karakan T, Cindoruk M, Alagozlu H, et al. EUS versus endoscopic retrograde cholangiography for patients with intermediate probability of bile duct stones: a prospective randomized trial. *Gastrointest Endosc* 2009;69:244-52.
85. Buscarini E, Tansini P, Vallisa D, et al. EUS for suspected choledocholithiasis: do benefits outweigh costs? a prospective controlled study. *Gastrointest Endosc* 2003;57:510-8.
86. Niderau C, Muller J, Sonenberg A, et al. Extrahepatic bile ducts in health subjects, in patients with cholelithiasis, and in postcholecystectomy patients: a prospective ultrasonic study. *J Clin Ultrasound* 1983;11:23-7.
87. Chawla S, Trick WE, Gilkey S, et al. Does cholecystectomy status influence the common bile duct diameter? A matched-pair analysis. *Dig Dis Sci* 2009 [Epub ahead of print].
88. Firoozi B, Choung R, Diehl DL. Bile duct dilation with chronic methadone use in asymptomatic patients: ERCP findings in 6 patients. *Gastrointest Endosc* 2003;58:127-30.
89. Sharma SS. Sphincter of Oddi dysfunction in patients addicted to opium: an unrecognized entity. *Gastrointest Endosc* 2002;55: 427-30.
90. Terhaar OA, Abbas S, Thornton FJ, et al. Imaging patients with "post-cholecystectomy syndrome": an algorithmic approach. *Clin Radiol* 2005;60:78-84.
91. Canto MI, Chak A, Stellato T, et al. Endoscopic ultrasonography versus cholangiography for the diagnosis of choledocholithiasis. *Gastrointest Endosc* 1998;47:439-48.
92. Corfield AP, Cooper MJ, Williamson RCN. Acute pancreatitis: a lethal disease of increasing incidence. *Gut* 1985;26:724-9.
93. Wilson C, Imrie CW, Carter DC. Fatal acute pancreatitis. *Gut* 1988;29: 782-8.
94. Acosta JM, Rubio Galli OM, Rossi R, et al. Effect of duration of ampullary gallstone obstruction on severity of lesions of acute pancreatitis. *J Am Coll Surg* 1997;184:499-505.
95. Neoptolemos JP, Carr-Locke DL, London NJ, et al. Controlled trial of urgent endoscopic retrograde cholangiopancreatography and endoscopic sphincterotomy versus conservative treatment for acute pancreatitis due to gallstones. *Lancet* 1988;2:979-83.
96. Fan ST, Lai ECS, Mok FPT, et al. Early treatment of acute biliary pancreatitis by endoscopic papillotomy. *N Engl J Med* 1993;328: 228-32.
97. Nowak A, Nowakowska-Dulawa E, Marek T, et al. Final results of the prospective, randomized, controlled study on endoscopic sphincterotomy versus conventional management in acute biliary pancreatitis [abstract]. *Gastroenterology* 1995;108(Suppl):A380.
98. Ranson JH, Rifkind KM, Roses DF, et al. Prognostic signs and the role of operative management in acute pancreatitis. *Surg Gynecol Obstet* 1974;139:69.
99. Blamey SL, Imrie CW, O'Neill J, et al. Prognostic factors in acute pancreatitis. *Gut* 1984;25:1340-6.
100. Folsch UR, Nitsche R, Ludtke R, et al. Early ERCP and papillotomy compared with conservative treatment for acute biliary pancreatitis; the German Study Group on acute biliary pancreatitis. *N Engl J Med* 1997;336:237-42.
101. Petrov MS, van Santvoort HC, Besselink MG, et al. Early endoscopic retrograde cholangiopancreatography versus conservative management in acute biliary pancreatitis without cholangitis: a meta-analysis of randomized trials. *Ann Surg* 2008;247:250-7.
102. Acosta JM, Katkhouda N, Debian KA, et al. Early ductal decompression versus conservative management for gallstone pancreatitis with ampullary obstruction: a prospective randomized clinical trial. *Ann Surg* 2006;243:33-40.
103. Oria A, Cimmino D, Ocampo C, et al. Early endoscopic intervention versus early conservative management in patients with acute gallstone pancreatitis and biliopancreatic obstruction: a randomized clinical trial. *Ann Surg* 2007;245:10-7.
104. Sugiyama M, Atomi Y. Acute biliary pancreatitis: the roles of endoscopic ultrasonography and endoscopic retrograde cholangiopancreatography. *Surgery* 1998;124:14-21.
105. Prat F, Edery J, Meduri B, et al. Early EUS of the bile duct before endoscopic sphincterotomy for acute biliary pancreatitis. *Gastrointest Endosc* 2001;54:724-9.
106. Romagnuolo J, Currie G. Calgary Advanced Therapeutic Endoscopy Center (ATEC) study group. Noninvasive vs. selective invasive biliary imaging for acute biliary pancreatitis: an economic evaluation by using decision tree analysis. *Gastrointest Endosc* 2005;61:86-97.

Prepared by: ASGE STANDARDS OF PRACTICE COMMITTEE

John T. Maple
 Tamir Ben-Menachem
 Michelle A. Anderson
 Vasundhara Appalaneni
 Subhas Banerjee
 Brooks D. Cash
 Laurel Fisher
 M. Edwyn Harrison
 Robert D. Fanelli
 Norio Fukami
 Steven O. Ikenberry
 Rajeev Jain
 Khalid Khan
 Mary Lee Krinsky
 Laura Strohmeyer
 Jason A. Dominitz (Chair)

This document is a product of the Standards of Practice Committee. This document was reviewed and approved by the Governing Board of the American Society for Gastrointestinal Endoscopy. This document was reviewed and endorsed by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Guidelines Committee and by the SAGES Board of Governors.
