



## Complications of ERCP

*This is one of a series of statements discussing the utilization 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 MEDLINE literature search was performed, and additional references were obtained from the bibliographies of the identified articles and from recommendations of expert consultants. When little or no data exist from well-designed prospective trials, emphasis is given to results from large series and reports from recognized experts.*

*Guidelines for appropriate utilization of endoscopy are based on a critical review of the available data and expert consensus. Further controlled clinical studies are needed to clarify aspects of this statement, and revision may be necessary as new data appear. Clinical consideration may justify a course of action at variance to these recommendations.*

Since its introduction in 1968,<sup>1</sup> endoscopic retrograde cholangiopancreatography (ERCP) has become a commonly performed endoscopic procedure. The diagnostic and therapeutic utility of ERCP has been well demonstrated for a variety of disorders, including the management of choledocholithiasis, the diagnosis and management of biliary malignancies, and the evaluation and treatment of benign and malignant diseases of the pancreas. The evolution of ERCP has occurred simultaneously with that of other diagnostic and therapeutic modalities, most notably MRI/MRCP, laparoscopic cholecystectomy (with or without intraoperative cholangiography), and EUS. As such, the appropriate use of ERCP changes constantly. In order for endoscopists to accurately assess the clinical appropriateness of ERCP, it is important to have a thorough understanding of the potential complications of this procedure. Numerous recent studies have helped determine the expected rates of complications, potential contributing factors for these adverse events, and possible methods for improving the safety of ERCP. This document will review the current understanding of ERCP-related complications.

Reported complication rates vary widely. To some extent this is the result of study design, with retrospective studies being prone to under-reporting adverse events. In addition, reported rates can vary depending upon the case mix (including the

**Table 1. Freeman et al.<sup>3</sup> (n = 1963)**

| Risk factor                             | Adjusted OR | 95% CI      |
|---|-------------|-------------|
| Prior history of post-ERCP pancreatitis | 5.35        | 2.97, 9.66  |
| Biliary balloon sphincter dilation      | 4.51        | 1.51, 13.46 |
| Moderate-to-difficult cannulation       | 3.41        | 2.13, 5.47  |
| Pancreatic sphincterotomy               | 3.07        | 1.64, 5.75  |
| ≥1 Pancreatic contrast injection        | 2.72        | 1.43, 5.17  |
| Suspected sphincter of Oddi dysfunction | 2.60        | 1.59, 4.26  |
| Female gender                           | 2.51        | 1.49, 4.24  |
| Normal serum bilirubin                  | 1.89        | 1.22, 29.3  |
| Absence of chronic pancreatitis         | 1.87        | 1.00, 3.48  |

proportion of study patients undergoing sphincterotomy or evaluation of suspected sphincter of Oddi dysfunction). Finally, complication rates will be critically affected by the definitions used for each complication.

### ERCP-INDUCED PANCREATITIS

Pancreatitis is the most common ERCP complication.<sup>2-6</sup> Although transient elevation of serum pancreatic enzymes is extremely common, such an elevation does not necessarily constitute pancreatitis. The consensus definition for ERCP pancreatitis is as follows: new or worsened abdominal pain and a serum amylase that is 3 or more times the upper limits of normal 24 hours after the procedure that requires at least 2 days of hospitalization.<sup>2</sup> By using this or similar definitions, the expected rate of ERCP-induced pancreatitis is generally between 1% and 7%.<sup>2-6</sup> Several situations exist in which the rate of pancreatitis may be significantly greater, and these circumstances need to be considered when deciding whether or not to pursue ERCP and when obtaining informed consent.

Numerous factors have been found to correlate with the development of pancreatitis. Focusing on 3 large, recently published prospective studies evaluating multiple variables, several risk factors have remained significant in multivariate analyses. These are summarized in Tables 1, 2, and 3.

### METHODS OF REDUCING ERCP-INDUCED PANCREATITIS

#### Patient selection

Careful patient selection is probably the most important method for reducing unnecessary pancreatitis, especially in light of the existence of other

**Table 2. Masci et al.<sup>6</sup> (n = 2444)**

| Risk factor                     | OR   | 95% CI     |
|---------------------------------|------|------------|
| Younger age ( $\leq 60$ )       | 2.11 | 1.16, 3.8  |
| Use of precut sphincterotomy    | 2.80 | 1.38, 5.84 |
| Failure to clear biliary stones | 3.35 | 1.33, 9.1  |

imaging modalities for the diagnosis of choledocholithiasis (CDL) and pancreaticobiliary malignancy. Many of the variables identified in the multivariate analyses discussed above can be assessed before the examination and should be accounted for when considering ERCP. In general, alternatives to ERCP should be considered when multiple risk factors are present and the likelihood of therapeutic intervention is low. Freeman et al.<sup>3</sup> have demonstrated that the risk of pancreatitis in a female with a normal bilirubin and suspected sphincter of Oddi dysfunction is 18% compared with 1.1% for a typical low-risk patient. Furthermore, approximately 1 in 5 episodes of pancreatitis in this setting will be severe (i.e., requiring more than a 10-night hospital stay, resulting in the development of necrosis, pseudocyst, or abscess formation, requiring surgical or percutaneous debridement, or resulting in death).

MRCP and EUS both have negligible risk of pancreatitis and similar sensitivity to ERCP for the detection of common bile duct stones.<sup>7-10</sup> These imaging modalities should be considered reasonable alternatives to ERCP particularly in low pretest probability settings. Intraoperative cholangiography should be considered as an alternative to ERCP in patients undergoing cholecystectomy with low to intermediate likelihood of CDL. EUS is highly accurate for the diagnosis and staging of pancreaticobiliary malignancies and can identify patients who may proceed directly to surgery without ERCP.<sup>11</sup> ERCP should be reserved for those patients with a reasonable likelihood of requiring therapeutic intervention, either based on clinical criteria (biliary dilation, sepsis, jaundice) or abnormalities identified by other imaging modalities.

The highest rate of complications appears to occur in a group of patients that is least likely to benefit from standard ERCP. The most effective method of reducing post-ERCP pancreatitis is to avoid unnecessary ERCP.

### Pharmacologic prophylaxis

Several methods of pharmacologic prophylaxis have been proposed. Somatostatin and octreotide reduce pancreatic secretion and therefore may limit pancreatic duct hypertension.<sup>12,13</sup> Other agents have been used in an effort to reduce spasm of the sphincter of Oddi,<sup>14,15</sup> inhibit proteolytic activity (gabex-

**Table 3. Loperfido et al.<sup>5</sup> (n = 2769)**

| Risk factor                     | Relative risk | 95% CI     |
|---------------------------------|---------------|------------|
| Small bile duct ( $\leq 10$ mm) | 3.79          | 1.88, 7.6  |
| Younger age ( $\leq 70$ )       | 2.87          | 1.23, 6.68 |
| Pancreatic duct opacification   | 3.21          | 1.57, 6.59 |

ate),<sup>16</sup> block the production of free radicals (allopurinol),<sup>17</sup> or manipulate the cytokine cascade (IL-10).<sup>18,19</sup>

Although a meta-analysis suggested that both somatostatin and gabexate are effective in reducing the rate of pancreatitis,<sup>20</sup> a recent multicenter randomized controlled trial (n = 579) failed to show a benefit of short-term infusion of either gabexate or somatostatin over placebo.<sup>21</sup> Meta-analysis including this study did not show benefit. Additionally, neither of these agents is currently clinically available in the US.<sup>21</sup> Octreotide, an analogue of somatostatin, was not effective in preventing pancreatitis.<sup>20</sup> Octreotide, unlike somatostatin, increases basal pressure in the sphincter of Oddi.<sup>22</sup> Whether or not octreotide would be effective in the presence of a pancreatic stent has not been studied.

IL-10 has been postulated to prevent pancreatitis by means of its anti-inflammatory activities. Two controlled prospective studies have been reported with conflicting results. A study from Belgium reported benefit in preventing pancreatitis when administered at doses of 4 or 20  $\mu\text{g}/\text{kg}$  30 minutes before the examination.<sup>18</sup> However, a U.S. study failed to find benefit at a dose of 8  $\mu\text{g}/\text{kg}$  given immediately before ERCP.<sup>19</sup>

Glyceryl trinitrate (AKA nitroglycerin) by decreasing sphincter of Oddi pressure has been shown in two randomized placebo-controlled studies to decrease post-ERCP pancreatitis. Both sublingual (7/90 vs. 17/96;  $p < 0.05$ ) and transdermal administration (3/71 vs. 11/73;  $p < 0.05$ ) were effective.<sup>23,24</sup> Although they are inexpensive, nitrates are limited by their hypotensive effects and should be used cautiously if at all in patients on antihypertensives or those with vascular disease.

A recent study suggested that heparin may be beneficial.<sup>25</sup> However, this has not been confirmed in prospective randomized trials.

The use of nonionic contrast agents has not reduced the incidence of pancreatitis and is associated with higher cost.<sup>26,27</sup> The use of periprocedural corticosteroids was suggested by a retrospective, noncontrolled study of patients with contrast allergy<sup>28</sup>; however, 3 subsequent well-conducted prospective controlled studies have failed to show benefit from this therapy.<sup>17,29,30</sup> Another recent randomized study failed to show benefit from prophylactic allopurinol.<sup>17</sup> Nifedipine was studied in a randomized

placebo-controlled trial and was ineffective at preventing pancreatitis.<sup>31</sup>

## TECHNIQUE-RELATED VARIABLES

### Access papillotomy

The use of a “precut” or access papillotomy is controversial. This technique involves using a bare wire with cautery (e.g., needle-knife) to obtain access to the desired duct when free cannulation is not possible. The rate of complications with this technique varies widely, with some authors reporting no increased risk of complications,<sup>32,33</sup> and others finding significantly increased complication rates.<sup>4,6</sup> This discrepancy probably relates to the endoscopist’s level of expertise and the number of failed attempts at cannulation before attempting precut. In experienced hands and an appropriate clinical setting, precut sphincterotomy appears to be an acceptable method of ductal access.

### Sphincter of Oddi manometry

The performance of sphincter of Oddi manometry has been controversial. When performed with aspiration-type catheters<sup>34</sup> (in which fluid is continually aspirated from the pancreatic duct during pancreatic manometry in order to prevent ductal hypertension) manometry is not associated with an increased risk of pancreatitis in multivariate analysis.<sup>3</sup> This is not to say that these patients are not at higher risk. ERCP in the setting of suspected sphincter of Oddi dysfunction (SOD) is associated with significant risk of pancreatitis (up to 20%-25%); however, this risk appears to be the same whether or not manometry is performed.<sup>3</sup> ERCP in a setting in which an endoscopist should reasonably suspect SOD should be performed after thorough discussion with the patient regarding the high risk and uncertain benefits of the procedure.

### Pancreatic duct stents

A single, prospective, randomized controlled study showed that prophylactic stent placement of the pancreatic duct can reduce the incidence of post-biliary sphincterotomy pancreatitis in patients with suspected SOD.<sup>35</sup> In this study, stent placement in patients with pancreatic sphincter hypertension significantly reduced the risk of pancreatitis from 26% to 7% (similar to reported risk in patients undergoing ERCP for other indications). A case-control study of pancreatic stent placement after balloon dilation of the major papilla for bile duct stone removal found decreased postprocedure hyperamylasemia but no significant effect on pancreatitis.<sup>36</sup>

### Electrocautery setting

A study randomizing 170 patients to either pure cut or blended current for biliary sphincterotomy

found a significantly lower rate of pancreatitis in those patients who underwent pure cut cautery (3% vs. 10%).<sup>37</sup> A larger nonrandomized study did not demonstrate any difference.<sup>5</sup> Monopolar cautery has been shown to be associated with a reduced risk of pancreatitis compared with bipolar cautery in a single randomized controlled study.<sup>38</sup>

### Hemorrhage

Hemorrhage is primarily a complication related to sphincterotomy rather than diagnostic ERCP. Clinically significant hemorrhage may be defined as the presence of melena, hematochezia, or hematemesis associated with a hemoglobin decrease of at least 2 g/dL or the need for blood transfusion.<sup>4</sup> The reported incidence of hemorrhage after sphincterotomy ranges from 0.76% to 2%.<sup>4-6</sup> In roughly half of cases this bleeding is delayed (recognition 1 or more days after the examination) and can occur up to 1 to 2 weeks later. The risk of severe hemorrhage (i.e., requiring 2 or more units of blood, surgery, or angiography) is estimated to be 0.1% to 0.5%.<sup>4,5</sup>

Risk factors for hemorrhage identified in multivariate analysis include coagulopathy at the time of the examination, the use of anticoagulants within 72 hours of the sphincterotomy, the presence of acute cholangitis or papillary stenosis, the use of precut sphincterotomy, and low case volume of the endoscopist (1 sphincterotomy per week or fewer).<sup>4-6</sup> Observed bleeding during the initial examination was also predictive of delayed bleeding.<sup>4</sup> The presence of cirrhosis was not significant in multivariate analysis, likely because the bleeding risk in the setting of cirrhosis is determined primarily by the presence or absence of coagulopathy.<sup>4</sup> Neither length of incision nor the use of aspirin or other nonsteroidal anti-inflammatory drugs appear to be important predictors of bleeding.<sup>4</sup>

The use of automated controlled cutting has not been shown to reduce the risk of clinically significant postsphincterotomy bleeding, although published randomized studies are lacking.

### Perforation

Reported perforation rates for ERCP are 0.3% to 0.6%.<sup>4-6,39</sup> Three distinct types of perforations have been described: guidewire-induced perforation, periampullary perforation during sphincterotomy, and perforation at a site remote from the papilla.<sup>39</sup> Prompt recognition of periampullary perforation and treatment with aggressive biliary and duodenal drainage (by means of nasobiliary and nasogastric tubes) coupled with broad-spectrum antibiotics can result in clinical resolution without the need for operative intervention in up to 86% of patients.<sup>40</sup>

The diagnosis of perforations remote from the papilla is frequently delayed and these typically require surgery.<sup>39</sup> Risk factors for perforation include the presence of a Billroth II partial gastrectomy, the performance of a sphincterotomy, the intramural injection of contrast, duration of procedure, biliary stricture dilation, and SOD.<sup>5,40</sup>

### CHOLANGITIS

The rate of cholangitis is 1% or less.<sup>4-6</sup> Risk factors identified as significant in univariate analysis include the use of combined percutaneous-endoscopic procedures, stent placement in malignant strictures, the presence of jaundice, low case volume, and incomplete or failed biliary drainage.<sup>4,5</sup> As such, methods for reducing cholangitis proposed by expert opinion include the placement of plastic stents in cases of incomplete/unsuccessful stone extraction. A special circumstance is the presence of a hilar obstruction (e.g., "Klatskin tumor"). Some endoscopists advocate attempts to avoid filling all intrahepatic segments and the importance of draining all intrahepatic segments that are filled with contrast.<sup>41</sup> A randomized prospective trial comparing unilateral with bilateral stents reported similar relief of jaundice but a lower rate of cholangitis in the unilateral group.<sup>42</sup> MRCP has been used as a guide to direct unilateral stent placement.<sup>43</sup>

### THE ROLE OF PROPHYLACTIC ANTIBIOTICS

Numerous studies have evaluated the potential role of prophylactic antibiotics for ERCP. A recent meta-analysis of this data failed to show benefit for routine antibiotic prophylaxis.<sup>44</sup> In addition, a study by van den Hazel et al.<sup>45</sup> failed to show a reduction in cholangitis in a group of patients perceived to be at higher risk (e.g., those suspected of having either a distal stone or biliary stricture). Routine prophylactic use of antibiotics is not supported by currently available data. This is not to say that antibiotics should not be used in patients with known cholangitis. In addition, it is possible that postprocedural antibiotics may reduce complications in patients with incomplete drainage (or inadvertent filling of pancreatic pseudocysts). Prophylaxis continues to be recommended for patients with biliary obstruction and prosthetic heart valves, a prior history of endocarditis, systemic-pulmonary shunt, or recent (<1 year) synthetic graft placement (refer to ASGE Guideline "Antibiotic Prophylaxis for Gastrointestinal Endoscopy," *Gastrointest Endosc* 1995;42:630-5.)

### CHOLECYSTITIS

Cholecystitis complicates approximately 0.2% to 0.5% of ERCPs.<sup>4,6</sup> The risk appears to be correlated

with the presence of stones in the gallbladder and possibly filling of the gallbladder with contrast during the examination.<sup>4</sup> There are no clear means for preventing post-ERCP cholecystitis other than cholecystectomy.<sup>46</sup>

### CARDIOPULMONARY COMPLICATIONS

Significant cardiopulmonary complications are rare (<1%); however, they constitute a leading cause of death from ERCP.<sup>4-6</sup> Complications may arise because of cardiac arrhythmia, hypoventilation, or aspiration. These may be due to underlying premonitory disease (either known or occult) or problems related to medications used for sedation and analgesia. Such complications might be reduced by careful preoperative evaluation and collaboration with anesthesiologists for high-risk or difficult-to-sedate patients. (See ASGE "Guidelines for the Use of Deep Sedation and Anesthesia for Gastrointestinal Endoscopy," *Gastrointest Endosc* 2002;56:613-7.)

### MORTALITY

The overall mortality rate after diagnostic ERCP is roughly 0.2% (1 in 500).<sup>5</sup> Death rates after therapeutic ERCP are twice as high (0.4%-0.49% in two large prospective studies).<sup>4,5</sup> Death may occur from any of the complications described above. This death rate must be considered in the context of the expected rate of mortality where intervention by ERCP was not performed.

### MISCELLANEOUS COMPLICATIONS

A wide variety of additional complications have been reported. These include ileus, antibiotic-related diarrhea, hepatic abscess formation, pneumothorax/pneumomediastinum, perforation of colonic diverticula, duodenal hematoma, portal venous air, and impaction of therapeutic devices such as stone retrieval baskets.<sup>5,6</sup> Pseudocysts may become infected, and filling of pseudocysts in the absence of subsequent drainage should be avoided if possible.

### ENDOSCOPIC BALLOON DILATION

Endoscopic balloon dilation has been proposed as an alternative to sphincterotomy for the removal of CDL. Two randomized controlled trials from abroad have addressed this technique.<sup>47,48</sup> Both showed no significant difference in the overall rate of complications and both showed a reduction in the risk of subsequent cholecystitis with the use of balloon dilation. A third multicenter U.S. study, which has been published only in abstract form, was halted early because of a significant increase in mortality and severe pancreatitis with balloon dilation.<sup>49</sup> Another prospective multicenter U.S. study found biliary balloon sphincter dilation to be an independent risk factor for pancreatitis.<sup>3</sup> Given the

concerns raised with these latter studies, balloon dilation cannot be routinely recommended.

### SUMMARY

ERCP is a relatively safe endoscopic procedure; however, there is the potential for severe, life-threatening complications. The most common complications are pancreatitis, hemorrhage, infectious complications, and perforation [B]. Several risk factors for ERCP-induced pancreatitis have been identified that can be assessed before the examination. These include a prior history of ERCP pancreatitis, nondilated ducts, normal bilirubin, young age, female gender, and suspected sphincter of Oddi dysfunction [B]. In these settings, careful consideration should be given to alternative imaging modalities such as MRCP or EUS [C]. Although pharmacologic methods for the reduction of ERCP-induced pancreatitis have been proposed, randomized trials have not consistently shown a clinical benefit and many are not currently available in the United States for clinical use [A]. Placement of a pancreatic stent in the setting of suspected SOD can reduce the incidence of pancreatitis [A]. Bleeding complications of sphincterotomy are more common in the setting of preexisting coagulopathy [B]. Balloon sphincter dilation has been proposed as an alternative to sphincterotomy; however, preliminary data has raised concern regarding the safety of this technique and it cannot be recommended at present [A]. Anticoagulants should be avoided within the first 72 hours of sphincterotomy whenever possible [B]. Aspirin and nonsteroidal anti-inflammatory drugs appear to be safe and may be continued when indicated [B]. Infectious complications are more common when biliary drainage is incomplete, malignant strictures are present, or combined radiologic-endoscopic procedures are performed [B]. The routine use of prophylactic antibiotics does not appear to influence this risk and is not recommended [A]. Prophylaxis continues to be recommended for patients with prosthetic heart valves, a prior history of endocarditis, systemic-pulmonary shunt or recent (<1 year) synthetic graft placement [C]. Endoscopists performing ERCP should receive adequate training and ensure that they are exposed to a sufficient case volume to warrant providing this service [C].

### REFERENCES

1. McCune WS, Shorb PE, Moscovitz H. Endoscopic cannulation of the ampulla of Vater: a preliminary report. *Ann Surg* 1968; 167:752-6.
2. Cotton PB, Lehman G, Vennes J, Geenen JE, Russell RC, Meyers WC, et al. Endoscopic sphincterotomy complications

A, Prospective controlled trials. B, Observational studies. C, Expert opinion.

- and their management: an attempt at consensus. *Gastrointest Endosc* 1991;37:383-93.
3. Freeman ML, DiSario JA, Nelson DB, Fennerty MB, Lee JG, Bjorkman DJ, et al. Risk factors for post-ERCP pancreatitis: a prospective, multicenter study. *Gastrointest Endosc* 2001; 54:425-34.
4. Freeman ML, Nelson DB, Sherman S, Haber GB, Herman ME, Dorsher PT, et al. Complications of endoscopic biliary sphincterotomy. *N Engl J Med* 1996;335:909-18.
5. Loperfido S, Angelini G, Benedetti G, Chilovi F, Costan F, De Berardinis F, et al. Major early complications from diagnostic and therapeutic ERCP: a prospective multicenter study. *Gastrointest Endosc* 1998;48:1-10.
6. Masci E, Toti G, Mariani A, Curioni S, Lomazzi A, Dinelli M, et al. Complications of diagnostic and therapeutic ERCP: a prospective multicenter study. *Am J Gastroenterol* 2001;96: 417-23.
7. de Ledinghen V, Lecesne R, Raymond JM, Gense V, Amouretti M, Drouillard J, et al. Diagnosis of choledocholithiasis: EUS or magnetic resonance cholangiography? A prospective controlled study. *Gastrointest Endosc* 1999;49:26-3.
8. Taylor ACF, Little AF, Hennessy OF, Banting SW, Smith PJ, Desmond PV. Prospective assessment of magnetic resonance cholangiopancreatography for noninvasive imaging of the biliary tree. *Gastrointest Endosc* 2002;55:17-22.
9. Prat F, Edery J, Meduri B, Chiche R, Ayoun C, Bodart M, et al. Early EUS of the bile duct before endoscopic sphincterotomy for acute biliary pancreatitis. *Gastrointest Endosc* 2001;54:724-9.
10. Prat F, Amouyal G, Amouyal P, Pelletier G, Fritsch J, Choury AD, et al. Prospective controlled trial of endoscopic ultrasonography and endoscopic retrograde cholangiography in patients with suspected common bile duct lithiasis. *Lancet* 1996;347:75-9.
11. Hunt GC, Faigel DO. Assessment of EUS for diagnosis, staging and determining resectability of pancreatic cancer: a review. *Gastrointest Endosc* 2002;55:232-7.
12. Testoni P, Masci E, Bagnoli F, Tittobello A. Endoscopic papillosphincterotomy: prevention of pancreatic reaction by somatostatin. *Ital J Gastroenterol* 1988;20:70-3.
13. Binmoeller KF, Harris AG, Dumas R, Grimaldi C, Delmont JP. Does the somatostatin analogue octreotide protect against ERCP induced pancreatitis? *Gut* 1992;33:1129-33.
14. Sand J, Norback I. Prospective randomized trial of nifedipine on pancreatic irritation after endoscopic retrograde cholangiopancreatography. *Digestion* 1993;54:105-11.
15. Sudhindran S, Bromwich E, Edwards PR. Prospective randomized double-blind placebo-controlled trial of glyceryl trinitrate in endoscopic retrograde cholangiopancreatography-induced pancreatitis. *Br J Surg* 2001;88:1178-82.
16. Cavallini G, Tittobello A, Frullioni L, Masci E, Mariana A, Di Francesco V. Gabexate for the prevention of pancreatic damage related to endoscopic retrograde cholangiopancreatography. *N Engl J Med* 1996;335:919-23.
17. Budzynska A, Marek T, Nowak A, Kaczor R, Nowakowska-Dulawa E. A prospective, randomized, placebocontrolled trial of prednisone and allopurinol in the prevention of ERCP-induced pancreatitis. *Endoscopy* 2001;33:766-72.
18. Deviere J, Le Moine O, van Laethem JL, Eisendrath P, Ghilain A, Severs N, et al. Interleukin 10 reduces the incidence of pancreatitis after therapeutic endoscopic retrograde cholangiopancreatography. *Gastroenterol* 2001;120:498-505.
19. Dumot JA, Conwell DL, Zuccaro G, Vargo JJ, Shay SS, Easley KA, et al. A randomized double blind study of interleukin 10 for prevention of ERCP-induced pancreatitis. *Am J Gastroenterol* 2001;96:2098-102.

20. Andriulli A, Leandro G, Niro G, Mangia A, Festa V, Gambassi G, et al. Pharmacologic treatment can prevent pancreatic injury after ERCP: a meta-analysis. *Gastrointest Endosc* 2000;51:1-7.
21. Andriulli A, Clemente R, Teruzzi V, Suriani R, Sigillito A, Leandro G, et al. Gabexate or somatostatin administration before ERCP in patients at high risk for post-ERCP pancreatitis: a multicenter placebo-controlled randomized clinical trial. *Gastrointest Endosc* 2002;56:488-95.
22. Binmoeller KF, Dumas R, Harris AG, Delmont JP. Effect of somatostatin analog octreotide on human sphincter of Oddi. *Dig Dis Sci* 1992;37:773-7.
23. Sudhindran S, Bromwich E, Edwards PR. Prospective randomized double-blind placebo-controlled trial of glyceryl trinitrate in endoscopic retrograde cholangiopancreatography-induced pancreatitis. *Br J Surg* 2001;88:1178-82.
24. Moreto M, Zaballa M, Casado I, Merino O, Rueda M, Ramirez K, et al. Transdermal glyceryl trinitrate for prevention of post-ERCP pancreatitis: a randomized double-blind trial. *Gastrointest Endosc* 2003;57:1-7.
25. Rabenstein T, Roggenbuck S, Framke B, Martus P, Fischer B, Nusko G, et al. Complications of endoscopic sphincterotomy: can heparin prevent acute pancreatitis after ERCP? *Gastrointest Endosc* 2002;55:476-83.
26. Sherman S, Hawes RH, Rathgaber SW, Uzer MF, Smith MT, Khusro QE, et al. Post-ERCP pancreatitis: randomized, prospective study comparing a low- and high-osmolality contrast agent. *Gastrointest Endosc* 1994;40:442-7.
27. Johnson GK, Geenen JE, Bedford RA, Johanson J, Cass O, Sherman S, et al. A comparison of nonionic versus ionic contrast media: results of a prospective, multicenter study. *Gastrointest Endosc* 1995;42:312-6.
28. Weiner GR, Geenen JE, Hogan WJ, Catalano MF. Use of corticosteroids in the prevention of post-ERCP pancreatitis. *Gastrointest Endosc* 1995;42:579-83.
29. Dumot JA, Conwell DL, O'Connor JB, Ferguson DR, Vargo JJ, Barnes DS, et al. Pretreatment with methylprednisolone to prevent ERCP-induced pancreatitis: a randomized, multicenter, placebo-controlled clinical trial. *Am J Gastroenterol* 1998;93:61-5.
30. De Palma GD, Catanzano C. Use of corticosteroids in the prevention of post-ERCP pancreatitis: results of a controlled prospective study. *Am J Gastroenterol* 1999;94:982-5.
31. Prat F, Amaris J, Ducot B, Bocquentin M, Fritsch J, Choury AD, et al. Nifedipine for prevention of post-ERCP pancreatitis: a prospective double-blind randomized study. *Gastrointest Endosc* 2002;56:202-8.
32. Huibregtse K, Katon RM, Tytgat GNJ. Precut papillotomy via fine needle-knife papillotome: a safe and effective technique. *Gastrointest Endosc* 1986;32:403-5.
33. Binmoeller KF, Seifert H, Gerke H, Seitz U, Portis M, Soehendra N. Papillary roof excision using the Erlangen-type pre-cut papillotome to achieve bile duct cannulation. *Gastrointest Endosc* 1996;44:689-95.
34. Sherman S, Troiano FP, Hawes RH, Lehman GA. Sphincter of Oddi manometry: decreased risk of clinical pancreatitis with use of a modified aspirating catheter. *Gastrointest Endosc* 1990;36:462-6.
35. Tarnasky PR, Palesch YK, Cunningham JT, Mauldin PD, Cotton PB, Hawes RH. Pancreatic stenting prevents pancreatitis after biliary sphincterotomy in patients with sphincter of Oddi dysfunction. *Gastroenterology* 1998;115:1518-24.
36. Aizawa T, Ueno N. Stent placement in the pancreatic duct prevents pancreatitis after endoscopic sphincter dilation for removal of bile duct stones. *Gastrointest Endosc* 2001;54:209-13.
37. Elta GH, Barnett JL, Wille RT, Brown KA, Chey WD, Scheiman JM. Pure cut electrocautery current for sphincterotomy causes less post-procedure pancreatitis than blended current. *Gastrointest Endosc* 1998;47:149-53.
38. Siegel JH, Veerappan A, Tucker R. Bipolar versus monopolar sphincterotomy: a prospective trial. *Am J Gastroenterol* 1994;89:1827-30.
39. Howard TJ, Tan T, Lehman GA, Sherman S, Madura JA, Fogel E, et al. Classification and management of perforations complicating endoscopic sphincterotomy. *Surgery* 1999;126:658-65.
40. Enns R, Eloubeidi MA, Mergener K, Jowell PS, Branch MS, Pappas TM, et al. ERCP-related perforations: risk factors and management. *Endoscopy* 2002;34:293-8.
41. Sherman S. Endoscopic drainage of malignant hilar obstruction: is one biliary stent enough or should we work to place two? *Gastrointest Endosc* 2001;53:681-4.
42. De Palma GD, Galloro G, Siciliano S, Iovino P, Catanzano C. Unilateral versus bilateral endoscopic hepatic duct drainage in patients with malignant hilar biliary obstruction: results of a prospective, randomized and controlled study. *Gastrointest Endosc* 2001;53:547-53.
43. Hintze RE, Abou-Rebyeh H, Adler A, Veltzke-Schlieker W, Felix R, Wiedenmann B. Magnetic resonance cholangiopancreatography-guided unilateral endoscopic stent placement for Klatskin tumors. *Gastrointest Endosc* 2001;53:40-6.
44. Harris A, Chan CH, Torres-Viera C, Hammett R, Carr-Locke D. Meta-analysis of antibiotic prophylaxis in endoscopic retrograde cholangiopancreatography. *Endoscopy* 1999;31:718-24.
45. van den Hazel SJ, Speelman P, Dankert J, Huibregtse K, Tytgat GN, van Leeuwen DJ. Piperacillin to prevent cholangitis after endoscopic retrograde cholangiopancreatography. A randomized controlled trial. *Ann Intern Med* 1996;125:442-7.
46. Boerma D, Rauws EAJ, Keulemans YCA, Janssen IMC, Bolwerk CJ, Timmer R, et al. Wait-and-see policy or laparoscopic cholecystectomy after endoscopic sphincterotomy for bile-duct stones: a randomised trial. *Lancet* 2002;360:761-5.
47. Bergmann JJ, Rauws EA, Fockens P, van Berkel AM, Bossuyt PM, Tijssen JG, et al. Randomised trial of endoscopic balloon dilation versus endoscopic sphincterotomy for removal of bile duct stones. *Lancet* 1997;349:1124-9.
48. Ochi Y, Mukawa K, Kiyosawa K, Akamatsu T. Comparing the treatment outcomes of endoscopic papillary dilation and endoscopic sphincterotomy for removal of bile duct stones. *J Gastroenterol Hepatol* 1999;14:90-6.
49. DiSario JA, Freeman ML, Bjorkrnan DJ, MacMathuna P, Petersen B, Sherman S, et al. Endoscopic balloon dilation compared to sphincterotomy (EDES) for extraction of bile duct stones: preliminary results [abstract]. *Gastrointest Endosc* 1997;45:AB129.

**Prepared by:  
STANDARDS OF PRACTICE COMMITTEE**

J. Shawn Mallery, MD  
 Todd H. Baron, MD  
 Jason A. Dominitz, MD  
 Jay L. Goldstein, MD  
 William K. Hirota, MD  
 Brian C. Jacobson, MD, MPH  
 Jonathan A. Leighton, MD  
 Hareth M. Raddawi, MD  
 John J. Vargo II, MD  
 J. Patrick Waring, MD  
 Robert D. Fanelli, MD, SAGES Rep.  
 Jo Wheeler-Harbough, RN, SGNA Rep.  
 Glenn M. Eisen, MD, Past Chair  
 Douglas O. Faigel, MD, Chair