SPECIAL ARTICLE

GIE Editorial Board top 10 topics: advances in GI endoscopy in 2019

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The American Society for Gastrointestinal Endoscopy's GIE Editorial Board reviewed original endoscopy-related articles published during 2019 in *Gastrointestinal Endoscopy* and 10 other leading medical and gastroenterology journals. Votes from each individual member were tallied to identify a consensus list of 10 topic areas of major advances in GI endoscopy. Individual board members summarized important findings published in these 10 areas of disinfection, artificial intelligence, bariatric endoscopy, adenoma detection, polypectomy, novel imaging, Barrett's esophagus, third space endoscopy, interventional EUS, and training. This document summarizes these "top 10" endoscopic advances of 2019. (Gastrointest Endosc 2020;92:241-51.)

GI endoscopy is a rapidly changing and continually evolving discipline. To identify major new advances in 2019, the American Society for Gastrointestinal Endoscopy's (ASGE's) GIE Editorial Board reviewed original research articles pertaining to GI endoscopy published in 10 major journals plus *Gastrointestinal Endoscopy*. These journals were selected on the basis of impact factor and included medical journals (*Annals of Internal Medicine, JAMA, Lancet,* and *New England Journal of Medicine*), gastroenterology journals (*American Journal of Gastroenterology, Clinical Gastroenterology and Hepatology, Gastroenterology, Gut, Hepatology*), and specific endoscopic journals (*Endoscopy, Gastrointestinal Endoscopy*). Reviewing the titles, each member of the 9-member board independently identified 10 areas of endoscopic research they considered a top priority based on the criteria of significance, novelty, impact on national health, and impact on global health. The list from each individual member was compiled, and the votes were then tallied to identify the consensus "top 10 topics in GI endoscopy in 2019."

Abbreviations: ADR, adenoma detection rate; AI, artificial intelligence; ASGE, American Society for Gastrointestinal Endoscopy; ATP, adenosine triphosphate; BE, Barrett's esophagus; BLI, blue laser imaging; CNN, convolutional neural network; ESG, endoscopic sleeve gastroplasty; FDA, U.S. Food and Drug Administration; GRAIDS, GI AI diagnostic system; HDWL, high-definition white light; IRIS, intelligent real-time image segmentation; LAMS, lumen-apposing metal stent; LCI, linked-color imaging; LHM, laparoscopic Heller myotomy; NBI, narrow-band imaging; POEM, peroral endoscopic myotomy; WE, water exchange.

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Each member of the 9-member board then individually searched the literature broadly on the selected topic(s) of interest. Each board member wrote a section of this document summarizing the important findings published in their assigned "top 10" topic area in 2019. The written sections were then compiled into 1 document and harmonized for style by the board chairman. The compiled document was then reviewed by all committee members and select chairs of ASGE's education and research committees.

Acknowledging there may still be some bias and subjectivity, the board trusts that the 10 advances listed below will interest readers by summarizing last year's endoscopic advances, guide educators by defining new endoscopic techniques that need to be propagated in clinical practice, and focus investigators on priority areas for research. The list is arranged in order of priority based on the number of votes for each topic:

1. Endoscope disinfection: to clean and how to clean—is technology the answer? Unanimous
2. Smart procedures: computer-assistance and artificial intelligence (AI) for endoscopy. Unanimous
3. Endoscopic sleeve gastroplasty (ESG): will endoscopists become the bariatric surgeons of tomorrow? Unanimous
4. Improving adenoma detection rates (ADRs). Unanimous
5. Techniques for polypectomy continue to evolve. 8 votes
6. To not just look but also to scope: enhanced imaging. 8 votes
7. Barrett's best practice: the debate rolls on. 7 votes
8. Third space endoscopy: the Appian way, quo vadis? 7 votes
9. EUS-guided drainage moves from the pancreas back to the biliary tree. 6 votes
10. Training competency for advanced endoscopy. 6 votes

ENDOSCOPE DISINFECTION: TO CLEAN AND HOW TO CLEAN—IS TECHNOLOGY THE ANSWER?

Endoscope reprocessing and the risk associated with transmission of infectious agents, particularly drug-resistant organisms, is a topical clinical issue that has been on the national news. The Centers for Disease Control and Prevention notified the U.S. Food and Drug Administration (FDA) in the fall of 2013 of a potential association of multidrug-resistant bacterial infections with the use of duodenoscopes. In the fall of 2015, the FDA ordered the manufacturers of duodenoscopes to conduct postmarket surveillance studies to understand real-world endoscope reprocessing and how it might be associated with transmitted infections. The FDA believes the best solution to reducing the risk of disease transmission by duodenoscopes is through innovative device designs that make reprocessing easier, more effective, or unnecessary. On August 29, 2019 the FDA issued a Safety Communication that included a recommendation that "hospitals and endoscopy facilities begin transitioning to duodenoscopes with innovative designs that facilitate or eliminate the need for reprocessing" (https://www.fda.gov/medical-devices/reprocessing-reusable-medical-devices/infections-associated-reprocessed-duodenoscopes).

There are numerous and complex steps in processing endoscopes, especially duodenoscopes, which have an elevator in their working channel that is presumed to be the source of transmitted infections. Each of the steps involved in endoscope reprocessing warrants further investigation.

A number of innovative research studies in 2019 delved into processing techniques for endoscope disinfections. Investigators compared endoscope drying methods and found that endoscopes dried manually were more likely to contain retained fluid and showed increased adenosine triphosphate (ATP) bioluminescence when compared with endoscopes dried using an automated drier, suggesting that automated processing may be more effective in endoscope reprocessing.[1] To date, the use of ATP strips for assessing disinfection remains a research technique. The FDA has not evaluated the effectiveness of ATP strips for assessing duodenoscope disinfection and does not recommend they be used to assess cleaning until there are sufficient data. Simethicone use during procedures has been debated in the past. The use of high-concentration simethicone (1%-3%) was found to be associated with increased fluid and ATP bioluminescence compared with low concentrations (.5%) of simethicone, and 2 automated processing cycles decreased the bioluminescence levels back to normal.[2] Argon plasma–activated gas is a novel disinfecting agent that was shown to be effective for disinfecting working channels. However, this study was not conducted in endoscopes or in the real-world setting, and this agent was not compared with standard high-level disinfection.[3]

An "autopsy" of 2 duodenoscopes used at an institution that had experienced an outbreak of multidrug-resistant *Klebsiella pneumonia* concluded that multiple factors were associated with infection risk: miscommunication, undetected damaged parts, inadequate repair of damaged duodenoscopes, and duodenoscope design abnormalities, including the forceps elevator, elevator lever, and instrumentation port sealing.[4] Only a systematic approach would satisfactorily mitigate this risk and should involve clear communication by all parties involved, a reliable servicing market, stringent surveillance measures, and eventually new duodenoscope designs and reprocessing procedures with a larger margin of safety.[4]

As an alternative to reusable endoscopes, various disposable options have been described ranging from disposable tips to completely disposable single-use

endoscopes. The use of disposable duodenoscopes was estimated to be about 10 times as expensive as using a reusable duodenoscope in a high-volume center.[5] The study concluded that using reusable endoscopes for a limited number of procedures and completely refurbishing endoscopes at regular intervals would be most cost-efficient. A detailed analysis of colonoscopy cost per procedure of reusable colonoscopes concluded that the cost was highly dependent on the practice setting, volume of procedures, and number of colonoscopes available.[6] A proper comparison with disposable colonoscopes is not yet possible.

All news was not bad news. After high-level disinfection, echoendoscopes (radial and linear) showed significantly lower contamination rates than duodenoscopes, suggesting that the elevator/working channel contamination issues in duodenoscopes may not be mirrored in linear echoendoscopes, which are the only other endoscopes with an elevator.[7]

A major gap in the research on this subject is the absence of meaningful data regarding the environmental burden of disposable endoscopes. Another area of significant concern is that the current business models for endoscopy may incentivize the industry to promote disposable single-use endoscopes, dramatically increasing societal costs.

SMART PROCEDURES: COMPUTER ASSISTANCE AND AI FOR ENDOSCOPY

During 2019, published studies of AI in GI endoscopy rapidly progressed from preclinical demonstrations to prospective trials. Several high impact reviews were published,[8-11] attesting that no organ remains untapped, the applications of AI seem endless, and the evidence for its utility is emerging. This knowledge has sparked debate and contemplation regarding the implications of AI for daily practice.[12-14] Nevertheless, as acknowledged in updated guidelines from the European Society of Gastrointestinal Endoscopy,[15] it now seems inevitable that AI will revolutionize endoscopy in the very near future.

In 2019, reports continued to support a role for AI in diagnosing esophageal and gastric cancers[16-18] and for endoscopic robots that can assist in efficient, effective, and safe removal.[19] A retrospective analysis from Japan of over 8000 images of esophageal cancer demonstrated that convolutional neural networks (CNNs) could improve detection rates.[16] A software called intelligent real-time image segmentation (IRIS) was introduced to enhance volumetric laser endomicroscopy for detecting Barrett's esophagus (BE).[17] IRIS works by rapidly interpreting 3 previously established volumetric laser endomicroscopy features of histology to differentiate between squamous epithelium and BE. The multicenter authors announced they are now pursuing a randomized controlled trial of volumetric laser endomicroscopy with and without IRIS to explore its potential for BE detection during esophageal surveillance protocols. In China, investigators amassed more than 1 million images of upper GI lesions with histologic proven malignancy from over 84,000 individuals at 6 large hospitals of different tiers (municipal, provincial and national) to develop and test their GI AI diagnostic system (GRAIDS).[18] The goal of GRAIDS is to use real-world endoscopic data from patients presenting with nonspecific symptoms to assist physicians with widely varying experience in malignancy detection. In a large, prospective, multicenter study, GRAIDS was found to provide both real-time intraprocedural assistance in community settings and what could essentially be considered easy access to a "virtual reality second opinion."

Progress in using AI to improve the accuracy and efficiency of small-bowel imaging continues, with high-powered explorations of various technologies to develop "truly smart" wireless capsule endoscopy systems.[20] A validated CNN-based wireless capsule endoscopy system has been developed that can detect erosions and ulcerations with remarkable accuracy and efficiency, requiring only seconds to analyze thousands of images correctly.[21,22] This concept was taken to a new level in a study that used more than 100 million images from 77 medical centers to train and test a deep learning model.[23] In this extraordinary demonstration of AI as a disruptive technology, CNN-based wireless capsule endoscopy was found to have 99.88% per patient and 99.90% per lesion sensitivity for detection of small-bowel variants, as compared with 74.57% per patient and 76.89% per lesion sensitivity for conventionally read studies by gastroenterologists. In addition, mean reading times for wireless capsule endoscopy were decreased from a conventional 96 minutes to only 5.9 minutes per study when the CNN-based system was used.

In the colon, investigators performed the first prospective randomized controlled trial of an automatic polyp detection system based on deep learning to increase ADRs during screening colonoscopies in a standard-risk population.[24] The open, nonblinded study design involved randomization of more than 1000 patients to either standard colonoscopy or colonoscopy with computer-assisted diagnosis. Computer-assisted diagnosis increased the ADR from 20% to 30%, mostly by increasing detection of diminutive adenomas. However, it also led to oversampling of hyperplastic polyps, emphasizing the need for differentiation, not just detection. Beyond cancers, novel computer-assisted diagnosis systems also illustrated their ability to histologically evaluate patients with inflammatory bowel disease and colitis.[25,26] Although diagnostic sensitivity, specificity, and accuracy in both studies are promising, neither reached super human levels, and both yielded varying results in proximal versus distal colon. Limitations of AI for colonic disease may reflect real-world limitations of colonoscopy, including quality of preparation and provider fatigue. To this end, a new application of AI for assessing bowel preparation was introduced that may help usher in a new era of

objectivity in the eternal quest for the perfect colonoscopy preparation.[27] At the same time, next-generation painless robotic colonoscopy systems may help providers improve procedural reliability, no matter how many hours they stand on their feet.[28]

ESG: WILL ENDOSCOPISTS BECOME THE BARIATRIC SURGEONS OF TOMORROW?

Obesity is a large and ever-increasing problem worldwide. Medical treatments have so far proven ineffective, but bariatric surgery, essentially sleeve gastrectomy and Roux-en-Y gastric bypass, have proven efficacy in achieving weight loss and comorbidity reduction. In spite of this, less than 1% of patients with severe class II or class III obesity receive surgery because of cost issues (cost of hospital procedure and/or insurance refusal) and patient resistance to the thought of an operation. To increase access and acceptability it would therefore be ideal to have a less invasive and less costly treatment. This has led to intense interest in endoscopic treatments of obesity and related metabolic diseases. Currently there are at least 9 general endoscopic approaches (and dozens of companies) in various stages of pre- or postcommercialization to treat obesity/metabolic disease.[29]

Significant numbers of academic publications were once again seen in 2019. These appeared in both surgery and GI focused journals as well as high and low impact factor journals. In *Gastrointestinal Endoscopy* there were 10 articles on bariatric endoscopy, and the most frequently described procedure (40%) was ESG. This replaced intragastric balloons and even bariatric adverse event management as the hot topic in bariatric endoscopy for 2019, partly because of growing evidence of the efficacy of ESG from large single-center studies or meta-analyses. A single-center study reported outcomes on 1000 ESGs.[30] Eighteen-month follow-up was available for 54 of 63 patients and showed good results with 15% total weight loss and 76% to 100% resolution of comorbidites. Adverse events included severe pain (n = 8), bleeding (n = 7), and perigastric abscess (n = 4). Eight patients were revised to sleeve gastrectomy, and 5 had redo-ESG. These results were reinforced by a multicenter study involving 7 leading centers in BE. One hundred ninety-three patients were reported with a total weight loss of 15% at 1 year and estimated weight loss of 59%, results of which are almost comparable with laparoscopic sleeve gastroplasty. There were significant adverse events (no deaths, but surgery was required) in 1.03%.[31] A meta-analysis with 1776 patients and up to 24 months follow-up had similar results.[32] Finally, we are starting to see comparative studies between ESG and other treatments, diet and exercise,[33] intragastric balloons,[34] gastric drainage (Aspire Assist Aspire Bariatrics, Exton, Penn, USA), and another endoscopic suturing technique (primary obesity surgery endolumenal).[35] In all cases, ESG had better weight loss and comorbidity reduction than the alternatives. There are no randomized prospective trials.

Overall, ESG has documented outcomes nearly as good as surgical results (sleeve gastrectomy, at least in the short term (<24 months) with less morbidity. It is not clear how generalizable the procedure is, because it is technically demanding and even more like surgery than other currently available bariatric procedures. So far ESG is only performed by skilled endoscopists (surgical and medical) and even then can result in severe adverse events.[36] It is obvious that longer follow-up studies with careful endpoints are required to allow determination of its role in obesity/metabolic management. Undoubtedly, a randomized controlled trial comparing ESG is needed, and if endoscopy is at least as effective, the results will disrupt current bariatric treatments.

IMPROVING ADRs

In studies focused on improving ADR, several advances from 2019 deserve mention. Conflicting accounts of Endocuff and water-aided colonoscopy (water immersion, water exchange [WE]) and a single positive study on balloon colonoscopy have been identified. How AI and WE may complement each other has been proposed as a new research direction.

In low adenoma detectors, Endocuff increased ADR from 36.2% to 40.9% ($P = .02$).[37] In high detectors, Endocuff did not increase ADR (61.4% vs 52%; $P = .21$) but decreased examination time (6.5 vs 8.4 minutes; $P < .0001$).[38] Two studies comparing Endocuff and cap reported no difference in ADR when colonoscopy was performed by high detectors; ADR was 50.8% with Endocuff versus 52.7% with cap ($P = .666$) in 1 study[39] and 50.4% (95% confidence interval, 45.1-55.7) with Endocuff versus 50.6% (95% confidence interval, 45.2-55.9) with cap in a second study.[40] In a meta-analysis of 17 studies (13,631 patients), use of distal attachments (cap, Endoring) (relative risk, 1.21; $P = .45$) and Endocuff (relative risk, 1.29; $P = .09$) did not show a significant improvement in serrated ADRs.[41] The number of serrated lesions detected per patient was not increased by Endocuff during surveillance of serrated polyposis syndrome.[42] In a meta-analysis of 9 studies (6038 patients), Endocuff increased ADR compared with conventional colonoscopy in low ADR settings; there was no significant effect on advanced ADR and mean number of adenomas per colonoscopy.[43]

A network meta-analysis (44,948 patients) compared efficacies of groups of methods: (1) enhanced imaging techniques (chromoendoscopy, narrow-band imaging [NBI], flexible spectral imaging color enhancement, and blue laser imaging), (2) add-on devices (cap, Endocuff [Olympus America, Center Valley, PA], Endoring [Steris Healthcare, Mentor, Ohio, USA], balloon colonoscopy), (3) new endoscopes (full-spectrum endoscopy,

extra-wide-angle-view colonoscopy, dual focus), and (4) low-cost optimizing existing resources (water-aided colonoscopy [eg, WE], second observer, dynamic position change). Newer endoscopes did not significantly increase ADR. Low-cost optimization of existing resources was as effective as enhanced imaging techniques or add-on devices in increasing ADRs.[44]

Two conflicting reports on water-aided colonoscopy[45,46] highlighted the salient features[47] of water immersion and WE. The negative impact of incomplete (66%) removal of infused water during insertion (water immersion) was an increase (23%-36%) in overall adenoma miss rate.[45] With 89% removal of the infused water (more closely meeting the strict definition of WE, ie, near-complete removal of infused water during insertion), right-sided colon adenoma miss rate was significantly reduced (34%-18%).[46] To show an increase in sessile serrated polyp detection rate, WE (23.6%) alone was sufficient.[48]

A significantly higher ADR (48.0%) was seen with balloon colonoscopy compared with standard high-definition colonoscopy (37.5%, $P = .0027$). Also, higher advanced ADR ($P = .0033$), flat ADR ($P < .0001$), and sessile serrated polyp detection rate ($P = .0026$) were demonstrated for balloon colonoscopy in an industry (Ra'anana, Israel) supported unblinded open access report.[49]

An area for future research was described. An increase in ADR in a low detector setting could be achieved by a real-time computer-aided detection system, but poor bowel preparation (33%) was a limiting factor (false alarms).[24] The salvage cleaning achieved during insertion with WE might complement AI by enhancing polyp exposure and obviating false alarms (eg, residual feces).[50]

TECHNIQUES FOR POLYPECTOMY CONTINUE TO EVOLVE

Polypectomy remains the criterion standard for resection of colorectal polyps and the related decrease in colorectal cancer risk. In 2019 research focused on improving the quality and outcomes of polypectomy.

Investigators examined the impact of a polypectomy "report card." They used the previously validated direct observation of polypectomy skills scoring system for assessing polypectomy. The report card contained baseline scores and instructional videos describing optimal polypectomy techniques. There was a significant improvement in direct observation of polypectomy skills scores after intervention.[51]

Many studies compared jumbo biopsy forceps and snare polypectomy. The latest such study is an elegant prospective randomized controlled study that showed the 2 modalities were similar with respect to completeness of resection of polyps ≤5 mm.[52] Another study prospectively evaluated the outcomes of jumbo forceps polypectomy of polyps measuring ≤3 mm. The sites were examined after 1 year by white-light imaging and NBI, showing a high complete resection rate at 99.4%.[53]

A new video-based cold snare polypectomy assessment tool was developed and validated.[54] Metrics chosen were relevant to polyp inspection, positioning, appropriate ensnarement of tissue to ensure a rim of normal tissue, tissue retrieval, and postpolypectomy site inspection. There was moderate correlation between the direct observation of polypectomy skills score and all 12 metrics chosen for the tool.

Underwater polypectomy is a novel resection technique based on the observation that the mucosa and submucosa float away from deeper layers when submerged. It eschews submucosal injection. A well-done prospective randomized trial compared underwater EMR with conventional EMR and demonstrated that underwater EMR achieved a significantly better en bloc resection rate and R0 resection rate compared with conventional EMR. Adverse events and procedure times were similar.[55]

A large population-based study examining the outcomes of endoscopic resection of malignant polyps compared with surgery in the general population found that the long-term outcomes were similar and excellent when the endoscopic resection margin was ≥1 mm.[56] Interestingly, the recurrence rate for sessile malignant polyps resected endoscopically dropped dramatically between 1983 to 2002 and 2003 to 2011 from 11.3% to 1.2%, respectively,[56] likely coinciding with the advent of advanced EMR.

In summary, in 2019 cold forceps polypectomy with jumbo forceps has been found to be similar to cold snare polypectomy for diminutive polyps. Effective assessment tools have been developed to assess polypectomy that require further large-scale validation. Underwater polypectomy is a novel technique that deserves further consideration.

TO NOT JUST LOOK BUT TO ALSO SCOPE: ENHANCED IMAGING

Image-enhanced endoscopy includes NBI, blue laser imaging (BLI), and linked-color imaging (LCI). NBI and BLI are imaging technologies that are similar in concept in which 2 different wavelengths of light in the blue/green spectrum are used to illuminate the mucosal surface to enhance imaging of vascular structures. The NBI International Colorectal Endoscopic and Japan NBI Expert Team classification systems can be used with both NBI and BLI, although the Japan NBI Expert Team classification system requires magnification capability. Unlike NBI and BLI, LCI uses wavelengths in the red, blue, and green spectra along with image processing to enhance the contrast of vascular structures with a more natural color representation of the mucosa and vascular structures. These modes of image-enhanced endoscopy have been under investigation for imaging of mucosal lesions, especially colon polyps.

In the past year, several publications have added to the evaluation of image-enhanced endoscopy in detecting and differentiating colorectal polyps. A prospective randomized study of 182 patients comparing BLI with high-definition white-light (HDWL) imaging for detection and differentiation of colon polyps demonstrated a higher ADR for BLI (46.2% vs 27.8%, $P = .01$).[57] In another prospective randomized study, BLI was compared with HDWL imaging to predict histology (adenoma or not adenoma) of colorectal polyps <1 cm.[58] A total of 483 polyps were evaluated. Overall accuracy of polyps characterized by BLI was 92% compared with 84% for HDWL imaging ($P = .011$). These studies suggest that BLI has the potential for improving detection and characterization of polyps similar to NBI.

In a retrospective study evaluating LCI, BLI, and HDWL for imaging colon polyps, the authors determined that LCI significantly improved the visibility of colon polyps without impacting image brightness; the authors proposed that LCI be used for routine detection of colon polyps.[59] A randomized trial compared LCI, BLI, and HDWL imaging for the detection of colorectal adenomas. LCI identified more colorectal adenomas than HDWL imaging (56.9% vs 43.2%, $P = .03$) but was not significantly better than BLI (56.9% vs 54%, not significant).[60] A prospective randomized tandem study comparing LCI with NBI demonstrated the polyp detection rate was significantly higher in the NBI group than the LCI group (71.3% vs 55.9%, $P = 0.008$).[61] No studies to date have compared BLI and NBI for detection and evaluation of colon polyps.

A meta-analysis of NBI for the detection of colon polyps using data from individual patients enrolled in randomized controlled trials demonstrated that the brighter second-generation NBI outperformed HDWL imaging in the setting of excellent bowel preparation, suggesting that NBI may still have a role in improving adenoma detection.[62] Studies published in 2019 suggest that NBI, BLI, and LCI may have a role in improving colon polyp detection and that BLI has similar utility as NBI in characterizing colon polyps.

BARRETT'S BEST PRACTICE: THE DEBATE ROLLS ON

Endoscopic eradication of dysplastic and early neoplastic BE has been a major advance over the past 2 decades. However, these therapies will have minimal impact if prevalent BE is not identified before diagnosis of esophageal cancer. Screening endoscopy for BE is recommended for patients with multiple risk factors.[63,64] A systematic review and meta-analysis of 49 studies published in 2019 estimated that the prevalence of BE was .8% in the general population with no risk factors, 3% in those with GERD, and 12.2% in patients with GERD plus another risk factor (23.4% for family history, 6.1% for age >50, 1.9% for obesity, and 6.8% for male gender).[65] Regression analysis discovered that the number of risk factors had a positive linear relationship with the prevalence of BE. The results of this meta-analysis support the new Grading of Recommendations, Assessment, Development, and Evaluation (GRADE)-based 2019 screening guidelines from the ASGE.[64] Although the quality of evidence based on observational studies is very low, these 2019 guidelines also support performing surveillance, and when surveillance is performed they strongly support the use of the rigorous Seattle biopsy protocol coupled with virtual or real chromoendoscopy. These new guidelines did not find sufficient evidence to support the use of other imaging methods such as EUS, confocal endomicroscopy, or volumetric laser endomicroscopy. Although the cost-effectiveness of wide-area transepithelial sampling has not been measured—and the significance of crypt dysplasia detected by wide-area transepithelial sampling yet determined—the new guidelines make a conditional recommendation that wide-area transepithelial sampling should be considered as an adjunct to the Seattle biopsy protocol and chromoendoscopy to enhance surveillance.

Advances in endoscopic eradication therapy for dysplastic BE in 2019 included a multicenter, prospectively maintained database study that followed 594 patients who had achieved complete eradication of intestinal metaplasia.[66] One-fourth of these patients had recurrence of intestinal metaplasia over a median follow-up of 2.8 years, supporting the current practice of close surveillance. Most recurrences (74%) were located at the gastroesophageal junction, and nearly one-fourth of these recurrences were dysplastic.[66] These findings[66] were supported by another publication that suggested surveillance of patients postablation should focus on obtaining biopsy specimens in the region just below the squamocolumnar junction.[67] As data on recurrence of dysplastic and nondysplastic BE are collected, it is expected that future modeling studies will help define appropriate surveillance intervals after successful endoscopic eradication therapy.

THIRD SPACE ENDOSCOPY: THE APPIAN WAY, QUO VADIS?

In 2019, there were further forays into the potential space within the wall of the GI tract now termed the "third space of the endoscopist." Endoscopic interventions coalesced around submucosal access and selective disruption of the smooth muscle architecture in motility disorders. In previous years, the literature reflected the description, feasibility, and subsequent collation of the experience regarding peroral endoscopic myotomy (POEM).

Robust evidence for the utility of POEM comes from a noninferiority randomized controlled trial of 221 patients assigned to either POEM or laparoscopic Heller myotomy

(LHM) with Dor's fundoplication.[68] At 2 years, POEM was associated with an 83% clinical success rate versus 81.7% in the LHM with Dor's fundoplication group ($P = .007$ for noninferiority). Reflux was more common in patients with POEM at 44% versus 29%. The authors concluded that POEM outcomes were not inferior to LHM with Dor's fundoplication at 2 years of follow-up. This important study changes the weight of heuristics toward other considerations such as costs, length of stay, and patient preference as the driver of decision-making when deciding on the optimal treatment approach for patients with achalasia.

In 2019, investigators also defined endoscopic characteristics that predict outcomes after POEM. In a retrospective study that included 1912 POEM procedures performed over a >6-year period in Shanghai, previous Heller myotomy (odds ratio [OR], 2.094; $P = .026$), submucosal fibrosis (OR, 4.530; $P < .001$), mucosal edema (OR, 1.834; $P = .001$), tunnel length ≥13 cm (OR, 2.69; $P < .001$), previous POEM (OR, 5.00; $P = .030$), and submucosal fibrosis (OR, 12.074; $P < .001$) were found to be significant predictors of clinically significant mucosal injury (leading to lack of tunnel protection and adverse events).[69] Conversely, procedures performed by operators with >1 year of experience were associated with an almost 40% decreased likelihood of mucosal injury. Tunnel length >8.5 cm was also associated with greater postprocedural pain and relatively longer lengths of stay, when other patients were more likely to be discharged home the same day of POEM.[70] Of note, another study of 1384 patients[71] did not identify prior treatment as a risk factor for adverse events (OR, 1.19; $P = .65$). Survival analysis identified an association of prior treatment for achalasia with clinical failure during follow-up (HR, 1.90, $P = .002$). These studies suggest that increased burden of dissection related to the extent of submucosal fibrosis is associated with less-favorable procedural outcomes. They also highlight the very low adverse event rate after POEM procedures.[69-71] POEM has emerged as the primary treatment choice in patients with achalasia.

Publications in 2019 provided insights into factors that influence the choice of treatment approach in achalasia. A cost-effectiveness analysis comparing POEM with Heller myotomy favored POEM across a wide range of scenarios. POEM and LHM were both associated with a similar health-related quality of life status at 1 year; however, POEM was preferred as long it offered a >10% cost savings over LHM.[72] LHM was the preferred approach if there was no cost differential between the 2 procedures. In a National Health Services study of 6938 patients who underwent treatment for achalasia in the United Kingdom, pneumatic dilation appeared to have a more durable outcome over a 10-year period when compared with LHM (86 vs 81%; $P < .001$).[73] The periprocedural mortality was higher after pneumatic dilation and appeared to be related to increasing age and comorbidity. Three attempts at pneumatic dilatation were allowed in this comparative study; however, repeat dilatations were associated with an increased likelihood of 30-day postprocedure mortality (OR, 1.58; $P < .05$).

A cohort of 44 patients with refractory gastroparesis were studied for a median of 18 months after gastric POEM.[74] There was significant improvement in health-related quality of life indices (manifested by Gastrointestinal Cardinal Symptom Index scores) and gastric retention as assessed by scintigraphy. Gastric retention was significantly reduced by 41.7% ($t = -7.90$; $P < .00001$). The improvements in Gastrointestinal Cardinal Symptom Index scores appeared to be weight driven by improvements in nausea and vomiting. The etiology of the gastroparesis did not predict post–gastric POEM outcomes; however, patients with a shorter duration of disease had better outcomes. The findings could very well alter the treatment for gastroparesis if they are reproducible.

The use of POEM-like techniques in the treatment of esophageal diverticula was also highlighted in a multicenter study of 11 patients demonstrating the feasibility of so-called D-POEM for the treatment of esophageal diverticulae.[75] The technique appears to allow for a more complete septotomy than the more traditional endoscopic myotomy techniques. Clinical success was achieved in all patients with a decrease in mean dysphagia score from 2.7 to .1 ($P < .001$) during a median follow-up of 145 days. Zenker myectomy, where snare excision of residual septal muscle is performed, is a novel third space endoscopy procedure. In a comparison of 20 patients with Zenker's diverticulum treated with cervical myectomy compared with 44 treated with a myotomy, symptom recurrence was reportedly decreased in the myectomy group despite similar technical and initial clinical outcomes.[76]

In 2019 there was a significant evolution of the literature with regard to refining the patients who best respond in the treatment of foregut disorders. These 2019 publications will serve as a pivot point for both decision-making and designing studies in this area of GI endoscopy.

EUS-GUIDED DRAINAGE MOVES FROM THE PANCREAS BACK TO THE BILIARY TREE

With the advent of the lumen-apposing metal stent (LAMS), a variety of EUS-guided interventions hs been developed. Although initially used primarily for drainage of pancreatic fluid collections, the use of LAMS has expanded to development of enteroenterostomy and gallbladder drainage.

Endosonographers reported their experience with EUS-directed gallbladder drainage versus transpapillary drainage, showing higher rates of both technical success (97.5% vs 84.2%) and clinical success (95% vs 76.3%) with EUS-directed gallbladder drainage and a comparable adverse event profile.[77] A similar study found higher

rates of technical and clinical success with EUS-directed gallbladder drainage compared with a transpapillary approach. Additionally, the transpapillary group suffered a significantly higher rate of adverse events (19.3% vs 7.1%) and a higher rate of recurrent cholecystitis (12.4% vs 3.2%).[78] A systematic review and meta-analysis of gallbladder drainage in high surgical risk patients with cholecystitis patients analyzed over 80 studies and compared outcomes of transpapillary, EUS-guided, or percutaneous drainage.[79] Clinical success with EUS-gallbladder drainage was superior to the other methods, with comparable adverse events between all groups. EUS-directed gallbladder drainage was associated with a 4.3% risk of bleeding and a 3.7% risk of perforation. These studies help to solidify the role of EUS-directed gallbladder drainage in the treatment of acute cholecystitis, particularly in poor surgical candidates.

Although many EUS-guided interventions initially used existing self-expanding metal stents, more recent studies incorporate LAMSs in the creation of choledochoduodenostomies for the treatment of distal biliary obstruction. A retrospective case series of 52 patients reported on the outcomes of EUS-choledochoduodenostomy using electrocautery-enhanced LAMS for treatment of distal malignant biliary obstruction.[80] Technical success was achieved in 43 patients (82.7%), with 100% of those achieving clinical success, defined by a decrease in bilirubin of at least 50% within 1 week. Two patients (3.8%) experienced short-term adverse events and 7 (13.5%) long-term events, mainly recurrent biliary obstruction and cholangitis from tumor ingrowth or sump syndrome. Rates of technical and clinical success between experts (>20 cases) and nonexperts were the same. Another case series reported on 46 patients who underwent EUS-choledochoduodenostomy (EUS-CD), with technical success in 93.5%, clinical success in 97.7%, and adverse events in 11.6%.[81]

Therapeutic EUS continues to play an important role in accessing the biliary tree as well as in the drainage of fluid collections and establishing enteroenteric fistulae. The widespread use of LAMS has led to the development of EUS-guided access in ways that were previously feasible only through an approach based on natural orifice transluminal endoscopic surgery.

TRAINING COMPETENCY FOR ADVANCED ENDOSCOPY

Mastering endoscopic (and especially advanced) skills is a formidable endeavor. Training is complex and requires acquisition of cognitive (knowledge and recognition), technical (psychomotor), and nontechnical (expertise and behavior) skills. Endoscopic education today is largely carried out in the endoscopy unit where trainees practice on patients under the guidance of an experienced preceptor. This hands-on experience is considered the backbone of endoscopic learning, and many trainees believe they learn best by directly performing procedures. This approach has been criticized as being inefficient and nonstandardized. Learning strategies such as game design, use of models, and a structured learning environment have been advanced as possibly better strategies, especially for millennial trainees where interactive technology is an important learning trait.[82]

Advanced endoscopy training programs were established to provide comprehensive ERCP and EUS training. Advanced procedures have expanded to include EMR, endoscopic submucosal dissection, endoluminal stent placement, bariatric endoscopy, therapeutic EUS, and third space endoscopy. More objective skills assessment tools with validity evidence predictive of real-time performance on patients are available for EUS and ERCP (eg, The EUS and ERCP Skills Assessment Tool).[83] These tools can be used in the clinical setting to monitor learning curves and to assess competence. They provide a framework for teaching, help trainers identify specific deficiencies, and facilitate detailed performance-enhancing feedback.

A large, prospective multicenter study designed to define the number of procedures required by an advanced endoscopy fellow to achieve competence in technical and cognitive EUS and ERCP was published in early 2019.[84] The average advanced trainee achieved competence in core EUS and ERCP skills after performing approximately 225 and 250 cases, respectively. Technical competence for grade 2 (more complex) ERCP was achieved at about 300 cases. Validated assessment tools such as the Assessment of Competency in Endoscopy-EGD (ACE-E) tool for EGD have been used for competency benchmarks and measurements.[85]

Simulation-based education is a possible alternative and complementary approach to mitigate patient safety and training efficiency concerns.[86] The use of simulation in GI endoscopy dates back to the 1960s. Less than half of adult gastroenterology training programs in the United States currently have simulation as part of their curriculum. Simulation uses educational tools that allow for repetitive instruction in a nonpatient care environment. GI endoscopy simulators include ex vivo animal tissue models, live animal models, mechanical models, and virtual reality computer simulators.

Ex vivo and in vivo animal models are more commonly used for advanced endoscopic training. Advantages of using simulation include the removal of procedure-associated discomfort and risks for patients. There is also no interference with endoscopic unit efficiency. Composite and explanted animal simulators are most promising for advanced endoscopic procedures such as EMR, polypectomy, ERCP, EUS, double-balloon enteroscopy, EUS-FNA, pseudocyst drainage, and placement of LAMSs. Live animal models are the most realistic simulators where

haptic feedback is similar to human tissue. Expense, infrastructure requirements, and ethical concerns limit the use of animal models.[87] In a meta-analysis of 18 trials, virtual reality simulation training was found to be advantageous over no training and supplemented conventional endoscopy training.[88,89]

In February 2017 leaders in endoscopic programs across the United States met over a weekend to discuss the latest techniques and methodologies related to endoscopic training.[90] Endoscopic trainers fall into 2 groups, consciously competent trainers and unconsciously competent trainers. Consciously competent trainers have explicit knowledge of their skills and in addition have the ability to deconstruct tasks and plan training beforehand. Unconsciously competent trainers were those who had an implicit rather than explicit understanding of their own skill sets but have trouble adequately verbalizing instructions adequately to a trainee. The recommendations after the meeting were that (1) formal training of endoscopic teachers to a level of conscious competence should be undertaken, (2) formal training structures should be incorporated into existing training curricula, and (3) feedback should be provided to instructors and trainees alike.

The ASGE Skills, Training, Assessment and Reinforcement program for practicing endoscopists was created to enhance practicing endoscopists' skills at therapeutic endoscopy in a particular area of interest such as EMR or endoscopic suturing. The curriculum for the program featured a blended learning format combined with live hands-on simulation-based learning using ex vivo models. It represents an example of thoughtful integration of assessment into an advanced endoscopy training curriculum. Long-term studies regarding the impact of such programs, however, are not available.

Reliable real-world performance data of newly independent advanced endoscopists are lacking. A large prospective study in the United Kingdom regarding colonoscopy in the early postcolonoscopy training period found cecal intubation rates were >90%, but there was a dip in performance by 18.4%, which was remedied with additional procedures.[91]

Significant strides in endoscopic training and competency are being undertaken. Validated tools for testing performance and teaching together with increasing use of simulators and other interactive technology have attracted more interest. The availability of "train the trainer" programs and procedure-based competencies represent significant development in this area.

CONCLUSION

The 9-member GIE Editorial Board Committee of the ASGE selected the 10 topics discussed in this document. These topics cover a wide range of subjects in GI endoscopy. Articles for discussion were selected by individual board members, and not all impactful articles in the field could be discussed. There is undoubtedly some subjectivity in the choices. However, the consensus among the 9 committee members reflects the importance of the advances discussed. The committee trusts this annual publication of "Top 10 advances in GI endoscopy" will be of value to practitioners of endoscopy and values productive feedback.

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