Communication from the ASGE Technology Committee

TECHNOLOGY STATUS EVALUATION REPORT

High-definition and high-magnification endoscopes

The American Society for Gastrointestinal Endoscopy (ASGE) Technology Committee provides reviews of existing, new, or emerging endoscopic technologies that have an impact on the practice of GI endoscopy. Evidence-based methodology is used, with a MEDLINE literature search to identify pertinent clinical studies on the topic and a MAUDE (U.S. 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 used. 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 October 2013 for articles related to endoscopy by using the keywords "high resolution," "high definition," "high magnification," and "magnifying endoscopy."

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BACKGROUND

Video endoscopy permits the endoscopist to examine GI mucosa and identify abnormal tissue. The quality of endoscopic visualization is a function of both resolution and magnification. Video resolution is defined as the ability to optically distinguish 2 closely approximated objects or points and is a function of pixel density (the number of pixels wide × the number of pixels or lines of height). High-resolution imaging improves the ability to discriminate detail, whereas magnification enlarges the image. This report reviews advances in white-light high-resolution/-definition and high-magnification endoscopic imaging systems.

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TECHNOLOGY UNDER REVIEW

Standard definition (SD) signals offer images in a 4:3 (width:height) aspect ratio, with image resolutions of 640 to 700 horizontal pixels (width) × 480 to 525 vertical pixels (height) or "lines" (~367,000 pixels).[1] SD (640 × 480) displays, such as cathode-ray TVs, have approximately 300,000 pixels.[1] SD endoscopes are equipped with charge-coupled device (CCD) chips that produce an image signal of 100,000 to 400,000 pixels, which are displayed in the SD format. Advances in CCD and, more recently, in complementary metal-oxide semiconductor (CMOS) technology have resulted in smaller chips with an increased number of pixels and increased resolution. The chips used in current high-resolution or high-definition (HD) endoscopes produce signal images with resolutions that range from 850,000 pixels to more than 1 million pixels (Table 1).

The general consensus definition of a HD image or display and the definition of high definition for the purposes of this review are one with more than 650 to 720 lines of resolution.[2] Details of HD displays have previously been discussed in another technology committee document.[3] Briefly, HD image displays can refresh on a line-by-line scan, which may be progressive (p) or interlaced (i). Progressive scanning provides twice the temporal resolution (60 frames/s) of interlaced scanning (30 frames/s) and is better for video display of fast-moving objects.

HD video imaging can be displayed in either TV or computer monitor formats. Broadcast HD TV is available in 3 standard formats, 720p, 1080i, and 1080p, all in a 16:9 aspect ratio. The 16:9 aspect ratio is not useful for display of images originating from round endoscopic lenses. Historically, SD endoscopic images have been displayed in a 4:3 aspect ratio to match the standard aspect ratios of SD TV. This ratio provides the highest pixel density and resolution possible, given the endoscope lens shape. HD endoscopic video chips display images in either 4:3 or 5:4 aspect ratios.

To provide true HD image resolution, each component of the system (eg, the endoscope video chip, the

TABLE 1. High-resolution and high-magnification endoscopes available in the United States

		Olympus America Inc (Center Valley, Pa)							
		Gastroscope				Colonoscope			
Model no.		**GIF–H190**	**GIF–HQ190**	**GIF–XP190N**	**GIF–Q160Z**	**PCF–PH190L/I**	**PCF–H190L/I**	**CF–HQ190L/I**	**CF–Q160ZL/I**
Optical system	Field of view, deg	140	Normal focus mode: 140 Near focus mode: 140	140	WIDE position: 140 TELE position: 75	140	170	Normal focus mode: 170 Near focus mode: 160	WIDE position: 140 TELE position: 50
	Depth of field, mm	2–100	Normal focus mode: 5– 100 Near focus mode: 2– 6	3–100	WIDE position: 8–10 TELE position: 1.5–3	2–100	2–100	Normal focus mode: 5–100 Near focus mode: 2–6	WIDE position: 7–10 TELE position: 2–3
Insertion section	Insertion tube outer diameter, mm	9.2	9.9	5.8	10.8	9.5	11.5	12.8	12.8
	Working length, mm	1030	1030	1100	1030	L: 1680 I: 1330	L: 1680 I: 1330	L: 1680 I: 1330	L: 1680 I: 1330
Angulation, deg	Up/down	210/90	210/90	210/90		180/180	180/180	180/180	
	Right/left	100/100	100/100	100/100		160/160	160/160	160/160	
Instrument channel	Channel inner diameter, mm	2.8	2.8	2.2	2.8	3.2	3.2	3.7	3.7
Water jet function		Yes	Yes	No		No	Yes	Yes	
Additional CE		NBI	NBI	NBI	NBI	NBI	NBI	NBI	NBI
HD format, pixels		1280 × 1024	1280 × 1024	1280 × 1024	640 × 480	1280 × 1024	1280 × 1024	1280 × 1024	640 × 480
Magnification		D, ×1.5	D, ×1.5; O, ×150	D, ×1.5	D, ×1.5; O, ×115+	D, ×1.5	D, ×1.5	D, ×1.5; O, ×150	D, × 1.5; O, ×150
Price, US$		40,000	42,000	38,000	†	44,000	46,000	46,000	
Processor, price, US$		Evis Exera III (CV-190) 26,000	Evis Exera III (CV-190) 26,000	Evis Exera III (CV-190) 26,001		Evis Exera III (CV-190) 26,002	Evis Exera III (CV-190) 26,003	Evis Exera III (CV-190) 26,004	
Light source, price, US$		Evis Exera III (CLV-190) 15,000	Evis Exera III (CLV-190) 15,000	Evis Exera III (CLV-190) 15,000		Evis Exera III (CLV-190) 15,000	Evis Exera III (CLV-190) 15,000	Evis Exera III (CLV-190) 15,000	

Deg, degrees; *TELE*, *L*, long version; *I*, intermediate version; *CE*, contrast enhancement; *NBI*, narrow-band imaging; *FICE*, Fujinon image contrast enhancement; *HD*, high-definition; *D*, digital; *O*, optical.
*HD format assumes pairing with EPK-i7000 processor.
†Requires MAJ–570, which is an additional cost.

processor, the monitor, and transmission cables) must be HD compatible. When the number of pixels and aspect ratio of the video source match those of the display, the highest possible image resolution or native resolution is displayed. HD processors and monitors can up-convert input image signals, such as from SD endoscopes, through pixel interpolation that may limit image quality.

Three different HD endoscope systems are currently available in the United States (Table 1). Olympus America

TABLE 1. Continued

PENTAX Medical Co (Montvale, NJ)				Fujinon Inc (Wayne, NJ)		
Gastroscope		Colonoscope		Gastroscope		Colonoscope
EG 2990i	EG 2790i	EC 3890Li	EC 3490Li	EG 590 WR	EG 590ZW	EC 590 ZW/L
140	140	140	140	140	140	140
5–100	4–100	4–100	4–100	4–100	3–100	3–100
9.8	9.0	13.2	11.6	10.8	10.8	12.8
1050	1050	1700	1700	1100	1100	1690
210/120	210/120	180/180	180/180	210/90	210/90	180/180
120/120	120/120	160/160	160/160	100/100	100/100	160/160
2.8	2.8	3.8	3.2	2.8	2.8	3.8
Yes	No	Yes	Yes	Yes	Yes	Yes
i–Scan	i–Scan	i–Scan	i–Scan	FICE	FICE	FICE
1920 × 1080*	1920 × 1080*	1920 × 1080*	1920 × 1080*	1280 × 1080i	1280 × 1080i	1280 × 1080i
D, ×2	D, ×2	D, ×2	D, ×2	D, ×2	D, ×2; O, × 135	D, ×2; O, ×135
38,000	38,000	43,000	43,000			
EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPX 4440HD	EPX 4440HD	EPX 4440HD

(Center Valley, Pa) HD endoscopes were designed based on commercial availability of TVs and recorders for output onto HDTVs. The output from the endoscope is enhanced to 1080i, with an option to output in 1080p; however, the endoscopic image itself is displayed within a 1280 × 1024-pixel frame. The actual video chip specifications are proprietary. PENTAX Medical Co (Montvale, NJ) and Fujinon Inc (Wayne, NJ) HD endoscopes were designed for output

TABLE 2. High-resolution and high-magnification endoscopes not available in the United States

	Olympus America Inc (Center Valley, Pa)							
	Gastroscope				Colonoscope			
Model no.	GIF-Q240Z	GIF-H260Z	GIF-H290	GIF-HQ290	CF-H260AZL/I	PCF-H290L/I	CF-H290L/I	CF-HQ290L/I
Insertion tube outer diameter, mm	9.8	10.5	8.9	9.9	12.9	11.5	12	12.8
Working length, mm	1030	1030	1030	1030	L: 1680 I: 1330	L: 1680 I: 1330	L: 1680 I: 1330	L: 1680 I: 1330
Channel inner diameter, mm	2.8	2.8	2.8	2.8	3.2	3.2	3.2	3.7
Additional CE	NBI	NBI	NBI	NBI	NBI	NBI	NBI	NBI
Magnification	×80	×85	D, ×1.5	O, ×150	×70	D, ×1.5	D, ×1.5	D, ×1.5; O, ×150
HD format, pixels	SD	HD	HD	HD	HD	HD	HD	HD
Processor	CV-260SL/260	CV-260SL/260			CV-260SL/260			

L, Long version; *I*, intermediate version; *CE*, contrast enhancement; *NBI*, narrow-band imaging; *FICE*, Fujinon image contrast enhancement; *HD*, high-definition; *D*, digital; *O*, optical; *SD*, standard definition.

onto monitors for computer display. The first Fujinon CCD chips were 1077 × 788 pixels (~850,000 pixels), and their output was equivalent to extended graphics array monitors (1024 × 728 pixels),[1] but current endoscopes have an output of 1280 × 960 pixels. The actual resolution of the video chip is proprietary. The newer processors enhance the image to 1080i. The PENTAX video chip is 1920 × 1080 pixels (>2 million pixels) and displays at native resolution.

HD video chips have lower light sensitivities because of the smaller size of their pixels compared with SD video chips. Hence, for optimal illumination, the standard light source for HD endoscopy is a 300-W xenon lamp. The digital output from the processors requires HD serial digital interface cables for HDTV displays or digital video interface cables for computer monitors.

High-magnification endoscopes are defined by the capacity to perform optical zoom by using a movable lens in the tip of the endoscope. A translucent cap on the tip of the endoscope may be used to stabilize the focal length between the lens and the target tissue to improve image quality.[4] Optical zoom obtains a magnified image of the target while maintaining image display quality. This is distinguished from electronic or digital magnification, which simply enlarges the image on the display, with a consequent decreased pixel density and decreased image quality. With the proper processor, conventional endoscopes permit a digital magnification of 1.5× to 2×. Although standard endoscopes magnify images 30 to 35 times, zoom endoscopes can optically magnify images up to 150 times, depending on the size of the monitor (Tables 1 and 2). All 3 companies have zoom endoscopes available in the United States, with combined optical and digital zoom (Table 1). Newer Olympus endoscopes have a feature called near-focus imaging (using a variable focus lens system) that allows the endoscope to be moved closer (within 2-6 mm) to the area of interest while maintaining the image in focus. Other Olympus zoom endoscopes reported in the literature are not commercially available in the United States (Table 2).

EFFICACY AND COMPARATIVE STUDIES

The review that follows focuses on HD/magnification systems. However, most studies evaluating image-enhanced endoscopy in GI lesion detection and classification have combined HD magnification endoscopy with dye-based or electronic chromoendoscopy. It is therefore difficult to establish the independent effect of HD/magnification endoscopy in the observed results. Dye-based and electronic chromoendoscopy are reviewed in other Technology Committee documents.[5,6]

TABLE 2. Continued

PENTAX Medical Co (Montvale, NJ)						Fujinon Inc (Wayne, NJ)					
Gastroscope			Colonoscope			Gastroscope	Colonoscope				
EG 29-i10	EG 27-i10	EG 2990Zi	EC 38-i10M/ F/L	EC 34-i10M/ F/L	EC 3890ZMi/ Fi/Li	EG 600WR	EC 590WM2	EC 590WM	EC 590WI	EC 590WL	EC 590 ZW/M
9.8	9.8	9.8	13.2	11.6	13.2	9.3	12.0	12.8	12.8	12.8	12.8
1050	1050	1050	M = 1300 F = 1500 L = 1700	M = 1300 F = 1500 L = 1700	M = 1300 F = 1500 L = 1700	1100	1330	1330	1520	1690	1330
2.8	2.8	2.8	3.8	3.8	3.8	2.8	3.8	3.8	3.8	3.8	3.8
i-Scan	i-Scan	i-Scan	i-Scan	i-Scan	i-Scan	FICE	FICE	FICE	FICE	FICE	FICE
D, ×2	D, ×2	D, ×2; O, ×136	D, ×2	D, ×2	D, ×2; O, ×136	D, ×2	D, ×2	D, ×2	D, ×2	D, ×2	D, ×2; O, ×135
1920 × 1080	1920 × 1080	1920 × 1080	1920 × 1080	1920 × 1080	1920 × 1080	HD 1080p	HD/HDTV 960p/1080i	HD/HDTV 960p/1080i	HD/HDTV 960p/1080i	HD/HDTV 960p/1080i	HD/HDTV 960p/1080i
EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000	EPK-i5010 EPK-i7000		EPX 4440HD	EPX 4440HD	EPX 4440HD	EPX 4440HD	EPX 4440HD

Esophagus

There have been multiple attempts with magnification endoscopy and mucosal enhancement to identify mucosal patterns that accurately predict the presence of Barrett's esophagus, with or without dysplasia. There are 3 commonly used magnification HD narrow-band imaging (NBI) classification systems; Kansas, Nottingham, and Amsterdam, which have similar degrees of accuracy and interobserver agreement.[7] An initial study using indigo carmine along with magnification endoscopy noted a correlation of slightly raised mucosa with a villiform pattern with Barrett's esophagus.[8] Another study used methylene blue and magnification endoscopy and described a villous and tubular staining pattern associated with Barrett's esophagus as opposed to small round and straight pits, which were associated with gastric epithelium.[9] An additional report described 4 different mucosal surface patterns enhanced by SD magnification endoscopy and acetic acid (type I, round; type II, reticular; type III, villous without pits; and type IV, ridged). Type III and IV patterns were associated with Barrett's epithelium.[10] Another report of the use of indigo carmine staining along with magnification endoscopy described 3 distinct patterns: ridged and/or villous, circular, and irregular and/or distorted.[11] Barrett's epithelium was most commonly identified in patients with the ridged-villous pattern, whereas high-grade dysplasia was found entirely within mucosa with the irregular-distorted pattern.[11] A study with magnification endoscopy and acetic acid identified 3 mucosal patterns (type 1, normal; type 2, slit reticular; and type 3, gyrus-villous), with Barrett's epithelium correlating with type 3.[12] However, all of the existing classifications require a learning process for the endoscopist.[13,14] A significant limitation of these classification systems is their inter- and intraobserver variability.[15,16] Three studies that used NBI and SD magnification endoscopy reported success in identifying intestinal metaplasia based on different types of capillary and fine mucosal patterns.[17-19]

A randomized, crossover trial compared SD magnification endoscopy and acetic acid–guided biopsies with SD conventional endoscopy and random 4-quadrant biopsies. Diagnostic yield in the detection of Barrett's esophagus increased 1.4-fold to 1.6-fold when using magnifying endoscopy with acetic acid.[20] However, it is difficult to determine the independent contribution of magnification endoscopy in this improved detection. Furthermore, magnification endoscopy has not uniformly been shown to be better than conventional endoscopy at detecting intestinal metaplasia.[21]

A randomized, blinded, tandem trial by Wolfsen et al[22] comparing HD-NBI targeted biopsy with SD-WLE targeted plus random biopsy demonstrated higher per-patient yield for dysplasia (57% vs 43%), higher grades of dysplasia (18% upstaged by HD-NBI, $P < .001$), and fewer biopsies (4.7 vs

8.5, $P < .001$) required with HD-NBI. A recent randomized, blinded study investigated the difference between HD white-light endoscopy and biopsies per the Seattle protocol with targeted biopsies by using NBI alone. The results suggest that NBI with targeted biopsies is as effective in detecting intestinal metaplasia as HD-WLE. NBI allowed fewer biopsies per patient (3.6 vs 7.6, $P < .0001$) and detected a higher proportion of areas with dysplasia (30% vs 21%, $P = .01$).[23] Another study examined patients with Barrett's esophagus with NBI as a "red-flag" technique, followed by NBI combined with dual-focus (DF) magnification function (Olympus 190 series; Exera III) for suspicious areas. This was followed by random biopsies per the Seattle protocol. The combination of NBI with targeted NBI-DF identified all nondysplastic Barrett's and high-grade dysplasia/early carcinoma. The authors concluded that the addition of NBI-DF would have reduced random biopsies by 86%.[24]

A prospective, randomized, crossover study that compared HD endoscopy with either indigo carmine or NBI showed that the mucosal enhancement techniques did not increase the detection of high-grade dysplasia or early cancer compared with HD imaging alone.[25] Another study used HD magnification endoscopy to characterize the blood vessel morphology, hence facilitating the diagnosis of superficial esophageal squamous cell cancer. The morphology of intrapapillary capillary loops became progressively more tortuous and disorganized with the evolution of dysplasia to cancer.[26]

Stomach

The use of chromoendoscopy or NBI with magnification endoscopy has primarily been used for the evaluation of early gastric cancers before endoscopic resection, but surrounding gastritis can compromise specificity.[27-30] Early adenocarcinomas were noted to have irregular, tortuous capillaries compared with adenomatous, hyperplastic, or normal mucosa. There were differences noted between elevated- and depressed-type lesions.[27] A feasibility study examined the effect of magnification endoscopy and i-Scan electronic chromoendoscopy (PENTAX Medical) in gastric neoplasia and found improvement in image quality without clear diagnostic benefit.[31] The importance of detecting early lesions and establishing depth of invasion based on mucosal patterns would help to stratify between surgical or endoscopic resection.[29,32] Mucosal pit patterns may also be useful for identifying *Helicobacter pylori*–induced gastritis,[28,33,34] intestinal metaplasia,[35,36] and gastric atrophy,[33,36] with good inter- and intraobserver agreement.[35,36] These data are primarily from Asian or Portuguese studies, and the generalizability to lower prevalence regions is unclear.

Small intestine

There are limited data regarding magnification endoscopy in small-bowel disease, although there are some promising reports suggesting advantages in targeting biopsies in patients with celiac sprue or malabsorption.[37-40] One study of 34 patients with either celiac or tropical sprue found that SD magnification chromoendoscopy identified villous atrophy better than did standard endoscopy and therefore helped to target biopsies.[37] A study of 191 patients showed that HD magnification endoscopy had a 95% sensitivity, 99% specificity, 95% positive predictive value, and 99% negative predictive value to detect the presence of any villous abnormality.[40] A recent article reported on the utility of magnification endoscopy combined with indigo carmine chromoendoscopy in celiac disease. It showed increased accuracy of diagnosis in a subgroup of patients with difficult-to-diagnose disease as long as they were treatment naive.[41]

Colon

HD and high-magnification endoscopy have been examined as tools to enhance detection and classification of colonic neoplasia, including flat or depressed lesions. Chromoendoscopy has been used as an adjunct in this effort. Kudo et al[42,43] proposed 5 major pit patterns to differentiate non-neoplastic, neoplastic, and malignant polyps. This classification system yielded a high level of inter- and intra-observer agreement.[44,45]

There are large cases series that report the utility of using magnification colonoscopy and pit-pattern analysis to differentiate neoplastic and non-neoplastic lesions,[46,47] including flat or depressed lesions.[48,49] Three studies found that SD magnification chromocolonoscopy is more accurate than nonmagnification chromocolonoscopy in differentiating adenomas from hyperplastic polyps. A prospective trial randomized 660 patients to magnification chromocolonoscopy (indigo carmine) or conventional chromocolonoscopy.[49] The accuracy of magnification chromocolonoscopy when using the Kudo pit pattern system to distinguish neoplastic from non-neoplastic lesions was significantly higher than for nonmagnification chromocolonoscopy (92% vs 68%). The higher accuracy of magnification chromocolonoscopy over conventional chromocolonoscopy was validated in a further 500-patient study.[50] Another study compared the diagnostic accuracy of differentiating neoplastic from non-neoplastic lesions by conventional colonoscopy, chromocolonoscopy with indigo carmine, and SD magnification chromocolonoscopy. All lesions were sequentially evaluated by all 3 methods.[51] Magnification chromocolonoscopy was found to have a significantly higher accuracy compared with either chromocolonoscopy (95.6 % vs 89.4%, $P = .015$) or conventional colonoscopy without indigo carmine (95.6% vs 84%, $P = .0001$). Prospective studies demonstrated that high magnification NBI was more accurate than conventional colonoscopy and was equivalent to magnification chromocolonoscopy in differentiating between neoplastic and non-neoplastic colonic lesions.[52,53] The Kudo system, which was originally developed for chromoendoscopy, was recently modified for NBI.[54-56]

Application of magnification endoscopy for adenoma detection

In an older randomized trial, HD (850,000 pixels) chromocolonoscopy (with indigo carmine) was compared with conventional colonoscopy in the detection of adenomas in high-risk patients.[57] The number of lesions detected was the same between the HD colonoscope without tissue staining and the standard colonoscope. More hyperplastic polyps and flat adenomas were detected by using tissue staining and HD colonoscopes than when using standard colonoscopes alone, but the total number of adenomas (the primary endpoint) was the same between the 2 groups. The investigators concluded that HD chromocolonoscopy was not required for routine care.

In a more recent study comparing HD colonoscopy alone with HD chromocolonoscopy, a moderate increase in the detection of flat and small adenomas was seen. HD chromocolonoscopy detected significantly more flat adenomas, adenomas smaller than 5 mm per patient, and non-neoplastic polyps per patient compared with HD colonoscopy alone.[58] Another prospective, cohort study showed similar adenoma detection rates between HD colonoscopy alone and HD colonoscopy with i-Scan–based electronic chromocolonoscopy.[59] HD colonoscopy was also found to increase the detection rate of right-sided, flat, and all adenomas compared with SD colonoscopy in a randomized, controlled trial.[60] A meta-analysis indicated that HD colonoscopy resulted in a 3.5% increase in the detection of adenomas with the number needed to treat for identifying an additional patient with an adenoma of 28.[61]

Magnification chromoendoscopy has been reported to be useful in predicting histology and invasive depth of cancer,[62-64] although the sensitivity may be low. Magnification colonoscopy with NBI has also shown promise in predicting histology and depth of invasion.[65] Ultimately, magnification colonoscopy with tissue stains or NBI may help to direct endoscopic therapy (eg, EMR) and to assess the completeness of the resection.[64,65]

HD magnification colonoscopy has also been studied in ulcerative colitis, typically with chromocolonoscopy. A recent trial demonstrated a threefold increase in dysplasia detection on targeted biopsies when comparing HD colonoscopy with SD white-light examination in patients with chronic colonic inflammatory bowel disease.[66] A randomized, controlled trial demonstrated that SD magnification colonoscopy with methylene blue was better than magnification colonoscopy alone for identifying intraepithelial neoplasia.[67] HD magnification with NBI may be useful in detecting dysplasia in patients with ulcerative colitis.[68] However, one study noted that active mucosal inflammation may interfere with the accuracy of magnification chromocolonoscopy in the detection of neoplasia.[13] In small studies, magnification chromocolonoscopy was also used to assess disease severity and may even predict relapse, but these findings require confirmation.[69,70]

SAFETY

There have been no reports of adverse events from the HD or magnification features of endoscopes.

FINANCIAL CONSIDERATIONS

The costs of equipment available in the United States are included in Table 1. The financial burden of converting to HD imaging systems requires updating the entire endoscopy unit, including monitors, processors, and endoscopes, and, if desired, peripherals (eg, recorders or printers). There are at present no Current Procedural Terminology codes (American Medical Association, Chicago, Ill) for HD or magnification endoscopy. There has been no formal cost-effective analysis of using HD magnification chromoendoscopy. The impact on endoscopy-unit efficiency has not been examined.

AREAS FOR FUTURE RESEARCH

Further refinement of current classification systems for GI mucosal abnormalities found on HD and magnification endoscopy is needed. The new standards need to be simple enough for clinical use and reliable interobserver interpretation. Data on the accuracy of HD magnification endoscopes available in the United States for GI mucosal lesion detection and classification are needed. Further studies that examine the value of HD magnification endoscopes compared with tissue biopsy are required, with reference to the ASGE Preservation and Incorporation of Valuable endoscopic Innovation (PIVI) thresholds.[71]

SUMMARY

HD and high-magnification endoscopy, with or without mucosal enhancement techniques, enable detailed visualization of GI mucosa. These new endoscopic systems help to improve detection and classification of GI mucosal lesions and also help minimize biopsies by allowing better targeting. These new endoscopes have played a role in the evolution of targeted endoscopic therapy for early GI neoplastic lesions.

DISCLOSURE

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Abbreviations: ASGE, American Society for Gastrointestinal Endoscopy; CCD, charge-coupled device; CMOS, complementary metal-oxide semiconductor; DF, dual-focus; HD, high definition; i, interlaced; NBI, narrow-band imaging; p, progressive; SD, standard definition.

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