Guidewires for use in GI endoscopy

The ASGE Technology Committee provides reviews of existing, new, or emerging endoscopic technologies that have an impact on the practice of gastrointestinal endoscopy. Evidence-based methodology is used, with a MEDLINE literature search to identify pertinent clinical studies on the topic and a MAUDE (Food and Drug Administration Center for Devices and Radiological Health) database search to identify the reported complications of a given technology. Both are supplemented by accessing the "related articles" feature of PubMed and by scrutinizing pertinent references cited by the identified studies. Controlled clinical trials are emphasized, but in many cases data from randomized controlled trials are lacking. In such cases, large case series, preliminary clinical studies, and expert opinions are utilized. Technical data are gathered from traditional and Web-based publications, proprietary publications, and informal communications with pertinent vendors.

Technology Status Evaluation Reports are drafted by 1 or 2 members of the ASGE Technology Committee, reviewed and edited by the committee as a whole, and approved by the Governing Board of the ASGE. When financial guidance is indicated, the most recent coding data and list prices at the time of publication are provided. For this review, the MEDLINE database was searched through January 5, 2007 for articles related to guidewires by using the keywords "guidewire" and "endoscopy" or "colonoscopy" or "ERCP."

Technology Status Evaluation Reports are scientific reviews provided solely for educational and informational purposes. Technology Status Evaluation Reports are not rules and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment or payment for such treatment.

BACKGROUND

Guidewires are used to achieve or maintain access to a lumen or cavity and to facilitate advancement of various devices. They have become indispensable tools in diagnostic and therapeutic endoscopy.

0016-5107/$32.00
doi:10.1016/j.gie.2006.10.003

TECHNOLOGY UNDER REVIEW

Ideal guidewire characteristics for gaining access to a lumen differ from those for advancement of dilators, stents, or other devices. Access to irregular or narrowed lumens is facilitated by slippery and flexible leading tips. Advancement of rigid and soft devices is best achieved over stiff and taut wires to minimize lateral deviation and to aid in forward axial transmission of forces. Friction can aid in maintaining wire tension; but, it hinders both wire and device movement. Variations in guidewire materials, length, diameter, and design are intended to optimize performance (Table 1).

Guidewire construction

Guidewires for GI applications use 1 of 3 designs (monofilament, coiled, or coated):

1. Monofilament wires are usually made of stainless steel and are designed primarily for rigidity. Monofilament wires for esophageal bougienage have coiled spring tips with graded flexibility.
2. Coiled wires have an inner monofilament core, or mandrel, which imparts stiffness, and an outer spiral coil, which lends flexibility and durability. Both are usually made of stainless steel. This combination improves "trackability," a subjective characteristic that refers to ease of advancement through a tortuous path. Most coiled wires are Teflon (DuPont, Washington, Del) painted to reduce resistance. One variant incorporates a movable core, which allows varied stiffening of the wire.[1]
3. Coated or sheathed wires have a monofilament core and an extruded, dipped, or sprayed-on outer sheath made of Teflon, polyurethane, or another "lubricious" polymer. The monofilament core may be made of stainless steel, nitinol, or other proprietary "shape-memory" alloys. By modifying their chemical characteristics or composition, the outer sheaths can be engineered to improve their radiopacity, slipperiness, and electrical insulating properties.

Flexibility of the tip is influenced by the taper of the inner core. Many wires have platinum or tungsten tipped cores to improve fluoroscopic visualization. Tips may be straight, angled, J shaped, or tapered. Some wires have graduated or continuous markings for visual endoscopic measurement or movement detection. Most angled wires cannot be well controlled in a radial direction, but some of

TABLE 1. Guidewire specifications and costs

Wire type/name (manufacturer)	Diameter (in)	Length (cm)	Core material	Sheath material/design	Tip material/ design*	Remarks	Cost ($)*
Monofilament							
Savary-Gilliard (Cook)	0.032, 0.072 tip	200, 250, 360	Stainless Steel	N/A	Coiled spring/S	Graduated markings; Reusable	127, 151, 175, varies by length
Axcess 21 (Cook)	0.021	650	Nitinol	N/A	Platinum/S	Kink resistant, available in enteroscopy length, must remove prior to sphincterotomy	263
American (Conmed)	Shaft .026 to .036 Tip .068 to .073	200-360	Stainless Steel	None	Coiled spring/S	Graduated markings; Reusable	365/box of 2
Amplatz (BSC)	0.038	260	Stainless Steel		S		149
Coiled							
WALLSTENT Super Stiff Guidewire (BSC)	0.035	500	Stainless Steel	Teflon Coated	Tapered		575/box of 5
Standard (Cook Endoscopy)	0.018, 0.021, 0.025, 0.035	480	Stainless Steel	PTFE Coated	S	Must remove prior to sphincterotomy	67
Standard (Cook Endoscopy) Coated	0.035	400	Stainless Steel	Teflon Coated	S	Must remove prior to sphincterotomy	67
Glidewire (BSC)	0.035 0.025 0.02	260, 450 260, 450 450	Nitinol	Polyurethane with Hydrophilic coat on entire length	Platnium/ S+A	Available in both Straight or Angled	619/box of 5 (260 cm)/1039/ box of 5 (450 cm)
Pathfinder (BSC)	0.018	450	Nitinol	Endoglide	Platinum Shapable tip		299/box of 2
Jagwire (BSC)	0.025 0.035 0.038	260, 450 260, 450 260	Nitinol	Teflon with hydrophilic coating on leading end	Tungsten/S+A Tungsten/S+A Tungsten/S	Available as "Extendable" wire in .035" x 260 cm version	299/box of 2
Jagtail (BSC)	0.035	200	Nitinol	Same as Jagwire		"Tail" for connecting to 0.035: x 260 cm extendable Jagwire	475/box of 5
Hydra Jagwire (BSC)	0.035	260, 450	Nitinol	Teflon with hydrophilic coating on both ends	Tungsten/ S+A	Double-ended guidewire with two distinct tips for multiple access options	399/box of 2

(*continued on next page*)

TABLE 1 (*continued*)

Wire type/name (manufacturer)	Diameter (in)	Length (cm)	Core material	Sheath material/design	Tip material/ design*	Remarks	Cost ($)*
XWire (ConMed)	.035 .025	260, 450	Regiliant™ Nitinol	PTFE + 5cm hydrophillic coating on tip	Nitinol and Tungsten/ S+A	Endoscopic measurement markers; Regiliant Nitinol gives the wire greater column strength	450 cm-173 260 cm-137
FXWire (ConMed)	.035 .025 (In Development)	260, 450	Regiliant™ Nitinol	PTFE + 5cm hydrophillic coating on tip	Nitinol and Tungsten/ S+A	Endoscopic, fluoroscopic and proximal measurement markers; Regiliant Nitinol gives the wire greater column strength	450 cm-183 260 cm-147
Director Wire (ConMed)	.035	480	Nitinol Stainless Steel	PTFE torquing segment, nitinol exchange segment, 40cm nitinol tip with hydrophillic coating	Platinum/A	Endoscopic measurement markers	198
Delta (Cook Endoscopy)	0.025, 0.035	260	Nitinol	Polyurethane	S+A	Kink resistant, fully hydrophilic	535/box of 5
Road Runner (Cook Endoscopy)	0.018	480	Nitinol	PTFE	Platinum/ S+A	Kink resistant, must remove prior to sphincterotomy	145
Tracer Hybrid (Cook Endoscopy)	0.035	480	Nitinol	PTFE	Platinum, W/15 or 25cm urethane tip/S+A	Kink resistant, graduated markings, hydrophilic tip	144
Tracer Metro (Cook Endoscopy)	0.025, 0.035	260, 480	Nitinol	PTFE	Platinum/ S+A	Kink resistant, graduated markings, hydrophilic tip	155
Tracer Metro Direct (Cook Endoscopy)	0.021, 0.025, 0.035	260, 480	Nitinol	PTFE	Platinum/ S+A	Kink resistant, hydrophilic tip	155
Fusion (Cook Endoscopy)	0.035	205	Nitinol	PTFE	Platinum, S	Kink resistant, hydrophilic tip	140
Flex-Ez (Hobbs Medical)	0.035 0.038	260 400 480 260	Stainless Steel	Teflon	7cm Floppy Tip	Generic use	38-46
LinearGuideV (Olympus)	0.035	270, 450	Nitinol	Polyurethane with hydrophilic coating for 50 cm, the balance is PTFE coated	Nitinol and polyurethane/ S+A	Entire length is radiopaque	162

S, Straight; *A*, angled; *C*, curved.
*List prices as of February, 2007.

the most lubricious designs are more easily torqued. Torque may be facilitated by use of a vise clamped to the shaft of the wire outside of the endoscope. Guidewire lengths range from 150 to 650 cm. One short wire (260 cm) design allows for attachment of a 200-cm extension when needed (Extendable Jagwire; Microvasive Endoscopy; Boston Scientific Corp, Natick, Mass). Nominal diameters vary between 0.46 and 0.97 mm (0.018 and 0.038 inches).

Guidewire use

For most applications within the GI tract, guidewires are advanced under visual control directly through the endoscope, with or without fluoroscopy. For ERCP applications, wires are advanced through catheters, which provide access, stiffness, and direction, while using fluoroscopy.[2] Flushing water through all dry or contrast-filled devices reduces friction and facilitates guidewire passage. Hydrophilic wires in particular require continuous moistening of exposed portions to avoid drying and sticking. Maintenance of the wire position is critical for the safety of dilating applications and for the success of tube placements. Printed distance markers or movement guides on the wire and fixation of the wire's external end on an immobile item can minimize the risk of displacement.[3] Even with these precautions, tube placement and stricture dilation may be facilitated by use of fluoroscopic guidance.[4,5] Dilation of uncomplicated esophageal lesions without fluoroscopy has been described.[5-8]

Larger caliber (>0.89 mm [>0.035 inches]) monofilament or coiled wires are predominantly used for applications in the luminal GI tract, whereas coated wires of varying size are becoming more routinely used, especially for ERCP applications. Wire lengths above 400 cm were previously necessary for exchange of devices but with lubricious wires and the newer short-wire systems, exchanges are possible over wires 260 cm or less in length. Smaller-caliber and hydrophilic wires are used primarily for cannulation and accessing difficult strictures. Only coated wires should be used for electrocautery applications.

INDICATIONS AND EFFICACY

Indications

Upper-GI endoscopy. Guidewires are used for advancement of rigid and balloon dilators, stents, manometry catheters, feeding tubes; for foreign-body removal; and during transmucosal pseudocyst drainage.[9-11]

Prior passage of a guidewire may facilitate endoscope advancement through tight strictures.[12] Difficult esophageal intubation may also be facilitated in patients with a Zenker's diverticulum[13] and esophageal strictures, and in pediatric patients, and occasionally in adult patients, with endotracheal tubes in place. Guidewire use has also been described in transluminal endoscopic enteral anastomosis creation.[14]

Colonoscopy. Guidewire applications in colonoscopy are analogous to those in the upper-GI tract. These include placement of decompression tubes and colonic stents, stricture dilation, and facilitation of endoscope advancement.[15,16]

ERCP. During ERCP, guidewires are used for achieving selective biliary, pancreatic, cystic, or intrahepatic duct access[17,18]; antegrade passage during combined "rendezvous" procedures; straightening and stabilizing the papilla during biliary cannulation via placement in the pancreatic duct,[19] or during parallel passage of other accessories in the same duct[20] and for maintenance of access during placement or exchange of devices. Examples include most therapeutic and many of the diagnostic maneuvers used during the performance of ERCP.[21-33]

EUS. Guidewire-assisted EUS-guided biliary and pancreatic access has been reported recently.[34-37] Wire guidance is also used for passage of intraductal US catheters for both diagnostic and therapeutic purposes.[38,39]

EFFICACY AND EASE OF USE

Although guidewires are an inherent element of most procedures in which they are used, there are few data regarding the relative efficacy of specific wires. Experience has shown that coated and hydrophilic wires improve the ultimate success of those ERCP procedures that require access through difficult papillae or tight strictures.[40] One report described achieving access with hydrophilic-coated wires after failure with standard wires in 12 tight strictures, 10 of 13 difficult cannulations, and 16 of 19 gallbladder intubations.[41] Several reports describe improved cannulation success with the use of a guidewire and sphincterotome together compared with cannulation with a standard cannula, with or without a guidewire.[42,43] The use of most wires is not difficult. Hydrophilic wires, however, are prone to inadvertent displacement from ducts or strictures and may add to the difficulty of catheter exchanges. To overcome this issue, the recently introduced "short-wire" ERCP systems allow the endoscopist to control and lock the guidewire, thus minimizing the chance for losing access.

SAFETY

Perforation and failed device placement are the main wire-related risks of wire-guided procedures in the GI tact[44] and in the pancreas or biliary tree.[45] Wire perforation can occur when excessive force is applied below a stricture or at an acute angle. Rigid devices can perforate when wire access is lost from a stricture or a tortuous lumen, or when tension is lost and the wire no longer serves as a guide.

Wire-guided sphincterotomy by using a single lumen or faulty double-lumen sphincterotomes can transmit significant electrical current from the cutting wire through standard Teflon-painted guidewires into the bile duct.[46,47] Double-lumen sphincterotomes can induce currents in all guidewires by capacitance coupling from the live cutting wire.[47-49] Intact coated wires are effectively insulated against transmission of both short circuits and induced currents[47,50] during in vitro normal-use studies performed through an endoscope. All marred or damaged wires are potential sources of dangerous currents.[49]

Two reports have described insignificant increases in pancreatitis and bleeding complications after wire-guided sphincterotomy.[51,52] Bile-duct perforation thought to be related to electrical burns[47] and fracture of a small-caliber wire[53] have been described from sphincterotomy performed over noninsulated coiled guidewires. Similar electrical injury has not been described for the coated guidewires, although complete fractures have been well documented.[54,55] A case of cholangitis resulting from a guidewire fracture has been reported.[56]

Sparking and short circuits have occurred between the cutting wire and the guidewire near the sphincterotome handle. Multiple loops of wire advanced above a stricture have led to entanglement and knot formation.[57-59] A search of the MAUDE database revealed similar occurrences of wire fragmentation, induced burns, and perforations to those noted in the literature, as well as a case of separation of the Teflon sheathing from the guidewire, with retention in the patient.[60]

Studies of post-ERCP pancreatitis previously identified guidewire use as a risk factor, most likely because of late use in cases of difficult cannulation.[61] In contrast, a recent prospective randomized controlled trial in 400 patients reported a significantly lower rate of post-ERCP pancreatitis with cannulation using a flexible-tipped guidewire through a sphincterotome versus cannulation using standard techniques and contrast (0% vs 4%, $P < .01$).[62]

FINANCIAL CONSIDERATIONS

Most coiled and coated wires used for ERCP and general GI applications are marketed as single-use items. Monofilament stainless-steel wires for esophageal dilation are reusable. Costs vary significantly and are minimal for the standard coiled wire but significant for the specialty coated wires (Table 1).

CONCLUSION

Endoscopic guidewire placement is an indispensable element of many GI procedures. A sound understanding of the available wires and their use is essential for the safe and efficient practice of therapeutic endoscopy.

REFERENCES

1. Gospos J, Kuhner W, Weingart J, et al. Transpapillary placement of an endoprosthesis with the aid of the Frimberger Varioguide. Endoscopy 1988;20:57-61.
2. Jacob L, Geenen JE. ERCP guide wires. Gastrointest Endosc 1996;43:57-60.
3. Cantor DS. Simple method for maintaining guide wire position. Gastrointest Endosc 1987;33:464-5.
4. Stark SP, Sharpe JN, Larson GM. Endoscopically placed nasoenteral feeding tubes: indications and techniques. Am Surg 1991;57:203-5.
5. Mohandas KM, Swaroop VS, Desai DC. Marked wire-guided esophageal dilation and the need for fluoroscopy. Gastrointest Endosc 1992;38:634-5.
6. Kadakia SC, Parker A, Carrougher JG, et al. Esophageal dilation with polyvinyl bougies, using a marked guidewire without the aid of fluoroscopy: an update. Am J Gastroenterol 1993;88:1381-6.
7. Wang YG, Tio TL, Soehendra N. Endoscopic dilation of esophageal stricture without fluoroscopy is safe and effective. World J Gastroenterol 2002;8:766-8.
8. Austin AS, Khan Z, Cole AT, et al. Placement of esophageal self-expanding metallic stents without fluoroscopy. Gastrointest Endosc 2001;54:357-9.
9. Mirhej MA, Koch J, Stansell J. A novel approach to ring-type foreign body removal: the "U-wire." Gastrointest Endosc 1999;49:243-5.
10. van Twisk JJ, Brummer RJ, Manni JJ. Retrograde approach to pharyngo-esophageal obstruction. Gastrointest Endosc 1998;48:296-9.
11. Bueno R, Swanson SJ, Jaklitsch MT, et al. Combined antegrade and retrograde dilation: a new endoscopic technique in the management of complex esophageal obstruction. Gastrointest Endosc 2001;54:368-72.
12. Catalano MF, Raijman I. Wire-guided endoscope passage. Gastrointest Endosc 1992;38:728.
13. Malik A, Chitnavis V, Epstein A. Use of a hydrophilic wire for esophageal intubation in Zenker's diverticulum. Gastrointest Endosc 1994;40:523-4.
14. Fritscher-Ravens A, Mosse CA, Mukherjee D, et al. Transluminal endosurgery: single lumen access anastomotic device for flexible endoscopy. Gastrointest Endosc 2003;58:585-91.
15. Rex DK, Goodwine BW. Method of colonoscopy in 42 consecutive patients presenting after prior incomplete colonoscopy. Am J Gastroenterol 2002;97:1148-51.
16. Vazquez-Iglesias JL, Gonzalez-Conde B, Vazquez-Millan MA, et al. Self-expandable stents in malignant colonic obstruction: insertion assisted with a sphincterotome in technically difficult cases. Gastrointest Endosc 2005;62:436-7.
17. Husain A, Debold C, Edmundowicz SA, et al. Directed balloon-assisted guidewire access into intrahepatic ducts. Gastrointest Endosc 2001;54:118-9.
18. Moxon DR, Hong K, Brown RD, et al. Selective intrahepatic ductal cannulation during ERCP with a sphincterotome. Gastrointest Endosc 2003;57:738-43.
19. Draganov P, Devonshire DA, Cunningham JT. A new technique to assist in difficult bile duct cannulation at the time of endoscopic retrograde cholangiopancreatography. JSLS 2005;9:218-21.
20. Lin LF, Siauw CP, Ho KS, et al. Guidewire technique for endoscopic transpapillary procurement of bile duct biopsy specimens without endoscopic sphincterotomy. Gastrointest Endosc 2003;58:272-4.
21. Higashizawa T, Tamada K, Tomiyama T, et al. Biliary guidewire facilitates bile duct biopsy and endoscopic drainage. J Gastroenterol Hepatol 2002;17:332-6.
22. Mergener K, Baillie J. Retrieval of distally migrated, impacted biliary endoprostheses using a novel guidewire/basket "lasso" technique. Gastrointest Endosc 1999;50:93-5.
23. Amann ST, Somogyi L. A wire-loop technique for removal of migrated and embedded biliary stents. Gastrointest Endosc 2000;51:485-6.
24. Mulcahy HE, Cunningham JT. A guidewire-assisted technique for removing retained biliary stents with rat-toothed forceps during

endoscopic retrograde cholangiography. Gastrointest Endosc 2001;53: 386-7.
25. Moon JH, Cha SW, Cho YD, et al. Wire-guided endoscopic snare papillectomy for tumors of the major duodenal papilla. Gastrointest Endosc 2005;61:461-6.
26. Carr-Locke DL. Biliary access during endoscopic retrograde cholangiopancreatography. Can J Gastroenterol 2004;18:251-4.
27. Wright BE, Cass OW, Freeman ML. ERCP in patients with long-limb Roux-en-Y gastrojejunostomy and intact papilla. Gastrointest Endosc 2002;56:225-32.
28. Burdick JS, London A, Thompson DR. Intramural incision technique. Gastrointest Endosc 2002;55:425-7.
29. Rumalla A, Baron TH, Wang KK, et al. Endoscopic application of photodynamic therapy for cholangiocarcinoma. Gastrointest Endosc 2001; 53:500-4.
30. Iodice G, Giardiello C, Francica G, et al. Single-step treatment of gallbladder and bile duct stones: a combined endoscopic-laparoscopic technique. Gastrointest Endosc 2001;53:336-8.
31. Wang HP, Huang SP, Sun MS, et al. Urgent endoscopic nasobiliary drainage without fluoroscopic guidance: a useful treatment for critically ill patients with biliary obstruction. Gastrointest Endosc 2000; 52:741-4.
32. Watanabe Y, Goto H, Hirooka Y, et al. Transpapillary biopsy in gallbladder disease. Gastrointest Endosc 2000;51:76-9.
33. Chan AC, Chung SC. New wire-guided basket for intrahepatic stone extraction. Gastrointest Endosc 1999;50:401-4.
34. Kahaleh M, Wang P, Shami VM, et al. EUS-guided transhepatic cholangiography: report of 6 cases. Gastrointest Endosc 2005;61:307-13.
35. Kahaleh M, Yoshida C, Kane L, et al. Interventional EUS cholangiography: a report of five cases. Gastrointest Endosc 2004;60:138-42.
36. Mallery S, Matlock J, Freeman ML. EUS-guided rendezvous drainage of obstructed biliary and pancreatic ducts: report of 6 cases. Gastrointest Endosc 2004;59:100-7.
37. Kahaleh M, Yoshida C, Yeaton P. EUS antegrade pancreatography with gastropancreatic duct stent placement: review of two cases. Gastrointest Endosc 2003;58:919-23.
38. Chak A, Isenberg G, Kobayashi K, et al. Prospective evaluation of an over-the-wire catheter US probe. Gastrointest Endosc 2000;51: 202-5.
39. Prat F, Lafon C, De Lima DM, et al. Endoscopic treatment of cholangiocarcinoma and carcinoma of the duodenal papilla by intraductal high-intensity US: results of a pilot study. Gastrointest Endosc 2002; 56:909-15.
40. Gane E, Lane M, Hamiltion I. Use of an alternative guidewire system in endoscopic placement of biliary endoprostheses. Endoscopy 1991;23: 215-7.
41. McCarthy JH, Miller GL, Laurence BH. Cannulation of the biliary tree, cystic duct and gallbladder using a hydrophilic polymer-coated steerable guide wire. Gastrointest Endosc 1990;36:386-9.
42. Cortas GA, Mehta SN, Abraham NS, et al. Selective cannulation of the common bile duct: a prospective randomized trial comparing standard catheters with sphincterotomes. Gastrointest Endosc 1999;50: 775-9.
43. Karamanolis G, Katsikani A, Viazis N, et al. A prospective cross-over study using a sphincterotome and a guidewire to increase the success rate of common bile duct cannulation. World J Gastroenterol 2005;11: 1649-52.
44. Clouse RE. Complications of endoscopic gastrointestinal dilation techniques. Gastrointest Endosc Clin N Am 1996;6:323-41.
45. Aliperti G. Complications related to diagnostic and therapeutic endoscopic retrograde cholangiopancreatography. Gastrointest Endosc Clin N Am 1996;6:379-407.
46. Schoenfeld PS, Jones DM, Lawson JM. Conducted current on guidewires in single lumen papillotomes. Gastrointest Endosc 1991;37: 344-6.
47. Johlin FC, Tucker RD, Ferguson S. The effect of guidewires during electrosurgical sphincterotomy. Gastrointest Endosc 1992;35:536-40.
48. Tucker RD, Silvis SE. Induced current on the guide wire during sphincterotomy. Gastrointest Endosc 1989;35:45-7.
49. Tucker RC, Voyles CR, Silvis SE. Capacitive coupled stray currents during laparoscopic and endoscopic electrosurgical procedures. Biomed Instrum Technol 1992;26:303-11.
50. Sisken RB, Fearn NE, Smith HJ. Electrosurgical safety of guide wires during endoscopic sphincterotomy. Gastrointest Endosc 1993;39: 770-3.
51. Sherman S, Uzer MF, Lehman GA. Wire-guided sphincterotomy. Am J Gastroenterol 1994;89:2125-9.
52. Cohen SA, Kasmin FE, Resnikow KA, et al. Techniques of endoscopic sphincterotomy (ES) in a referral population [abstract]. Gastrointest Endosc 1992;38:262.
53. Burdick JS, Schmalz MJ, Geenen JE. Guidewire fracture during endoscopic sphincterotomy. Endoscopy 1993;25:251-2.
54. Heinerman M, Mann R, Boeckl O. An unusual complication in attempted non-surgical treatment of pancreatic bile duct stones. Endoscopy 1993;25:248-50.
55. Pruitt A, Schutz SM, Baron T, et al. Fractured hydrophilic guidewire during ERCP: a case series. Gastrointest Endosc 1998;48:77-80.
56. Fry LC, Linder JD, Monkemuller KE. Cholangitis as a result of hydrophilic guidewire fracture. Gastrointest Endosc 2002;56:943-4.
57. Murray RN, Kadadia SC, Parker A. Guidewire loop formation in common bile duct during biliary manometry. Am J Gastroenterol 1992; 87:1679-81.
58. Cohen SA, Kasmin FE, Siegel JH. Another unusual guidewire complication in the common bile duct. Am J Gastroenterol 1993;88:969-71.
59. Bhasin DK, Poddar U, Wig JD. Knot formation in a floppy-tipped guidewire in the common bile duct: an unusual complication of ERCP. Endoscopy 2000;32:S17.
60. Guidewires. Available at: http://www.fda.gov/cdrh/maude.html. Accessed September 1, 2006.
61. Vandervoort J, Soetikno RM, Tham TC, et al. Risk factors for complications after performance of ERCP. Gastrointest Endosc 2002;56:652-6.
62. Lella F, Bagnolo F, Colombo E, et al. A simple way of avoiding post-ERCP pancreatitis. Gastrointest Endosc 2004;59:830-4.

Prepared by:
TECHNOLOGY ASSESSMENT COMMITTEE
Lehel Somogyi, MD
Ram Chuttani, MD
Joseph Croffie, MD
James DiSario, MD
Julia Liu, MD
Daniel Mishkin, MD
Raj Shah, MD
William Tierney, MD
Louis M. Wong Kee Song, MD
Bret T. Petersen, MD, Chair
This document is a product of the Technology Assessment Committee. The document was reviewed and approved by the Governing Board of the American Society for Gastrointestinal Endoscopy.