American Society For Gastrointestinal Endoscopy

Tissue sampling and analysis

This is one of a series of statements discussing the utilization of gastrointestinal 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 the appropriate use of endoscopy are based on a critical review of the available data and expert consensus. Controlled clinical studies are needed to clarify aspects of this statement, and revision may be necessary as new data appear. Clinical considerations may justify a course of action at variance from these recommendations.

This document replaces the previously published document "Tissue Sampling and Analysis," Gastrointestinal Endoscopy 1991;37:633-5.

The purpose of this statement is to provide a practical basis for tissue analysis (biopsy, snare excision, cytology, and culture) during GI endoscopy.

Histopathologic evaluation is helpful to differentiate malignant, inflammatory, and infectious processes. Tissue biopsy specimens are routinely obtained from any suspicious lesion during endoscopic evaluation. When the gross endoscopic appearance is normal, histologic analysis may still provide useful information. Tissue analysis is occasionally performed to document the outcome of prior endoscopic or medical therapy. When the gross endoscopic appearance reveals a specific condition, tissue analysis is unnecessary if therapy will not be altered. Tissue biopsy should be avoided when there is an increased potential for hemorrhage such as in patients with coagulopathies.

TECHNIQUES

Numerous techniques and devices have been designed to obtain adequate tissue samples. Pinch biopsy is done with biopsy forceps and is the most commonly used form of tissue sampling. Multiple biopsies improve the diagnostic yield; the size, location, specimen orientation, fixation, and staining are also important.[1,2] Pinch biopsy forceps usually obtain mucosal specimens. Occasionally, jumbo biopsy forceps may also reach the submucosa. However, these forceps require a biopsy channel of at least 3.6 mm and yield 2 to 3 times the surface area but are not generally deeper specimens.[3] Brush cytology may be a useful adjunct to pinch biopsy and helpful in the diagnosis of certain malignancies and infections.[4] Snare excision is used for removal of large polyps.[5] A combination of techniques can increase diagnostic accuracy.[6] EUS-guided FNA is capable of sampling subepithelial lesions and those extrinsic to the GI tract such as lymph nodes and pancreatic masses and is more fully discussed in the ASGE Status Evaluation Report "Tissue Sampling During Endosonography."[7]

ESOPHAGUS

Malignant tumors of the esophagus can be diagnosed by biopsy alone in 95% of cases, except when obstruction prevents adequate visualization and biopsy of the lesion. Eight to 10 biopsy specimens should be obtained.[1] The addition of brush cytology may increase the diagnostic yield.[8,9] The most common inflammatory condition, reflux esophagitis, occurs in patients with GERD. Endoscopy with tissue analysis is indicated to evaluate for the presence of Barrett's esophagus or to rule out infection or malignancy masquerading as GERD.[10] Erosive changes seen on endoscopy correlate well with histology, but isolated erythema is an unreliable criterion for esophagitis. Conversely, abnormal histology (inflammatory cell infiltration with polymorphonuclear cells or eosinophils) may be found by biopsy in patients with reflux symptoms who have normal-appearing esophageal mucosa.[10,11] Biopsy and cytology specimens of abnormal-appearing mucosa may be needed to exclude malignancy, infectious esophagitis, certain autoimmune disorders, and to detect Barrett's esophagus.[10,12]

Barrett's esophagus is a condition in which the normal squamous mucosa is replaced by metaplastic specialized intestinal epithelium and requires endoscopic biopsy for diagnosis.[13] Patients with Barrett's esophagus are at increased risk for esophageal adenocarcinoma, and their identification allows for inclusion in surveillance programs.[14] Histopathology reveals columnar epithelium without a brush border and is distinguished from gastric mucosa by the identification of goblet cells, which may be aided by the use of special stains (alcian blue).[15] Severe ulcerative esophagitis may obscure underlying Barrett's mucosa, and inflammation-induced atypia may be confused with dysplasia. In these instances, aggressive medical therapy to heal esophagitis clarifies subsequent histopathologic interpretation.[13,15,16]

Biopsies are also performed to detect dysplasia or adenocarcinoma. If dysplasia is known or suspected to be present, then 4-quadrant biopsies at 1- to 2-cm intervals with additional specimens from any mucosal abnormalities should be taken.[17,18] A 2-cm protocol missed 50% of cancers in patients with high-grade dysplasia, which were detected in a 1-cm protocol.[18] Although large-capacity "jumbo" forceps have been advocated, a retrospective study found that 4-quadrant biopsies every 2 cm missed the same proportion of cancers when done with large-capacity (4/12, 33%) or standard-sized (6/16, 38%) forceps.[19] The turn-and-suction technique is advocated, in which the open forceps is drawn close to the endoscope's tip, the scope turned toward the wall, suction applied, the forceps advanced, closed, and the specimen obtained.[17] For patients with high-grade dysplasia who opt against esophagectomy, this technique performed at 3- to 6-month intervals has been reported to accurately detect carcinoma, 96% of which were confined to the mucosa.[17,18]

High-resolution magnifying endoscopy and chromoendoscopy with methylene blue has been advocated to increase the detection of short-segment Barrett's esophagus by directing biopsy location.[19-23] Chromoendoscopy with Lugol's solution[24] and methylene blue[21,25] has been reported to increase the detection of squamous cell carcinoma and neoplastic areas within Barrett's esophagus, respectively, although the value of methylene blue in the surveillance of Barrett's esophagus has been questioned.[26] Analyzing the biopsy specimens with flow cytometry and DNA analysis may identify patients with aneuploidy, polyploidy or 17p (p53) loss-of-heterozygosity and predict an increased cancer risk.[27-29]

Discrete lesions of the esophagus may be removed by endoscopic mucosal resection (EMR). This involves a submucosal injection of saline to raise the lesion followed by snare-cautery excision.[30] This technique has been successfully used on neoplastic lesions arising in Barrett's esophagus and for benign esophageal tumors.[31-33]

Infectious esophagitis occurs primarily in immunocompromised patients such as those on systemic antiimmune therapy, inhaled steroids, patients with cancer (especially those on chemotherapy), those with diabetes, and patients with AIDS.[34] The most common infectious agents are *Candida* species, Herpes simplex virus (HSV), and cytomegalovirus (CMV). Fungal esophagitis appears endoscopically as white plaques over the inflamed mucosa.[35] Brushings and biopsy specimens are obtained, but brush cytology is more sensitive.[36] Viral esophagitis manifests as ulcers. Specimens should be taken from both the edge and the center of the ulcer. Histopathology is usually diagnostic but multiple specimens (up to 10) may be required in patients with AIDS.[37] Viral culture may help provide a definitive diagnosis but may be less sensitive than histology for CMV.[35,37-39]

STOMACH

Gastric neoplasia can present as an ulcerative, polypoid, or submucosal lesion, or as thick gastric folds. Adequate tissue sampling sometimes requires a combination of techniques. Pinch biopsy has the highest diagnostic yield for ulcerative or polypoid masses.[1] Multiple biopsy specimens should be obtained from the edge of each quadrant of an ulcer and from the base.[40] Brush cytology may increase the yield over biopsy alone.[41] Biopsy should be performed on polypoid lesions, and polyps greater than 2 cm should be removed when technically feasible.[42] Gastric polypectomy may carry a higher risk of bleeding than colon polypectomy; therefore, postprocedure acid suppressive therapy should be considered.[43]

EMR is used in the stomach to sample thick gastric folds to exclude malignancy, and for treatment of early gastric cancer (EGC). Candidate EGC lesions for EMR are generally less than 20 mm and confined to the mucosa by EUS or endoscopic criteria. The lesion is lifted from the submucosa by an endoscopic fluid injection, and the lesion excised by using one of several described techniques (see Technology Status Evaluation Report–Endoscopic Mucosal Resection).[30]

Patients with peptic ulcer disease, gastric mucosa–associated lymphoid tissue (MALT), lymphoma, and possibly those at increased risk for developing gastric cancer (e.g., family or personal prior history of gastric cancer) should all have their *Helicobacter pylori* status determined.[44-47] Tissue-based tests are performed on endoscopically obtained forceps biopsies of gastric mucosa. These include testing the sample for urease activity (rapid urease test), histologic examination for typical curved bacilli, and culture.[47,48] In untreated patients, biopsy specimens should be obtained from the lesser curvature of the antrum near the incisura angularis.[49] Rapid urease tests (RUT) are inexpensive, highly specific, and can be performed in the endoscopy unit providing results in 1 hour.[48] Less-than-perfect sensitivity has lead to recommendations that a second test be performed if the rapid urease test is negative.[50] Specimens submitted for histologic examination should be assessed for the presence of inflammatory cells and for typical curved bacilli, the latter of which may require the use of special stains.[48,51,52] The presence of significant gastric inflammatory cell infiltration in the absence of bacteria should prompt additional testing with serology, a urea-breath test, or stool antigen testing.[51] Bacterial culture allows for determination of antimicrobial resistance but lacks sensitivity and is cumbersome to perform.[47] The sensitivity of these tissue-based tests may be decreased in patients using proton pump inhibitors or antibiotics, those who have recently been treated for *H pylori* (but may have persistent infection), or in the setting of GI bleeding. In these patients, multiple biopsy specimens from the antrum and corpus

should be obtained, and a negative RUT should be confirmed with an alternative test.[53-56] If possible, patients should be asked to cease taking proton pump inhibitors for at least 1 week before testing for *H pylori*.[57]

SMALL INTESTINE

Biopsy is an essential part of the investigation of patients with suspected small bowel disease. Peroral biopsy samples have traditionally been obtained from the region of the ligament of Treitz. Endoscopic biopsy is now more commonly used and has the advantage of being a shorter, more comfortable procedure wherein multiple directed biopsy specimens can be obtained.[58] Pinch biopsies will usually yield tissue adequate for diagnosis in diffuse mucosal disease if at least 3 biopsy specimens are taken from a site distal to the duodenal bulb in order to avoid misinterpretation of biopsy findings related to Brunner's glands.[59] In diseases in which involvement may be patchy, multiple biopsies from more distal sites of the small intestine using longer and smaller-caliber endoscopes may be necessary.[60] Biopsy may be useful in establishing the diagnosis even in macroscopically normal tissue.[61]

Small bowel biopsies remain the reference standard for accurately diagnosing mucosal malabsorption syndromes. A small bowel biopsy is still considered necessary to confirm the suspicion of celiac disease, even in the presence of positive screening blood tests (e.g., endomysial antibodies or tissue transglutaminase). This should be done before treatment is started, because false-positive blood tests may occur.[59,62]

Infection of the small bowel may be diagnosed by histologic examination. *Giardia lamblia* and a number of other protozoal agents may be associated with inflammatory changes in the small intestinal mucosa, and detection of the mature adult organism, its trophozoites, or a component of the life cycle in or on the surface epithelium may lead to a specific diagnosis. In some patients the morphologic appearance may be similar to eosinophilic gastroenteritis, a diagnosis that can only be established after parasitic disease has been excluded.[22,26]

Patients with immunodeficiency, including post-transplantation or HIV infection, may harbor agents such as *Isospora belli*, *Cryptosporidia*, *Cyclospora*, and *Microsporidia*, which may be detected on small intestinal biopsy specimens. Other pathogens detected on a small bowel biopsy in an immune deficient patient include CMV, fungal organisms such as Candida species and histoplasmosis, and Mycobacterium avium-intracellulare complex.[22] It may be useful to use a large cup jumbo forceps rather than a conventional biopsy forceps if two biopsy specimens are to be taken in sequence before withdrawing the biopsy forceps (Double-bite technique). It is also advisable to use a needle to transfer the biopsy out of the forceps to the fixative rather than shaking it off in a fixative bottle because this may alter the surface epithelium and result in the loss of any adherent exudates.[63]

Tumors of the duodenum should be evaluated by endoscopy and biopsy. The choice of forward- or side-viewing instruments and sampling technique depends on the location and size of the tumor.

Duodenal, jejeunal, and gastric polyps may occur in 33% to 100% of patients with familial adenomatous polyposis (FAP).[64-69] Gastric polyps in patients with FAP are most often fundic gland polyps, which have no malignant potential, but biopsy should be considered to exclude adenoma. Duodenal polyps are typically adenomatous and occur primarily in the ampulla or periampullary region.[68] Upper GI polyps may appear synchronous or metachronous to the identification of colonic polyps.[70] Adenocarcinoma developing from periampullary adenomas is a well-recognized entity and is the most common cause of death in patients with FAP once colorectal cancer is excluded.[68-70] Although its efficacy is yet to be established, a surveillance program is advisable.[71] There are case reports of pancreatitis related to endoscopic biopsy of the papilla.[72,73] Despite this, complications related to endoscopic biopsy or removal of duodenal adenomas at a distance from the papilla appear to be uncommon.[73]

COLON

Previous guidelines have outlined the general indications for colonoscopy and biopsy in patients with colonic polyps and inflammatory bowel disease.[74-76]

Visual evidence of a lesion warrants histopathologic evaluation. If lesions are too numerous for removal, representative samples should be obtained for analysis. Diminutive polyps found during screening sigmoidoscopy should be biopsied; larger polyps should be completely removed at subsequent colonoscopy. Detection of adenomas or carcinoma is an indication for complete examination of the colon. The published reports as to the significance of hyperplastic polyps detected during sigmoidoscopy remains conflicted,[77,78] although most gastroenterologists in the United States do not feel that these polyps indicate an increased risk of harboring significant proximal neoplasia.

For the evaluation of colitis, endoscopy and biopsy may be useful in distinguishing between different causes of colitis, assisting in the management of inflammatory bowel disease, and establishing the extent of bowel involved. Biopsy specimens obtained during the acute phase of a bloody diarrheal illness may differentiate acute self-limited colitis from an initial or recurrent attack of chronic ulcerative colitis or ischemic colitis.[79,80] Terminal ileal biopsy may be useful in the diagnosis of Crohn's disease, infectious ileitis, and lymphoid nodular hyperplasia.[81] Both Crohn's dis-

ease and ulcerative colitis are associated with an increased risk of developing colorectal cancer.[82,83] Surveillance colonoscopy looking for dysplasia is recommended, beginning at 8 years of disease when the cancer risk starts to increase.[83] A longer delay is suggested in patients with left-sided disease only (e.g., 15 years). In patients with pancolitis, 4-quadrant biopsy specimens taken every 10 cm, with biopsies every 5 cm in lower 25 cm, is a frequent approach. In cases of left-sided colitis, specimens should also be taken in the proximal colon to reassess extent of disease.[84-86]

The approach to dysplastic lesions in patients with chronic colitis is evolving. When dysplastic mass lesions are large, irregular, or associated with strictures, surgery is required. However, when typical-appearing adenomas are encountered in a colitic segment they should be removed and the surrounding mucosa biopsied. If the polyp is completely removed and there is no surrounding dysplasia, then this may be regarded as an adequately treated sporadic adenoma and endoscopic surveillance continued.[74,86-88]

It remains unclear as to the number and location that biopsy specimens should be taken in assessing a patient with chronic diarrhea and a grossly normal colon. Microscopic colitis is diagnosed by compatible histologic features in a patient with chronic watery diarrhea whose endoscopic and microbial evaluations are normal. Biopsy specimens taken during a flexible sigmoidoscopy may be adequate to diagnose this disease entity.[89-91]

SUMMARY

Tissue sampling is useful in differentiating malignant, inflammatory, and infectious processes [C]. Techniques include pinch forceps biopsy, brush cytology, snare excision, and FNA [B]. For malignant lesions, maximal yield is attained with 8 to 10 biopsies [A]. Patients with Barrett's esophagus should undergo systematic biopsy to evaluate for dysplasia [C]. Patients with Barrett's esophagus and high-grade dysplasia should have 4-quadrant biopsies performed every 1 to 2 cm to detect underlying carcinoma [A, B]. Endoscopic mucosal resection may be used to remove malignant or premalignant mucosal lesions [B]. Infectious conditions require multiple biopsies, and if ulcers are present these should be obtained from both the center and edge; brushing and viral culture are adjunctive techniques [B]. *H pylori* infection can be assessed by gastric biopsy submitted for histologic examination or rapid urease testing [A]. Biopsy of the incisura angularis gives the highest yield for *H pylori* in untreated patients, but those who have been treated or are taking proton pump inhibitors or antibiotics should have specimens of the corpus and fundus taken as well [A]. Gastric polyps should be extensively sampled or removed when feasible [C]. Gastric polypectomy may carry a higher risk of bleeding than colon polypectomy and postprocedure acid suppressive therapy should be considered [B]. Random biopsies of the small intestine are indicated in the evaluation of diarrheal states, celiac disease, or infections [C]. Duodenal adenomas may be sporadic or associated with familial adenomatosis polyposis and should be sampled or removed when feasible [C]. Colon lesions should be endoscopically excised (polypectomy, EMR) or sampled if lesions are too numerous or removal is not technically feasible [C]. In patients with acute colitis, biopsy may help establish an etiology [B]. Patients with longstanding chronic colitis should undergo systematic surveillance to detect dysplasia, which may indicate an increased risk of cancer [B]. In patients with diarrhea, random biopsy of normal-appearing colonic mucosa may reveal microscopic colitis [B].

REFERENCES

1. Graham DY, Schwartz JT, Gain GD, Gyorkey F. Prospective evaluation of biopsy number in the diagnosis of esophageal and gastric carcinoma. Gastroenterology 1982;82:228-31.
2. Hatfield ARW, Slavin G, Segal AW, Levi AJ. Importance of the site of endoscopic gastric biopsy in ulcerating lesions of the stomach. Gut 1975;16:884-6.
3. Levine DS, Blount PL, Rudolph RE, Reid BJ. Safety of a systematic biopsy protocol in patients with Barrett's esophagus. Am J Gastroenterol 2000;95:1152-7.
4. Cook IJ, de Carle DJ, Haneman B, Hunt DR, Talley NA, Miller D. The role of brushing cytology in the diagnosis of gastric malignancy. Acta Cytologica 1988;32:461-4.
5. Panish IF. Management of patients with polypoid lesions of the colon - current concepts and controversies. Am J Gastroenterol 1979;71:315-24.
6. Graham DY, Tabibian N, Michaletz PA, Kinner BM, Schwartz JT, Heiser MC, et al. Endoscopic needle biopsy: a comparative study of forceps biopsy, two different types of needles and salvage cytology in gastrointestinal cancer. Gastrointest Endosc 1989;35:207-9.
7. ASGE. Tissue sampling during endosonography. Gastrointest Endosc 1998;47:576-8.
8. Young JA, Hughes HE, Lee FD. Evaluation of endoscopic brush and biopsy touch smear cytology and biopsy histology in the diagnosis of carcinoma of the lower esophagus and cardia. J Clin Pathol 1980;33:811-4.
9. Winawer SJ, Sherlock P, Belladonna JA, Melamed M, Beattie E Jr. Endoscopic brush cytology in esophageal cancer. JAMA 1975;323:1358-64.
10. Ippoliti AF. Esophageal biopsy. Gastrointest Clin N Am 2000; 10:713-22.
11. Tummala V, Barwick KW, Sontag SJ, Vlahcevic RZ, McCallum RW. The significance of intraepithelial eosinophils in the histologic diagnosis of gastroesophageal reflux. AMJ Clin Pathol 1987;87:43-8.
12. Faigel DO, Fennerty MB. Miscellaneous diseases of the esophagus. In: Yamada T, editor. Textbook of gastroenterology. 3rd edition. Philadelphia: Lippincott, Williams & Wilkins; 1999. p. 1304-25.
13. Ertan A, Younes M. Barrett's esophagus. Dig Dis Sci 2000;45: 1670-3.
14. Provenzale D, Schmitt C, Wong JB. Barrett's esophagus: a new look at surveillance based on emerging estimates of cancer risk. Am J Gastroenterol 1999;94:2043-53.

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

15. Weinstein WM, Ippoliti AF. The diagnosis of Barrett's esophagus: goblets, goblets, goblets. Gastrointest Endosc 1996;44:91-5.
16. Reid BJ, Haggitt RC, Rubin CE, Roth G, Surawicz CM, Van Belle G, et al. Observer variation in the diagnosis of high grade dysplasia in Barrett's esophagus. Hum Pathol 1988;19:166-78.
17. Levine DS, Haggitt RC, Blount PL, Rabinovitch PS, Rusch VW, Reid BJ. An Endoscopic biopsy protocol can differentiate high-grade dysplasia from early adenocarcinoma in Barrett's esophagus. Gastroenterol 1993;105:40-50.
18. Reid BJ, Blount PL, Feng Z, Levine DS. Optimizing endoscopic biopsy detection of early cancers in Barrett's high grade dysplasia. Am J Gastroenterol 2000;95:3098-6.
19. Falk GW, Rice TW, Goldblum JR, Richter JE. Jumbo biopsy forceps protocol still misses unsuspected cancer in Barrett's esophagus with high-grade dysplasia. Gastrointest Endosc 1999;49:170-6.
20. Guelrud M, Herrera I, Essenfeld H, Castro J. Enhanced magnifying endoscopy: a new technique to identifiy specialized intestinal metaplasia in Barrett's esophagus. Gastrointest Endosc 2001;53:559-65.
21. Canto MIF, Setrakian S, Willis J, Chak A, Petras R, Powe NR, et al. Methylene blue-directed biopsies improve detection of intestinal metaplasia and dysplasia in Barrett's esophagus. Gastrointest Endosc 2000;51:560-8.
22. Sharma P, Topalovski M, Mayo MS, Weston AP. Methylene blue chromoendoscopy for detection of short-segment Barrett's esophagus. Gastrointest Endosc 2001;54:289-93.
23. Wo JM, Ray MB, Mayfield-Stokes S, Al-Sabbagh G, Gebrail F, Slone SP, et al. Comparison of methylene blue-directed biopsies and conventional biopsies in the detection of intestinal metaplasia and dysplasia in Barrett's esophagus: a preliminary study. Gastrointest Endosc 2001;54:294-301.
24. Tincani AJ, Brandalise N, Altemani A, Scanavini RC, Valerio JB, Lage HT, et al. Diagnosis of superficial esophageal cancer and dysplasia using endoscopic screening with a 2% lugol dye solution in patients with head and neck cancer. Head Neck 2000;22:170-4.
25. Canto MI. Methylene blue chromoendoscopy for Barrett's esophagus: coming soon to your GI unit? Gastrointest Endosc 2001;54: 403-9.
26. Wong RKH, Horwhat JD, Maydonovitch CL. Sky blue or murky waters: the diagnostic utility of methylene blue. Gastrointest Endosc 2001;54:409-13.
27. Reid BJ, Levine DS, Longton G, Blount PL, Rabinovitch. Predictors of progression to cancer in Barrett's esophagus: baseline histology and flow cytometry identify low- and high-risk patient subsets. Am J Gastroenterol 2000;95:1669-76.
28. Reid BJ, Prevo LJ, Galipeau PC, Sanchez CA, Longton G, Levine DS, et al. Predictors of progresion to cancer in Barrett's esophagus II: baseline 17p (p53) loss of heterozygosity identifies a patient subset at increased risk for neoplastic progression. Am J Gastroenterol 2001;96:2839-48.
29. Rabinovitch PS, Longton G, Blount PL, Levine DS, Reid BJ. Predictors of progression in Barrett's esophagus III: baseline flow cytometric variables. Am J Gastroenterol 2001;96:3071-83.
30. Nelson DB, Block KP, Bosco JJ, Burdick JS, Curtis WD, Faigel DO, et al. Endoscopic mucosal resection. Gastrointest Endosc 2000;52: 860-3.
31. Ell C, May A, Gossner L, Pech O, Gunter E, Mayer G, et al. Endoscopic mucosal resection of early cancer and high-grade dysplasia in Barrett's esophagus. Gastroenterol 2000;118:670-77.
32. Waxman I, Saitoh Y, Raju GS, Watari J, Yokota K, Reeves AL, Kohgo Y. High-frequency probe EUS-assisted endoscopic mucosal resection: a therapeutic strategy for submucosal tumors of the GI tract. Gastrointest Endosc 2000;55:44-9.
33. Nijhawan PK, Wang KK. Endoscopic mucosal resection for lesions with endoscopic features suggestive of malignancy and high-grade dysplasia within Barrett's esophagus. Gastrointest Endosc 2000;52:328-32.
34. Wilcox CM. Esophageal infections, including disorders associated with AIDS. In: Yamada T, editor. Textbook of gastroenterology . 3rd edition. Philadelphia: Lippincott, Williams & Wilkins; 1999. p. 1263-77.
35. Wilcox CM, Schwartz DA. Endoscopic-pathologic correlates of Candida esophagitis in acquired immunodeficiency syndrome. Dig Dis Sci 1996;41:1337-45.
36. Kodsi BE, Wickremesinghe C, Kozinn PJ, Iswara K, Goldberg PK. Candida esophagitis: a prospective study of 27 cases. Gastroenterol 1976;71:715-9.
37. Wilcox CM, Straub RF, Schwartz DA. A prospective evaluation of biopsy number for the diagnosis of viral esophagitis in patients with HIV infection and esophageal ulcer. Gastrointest Endosc 1996;44:587-93.
38. McBane RD, Gross JR Jr. Herpes esophagitis: clinical syndrome, endoscopic appearance, and diagnosis in 23 patients. Gastrointest Endosc 1991;37:600-3.
39. Goodgame RW, Genta RM, Estrada R, Demmler G, Buffone G. Frequency of positive tests for cytomegalovirus in AIDS patients patients: endoscopic lesions compared with normal mucosa. Am J Gastroenterol 1993;88:338-43.
40. Hatfield ARW, Slavin G, Segal AW, Levi AJ. Importance of the site of endoscopic gastric biopsy in ulcerating lesions of the stomach. Gut 1975;16:884-6.
41. Cook IJ, de Carle DJ, Haneman B, Hunt DR, Talley NA, Miller D. The role of brushing cytology in the diagnosis of gastric malignancy. Acta Cytol 1988;32:461-4.
42. Ginsberg GG, Al-Kawas FH, Fleischer DE, Reilly HF, Benjamin SB. Gastric polyps: relationship of size and histology to cancer risk. Am J Gastroenterol 1996;91:714-7.
43. ReMine SG, Hughes RW, Weiland LH. Endoscopic gastric polypectomies. Mayo Clinic Proc 1981;56:371-5.
44. Morgner A, Bayerdorffer E, Neubauer A, Stolte M. Malignant tumors of the stomach. Gastric mucosa-associated lymphoid tisuue lymphoma and *Helicobacter pylori*. Gastroenterol Clin North Am 2000;29:593-607.
45. Ebert MP, Leodolter A, Malfertheiner P. Novel strategies in the prevention of gastric cancer. Hepatogastroenterology 2001;48: 1569-71.
46. Blaser MJ. *Helicobacter pylori* and gastric diseases. BMJ 1998; 316:1507-10.
47. Peterson WL, Fendrick AM, Cave DR, Peura DA, Garabedian-Ruffalo SM, Laine L. *Helicobacter pylori* related disease: guidelines for testing and treatment. Arch Intern Med 2000;160:1285-91.
48. Cutler AF, Havstad S, Ma CK, Blaser MJ, Perez-Perez GI, Schubert TT. Accuracy of invasive and noninvasive tests to diagnose *Helicobacter pylori* infection. Gastroenterology 1995;109: 136-41.
49. Genta RM, Graham DY. Comparison of biopsy sites for the histopathologic diagnosis of *Helicobacter pylori*: a topographic study of *H pylori* density and distribution. Gastrointest Endosc 1994;40:342-5.
50. Hahn M, Fennerty MB, Corless CL, Magaret M, Lieberman DA, Faigel DO. Non-invasive tests as a substitute for histology in the diagnosis of *Helicobacter pylori* infection. Gastrointest Endosc 2000;52:20-6.
51. Faigel DO, Furth EE, Childs M, Goin J, Metz DC. Histological predictors of active *Helicobacter pylori* gastritis. Dig Dis Sci 1996;41:937-43.
52. Laine L, Lewin DN, Naritoku W, Cohen H. Prospecytive comparison of H&E, Giemsa, and Genta stains for the diagnosis of *Helicobacter pylori*. Gastrointest Endosc 1997;45:463-7.
53. Logan RPH, Walker MM, Misiewicz JJ, Gummett PA, Karim QN, Baron JH. Changes in the intragastric distribution of *Helicobacter pylori* during treatment with omeprazole. Gut 1995;36:12-6.
54. Graham DY, Genta R, Evans DG, Reddy R, Clarridge JE, Olson CA, et al. *Helicobacter pylori* does not migrate from the antrum to the corpus in response to omeprazole. Am J Gastroenterol 1996;91:2120-4.
55. Laine L, Suchower L, Johnson E, Ronca P, Neil G. Accuracy of

CLOtest after *Helicobacter pylori* therapy. Gastrointest Endosc 1998;47:250-3.
56. Laine L, Sugg J, Suchower L, Neil G. Endoscopic biopsy requirements for post-treatment diagnosis of *Helicobacter pylori*. Gastrointest Endosc 2000;51:664-9.
57. Midolo P, Marshall BJ. Accurate diagnosis of *Helicobacter pylori* urease tests. Gastroenterol Clin North Am 2000;29:871-8.
58. Achkar E, Carey WD, Petras R, Sivak MV Jr, Revta R. Comparison of suction capsule and endoscopic biopsy of small bowel mucosa. Gastrointest Endosc 1986;32:278-81.
59. Freeman HJ. Small intestinal mucosal biopsy for investigation of diarrhea and malabsorption in adults. Gastrointest Endosc Clin N Am 2000;10:739-53.
60. Freeman HJ, Chiu Bk. Small bowel malignant lymphoma complicating celiac sprue and the mesenteric lymph node cavitation syndrome. Gastroenterology 1986;90:2008-112.
61. Lewin KJ, Riddell RH, Weinstein WM. Gastrointestinal pathology and its clinical implications. Tokyo: Igaku-Shoin; 1992.
62. Gillett HR, Freeman HJ. Serological testing for screening in adult celiac disease. Can J Gastroenterol 1999;13:265-9.
63. Weinstein WM. Mucosal biopsy techniques and interaction with the pathologist. Gastrointest Endosc Clin N Am 2000;10:555-72.
64. McGannon E. Gastric and duodenal polyps in familial adenomatous polyposis: a prospective study of the nature and prevalence of upper gastrointestinal polyps. Gut 1987;28:306-14.
65. Offerhaus GJ, Giardiello FM, Krush AJ, Booker SV, Tersmette AC, Kelley NC, et al. The risk of upper gastrointestinal cancer in familial adenomatous polyposis. Gastroenterology 1992;102:1980-2.
66. Burt RW, Bishop DT, Cannon-Albright L, Samowitz WS, Lee RL, DiSario JA, et al. Population genetics of colonic cancer. Cancer 1992;70(Suppl):1719-22.
67. Jagelman DG, DeCosse JJ, Bussey HJR. Upper gastrointestinal cancer in patients with Gardner syndrome. Lancet 1988;2:1149-50.
68. Beckwith PS, van Heerden JA, Dozois RR. Prognosis of symptomatic duodenal adenomas in familial adenomatous polyposis. Arch Surg 1991;126:825-8.
69. Iida M, Matsui T, Itoh H, Mibu R, Fujishima M. The value of push-type jejeunal endoscopy in familial adenomatosis coli/Gardner's syndrome. Am J Gastroenterol 1990;85:1346-48.
70. Kotzampassi K, Eleftheriadis E, Zissiadis A, Aletras H. Duodenal polyposis in Gardner's syndrome: the significance of endoscopic surveillance. Am J Gastroenterol 1990;85:1541-2.
71. ASGE. The role of endoscopy in the surveillance of premalignant conditions of the upper gastrointestinal tract. Gastrointest Endosc 1998;48:663-8.
72. Nugent KP, Spigelman AD, Williams CB, Phillips RK. Iatrogenic pancreatitis in familial adenomatous polyposis. Gut 1993;34: 1269-70.
73. Norton ID, Geller A, Petersen BT, Sorbi D, Gostout CJ. Endoscopic surveillance and ablative therapy for periampullary adenomas. Am J Gastroenterol 2001;96:101-6.
74. ASGE. The role of colonoscopy in the management of patients with inflammatory bowel disease. Gastrointest Endosc 1998;48: 689-90.
75. ASGE. The role of colonoscopy in management of patients with colonic neoplasia. Gastrointest Endosc 1999;50:921-4.
76. Fleischer DE, Goldberg SB, Browning TH, Cooper JN, Friedman E, Goldner FH, et al. Detection and surveillance of colorectal cancer. JAMA 1989;261:580-5.
77. Jass JR. Hyperplastic polyps of the colorectum: innocent or guilty? Dis Colon Rectum 2001;44:163-6.
78. Imperiale TF, Wagner DR, Lin CY, Larkin GN, Rogge JD, Ransohoff DF. Risk of advanced proximal neoplasms in assymptomatic adults according to the distal colorectal findings. N Engl J Med 2000;343: 169-74.
79. Nostrant TT, Kumar NB, Appelman HD. Histopathology differentiates acute self- limited colitis from ulcerative colitis. Gastroenterology 1987;92:318-28.
80. Surawicz CM, Belic L. Rectal biopsy helps to distinguish acute self-limited colitis from idiopathic inflammatory bowel disease. Gastroenterology 1984;86:104-13.
81. Coremans G, Rutgeerts P, Geboes K, Van den Oord J, Ponette E, Vantrappen G. The value of ileoscopy with biopsy in the diagnosis of intestinal Crohn's disease. Gastrointest Endosc 1984;30:167-72.
82. Kornbluth A, Sachar DB. Ulcerative colitis practice guidelines in adults. American College of Gastroenterology, Practice Parameters Committee. Am J Gastroenterol 1997;92:204-11.
83. Friedman S, Rubin PH, Bodian C, Goldstein E, Harpaz N, Present DH. Screening and surveillance colonoscopy in chronic Crohn's colitis. Gastroenterology 2001;120:820-6.
84. Riddell RH. Pathology of idiopathic inflammatory bowel disease. In: Kirsner JB, Shorter RG, editors. Inflammatory bowel disease. 3rd ed. Philadelphia: Lea and Febiger; 1988. p. 329-50.
85. Riddell RH, Goldman H, Ransohoff DF, Appelman HD, Fenoglio CM, Haggitt RC, et al. Dysplasia in inflammatory bowel disease: Standardized classification with provisional clinical applications. Hum Pathol 1983;14:931-68.
86. Bernstein CN, Riddell RH. Colonoscopy plus biopsy in the inflammatory bowel diseases. Gastrointest Endosc Clin N Am 2000;10: 755-74.
87. Engelsgjerd M, Torres C, Odze RD. Adenoma-like polypoid dysplasia in chronic ulcerative colitis:A follow up study of 23 cases. Gastroenterology 1999;117:1288-94.
88. Rubin PH, Friedman S, Harpaz N, Goldstein E, Weiser J, Schiller J, et al. Colonoscopic polypectomy in chronic colitis: conservative management after endoscopic resection of dysplastic polyps. Gastroenterology 1999;117:1295-300.
89. Salt WB, Llaneza PP. Collagenous colitis: a cause of chronic diarrhea diagnosed only by biopsy of normal appearing colonic mucosa. Gastrointest Endosc 1986;32:421-3.
90. Tanaka M, Mazzoleni G, Riddell RH. Distribution of collagenous colitis: utility of flexible sigmoidoscopy. Gut 1992;33:65-70.
91. Elliott PR, Williams CB, Lennard-Jones JE, Dawson AM, Bartram CI, Thomas BM, et al. Colonoscopic diagnosis of minimal change colitis in patients with a normal sigmoidoscopy and normal air- contrast barium enema. Lancet 1982;1:650-1.

Prepared by:

STANDARDS OF PRACTICE COMMITTEE

Douglas O. Faigel, MD, Chair
Glenn M. Eisen, MD, Past Chair
Todd H. Baron, MD
Jason A. Dominitz, MD
Jay L. Goldstein, MD
William K. Hirota, MD
Brian C. Jacobson, MD, MPH
John F. Johanson, MD
Jonathan A. Leighton, MD
J. Shawn Mallery, MD
Kathryn A. Peterson, 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.