Simulation-based mastery learning (SBML) for rapid acquisition of upper endoscopy knowledge and skills–initial observation

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At present, most endoscopy training during fellowship is based on the apprenticeship method, wherein trainees learn directly through patient cases in the endoscopy unit. In this method, trainees need to perform a high volume of cases and undergo a long training period to achieve competency. For example, it takes approximately 250 upper endoscopies before trainees attain minimum competence[1] and 450 colonoscopies to achieve an adenoma miss rate of less than 25%.[2] Unfortunately, many trainees may never reach this number of procedures during their fellowship.[2] In addition, trainees may experience cognitive overload during their early cases, when they do not yet have fundamental knowledge and technical skills. Consequently, their experience in patient cases may become less effective, limiting the potential learning opportunity.[3] An alternative training model, in which trainees initially learn the knowledge base and skills by using simulators, has the potential to mitigate these problems.

With simulation-based mastery learning (SBML), trainees can acquire certain procedural skills rapidly and safely through repeated practice.[4,5] Before such a system is developed for endoscopy, however, we believe it is important to demonstrate that novice endoscopy trainees can learn an extensive amount of information in a short time without experiencing cognitive overload. Herein, we discuss the feasibility of systematic stepwise learning for the rapid acquisition of upper endoscopy knowledge and skills.

FLIPPED LEARNING AND MASTERY LEARNING

We used the flipped learning and mastery learning frameworks to develop our SBML program. Flipped learning is increasingly used in medical education.[6] It differs from the traditional classroom in that it uses online platforms to deliver lectures that are traditionally taught in person, reserving in-person sessions for group activities and interactive demonstrations. A meta-analysis of 28 studies evaluating its use in graduate health education (ie, medicine, dentistry, pharmacy, and nursing) suggests superiority of the flipped classroom over traditional teaching methods for learners' knowledge retention and results.[7] In addition, we incorporated the principles of mastery learning, a method of learning in which trainees are required to reach a competency threshold prior to moving forward to learn the next topic. Mastery learning emphasizes the role of feedback and has been shown to be effective in many procedural subspecialties.[4,5]

PARTICIPANTS

We enrolled a total of 6 first-year gastroenterology fellows from the University of California, San Francisco (2), California Pacific Medical Center (2), and Singapore General Hospital (2). The participants were complete novices with no prior endoscopy experience. The course was conducted during the first 2 weeks of fellowship.

The training sessions were conducted at the San Francisco Veterans Affairs Medical Center and Singapore General Hospital. The course was conducted as a quality improvement effort and was deemed exempt from institutional review board approval by the respective institutions.

LEARNING OBJECTIVES

The entire SBML course was completed during an intensive 2-week session (Fig. 1). A detailed list of the topics covered for each module is presented in Table 1. In the first phase (week 1), the fellows learned the basics of EGD. We broke this down further into 4 components: proper endoscope handling and tip control, standardized EGD protocol, endoscopic photo documentation, and endoscopic biopsy and clip application. In the second phase (week 2), the fellows were introduced to various endoscopic therapies, including hemostasis using coaptive coagulation, esophageal band ligation, electrocautery, and foreign body retrieval. We used Canvas, a cloud-based learning management system (Instructure, Inc., Salt Lake City, UT, USA), to disseminate cognitive knowledge and facilitated small-group, guided practice sessions using our hybrid simulators (Fig. 1). The fellows learned the cognitive knowledge base using an online learning management system and completed self-assessments before attending the in-person technical skills training.

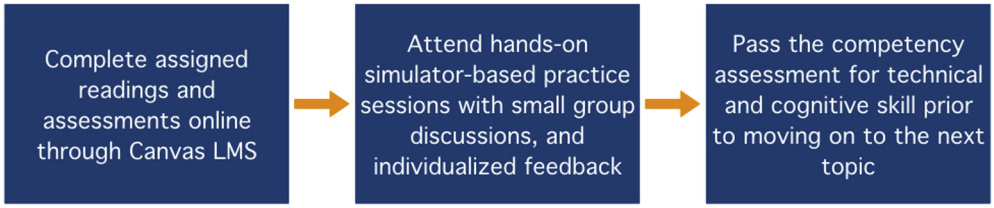

Figure 1. Our structure for teaching upper endoscopy to novice first-year trainees. For each topic, the trainees were required to demonstrate cognitive and technical competence before moving on to the next topic.

TABLE 1. Core modules for the standardized EGD course

Module	Topics covered
Preparing for an upper endoscopy	A Indications for upper endoscopy B Adverse events C Getting informed consent D Mallampati and anesthesia E ASA classification F Proper endoscope handling
Anatomy	A Normal anatomy during an EGD B Abnormal anatomy C UGI findings
Cancers	A Classifications (Paris, Sarin, Forest, Prague C&M for Barrett's, early vs advanced cancers) B Nomenclature for digestive cancers C Using a distal attachment cap
Mucosal biopsies	A When to take mucosal biopsies B Common findings (EOE, viral esophagitis, gastritis, and celiac sprue) C How to perform biopsies
Diagnosing diseases	A IEE B Mucosal detail of the esophagus and GE junction C Early Barrett's cancer D IEE findings in the stomach
Endoscopic clipping	A Tips for successful clip application B Indications for clipping (hemostasis, defect closure, marking, and anchoring) C Limitations of clipping
Midcourse assessment	
NVUGIB	A NVUGIB background B Heater probe and gold probe C Hemospray
Electrocautery and polypectomy	A How to use APC B Indications and limitations of APC C Basic polypectomy techniques (biopsy, cold snare, hot snare)
Foreign body retrieval	A Techniques to remove a foreign body B Safety and limitations of foreign body removal
Dilation	A Techniques for performing TTS esophageal dilation B Mechanics of the TTS balloon C Tools for dilation
VUGIB	A The portal system B Guidelines (AASLD, UK) C Management of gastroesophageal varices D Endoscopic classification and stigmata E Banding techniques and post-banding bleeding prevention F Interventional and therapeutic endoscopy
Final assessment	

ASA, American Society of Anesthesiologists; UGI, upper gastrointestinal; EOE, eosinophilic esophagitis; IEE, image-enhanced endoscopy; NVUGIB, nonvariceal upper GI bleeds; APC, argon plasma coagulation; TTS, through the scope; AASLD, American Association for the Study of Liver Diseases.

Learning the technical skills

Each session took around 4 hours, and we allotted additional time for independent practice and content review. We used previously validated and commercially available simulators.[8] We used the standard upper endoscopy plastic model (Koken, Tokyo, Japan) and the Ovesco model (Ovesco, Tubingen, Germany) to teach standardized upper endoscopy and therapy. We modified these models to have interchangeable parts to simulate various clinical presentations, such as a bleeding ulcer, arteriovenous malformation, and gastric polyps.

The course was primarily taught by 1 attending gastroenterologist in the United States and 1 in Singapore. The learning modules, simulators, and assessment methods were standardized between the 2 sites.

ASSESSMENT AND FEEDBACK

We assessed the fellows' skills after each phase using a knowledge-based assessment and a technical skills assessment after every module. We also administered cumulative assessments after the first and second phases of the program. These assessments provided constant feedback on both cognitive and technical skills, allowing the instructors to identify and work on areas in need of improvement to ensure that the fellows showed competency before advancing to more complex techniques.[9]

PEER INSTRUCTION AND REFLECTION

We implemented peer instruction, a well-researched teaching strategy that has been widely used in medical education[10] and which has been shown to improve trainees' conceptual understanding, problem-solving skills, and overall enthusiasm. We asked our fellows to work in pairs to submit a summary document (eg, PDF, video, PowerPoint [Microsoft, Redmond, Wash., USA]) after each online module. These documents were uploaded to a storage cloud and shared as study materials for the group and future trainees. Through this process, the fellows actively survey their grasp of the material and can address misunderstandings before moving on to the next topic.

At the end of the course, the fellows were required to create a final summary video to recap the topics taught throughout the 2-week program. All 6 fellows, including the 2 fellows in Singapore, needed to collaborate on the project. Requiring the trainees to reflect on the material learned and develop their own material to teach others may help them gain teamwork skills and identify strengths and weaknesses in their knowledge. In addition, it can help trainees develop leadership, problem-solving, and presentation skills, which were all identified as key skills in endoscopy.[11]

RESULTS

The fellows submitted a final summary video with a collated reflection of the concepts learned and their overall experience with our flipped training course. We show that gastroenterology trainees are able to master endoscope handling, perform standardized upper endoscopy competently, and become facile with standard therapies after just 14 days (Video 1, available online at www.VideoGIE.org). In the first half of the program, the fellows learned how to maintain effective control of the endoscope tip, perform high-quality inspection, diagnose common diseases and cancers, apply endoscopic clips, and perform biopsies. For endoscope handling, they specifically practiced using only their left hand to control the up/down and right/left knobs until they were able to do so reflexively. The second half of the course focused on more advanced endoscopic therapies, including polypectomies (EMR and cold snare), Hemospray (Cook Medical, Bloomington, Ind., USA), gold probe, and balloon dilation. The trainees appeared to have a strong grasp of the stepwise components required to perform these techniques. All fellows completed all the hands-on sessions and online modules.

DISCUSSION

We show that novice gastroenterology trainees are able to learn a vast number of endoscopic procedures and therapies through an intensive 2-week introductory training course. By developing a strong foundation of cognitive and technical skills, trainees may be better equipped to perform endoscopy in clinical practice and learn more advanced endoscopic interventions in the future. The rapid acquisition of knowledge and skills in upper endoscopy demonstrated by the fellows allows us to understand the promising role that simulators play in endoscopy, especially in the early phases of training.

The SBML program we have developed based on flipped learning and mastery learning is a promising supplement to the current apprentice-based learning model. Our program's structure and design allowed the trainees to maximize their 2 weeks of dedicated training to master and refine their fundamental endoscopic skills and to practice more standard- techniques that are usually not encountered until the later stages of training. The simulators were easy to assemble and versatile, giving the trainees ample opportunity for repetitive practice. In addition, deconstructing endoscopy into smaller technical components allowed trainees to individualize their learning by focusing on the specific skills they want to refine. The use of online modules to deliver cognitive material also allowed trainees to learn the information at their own pace, helping to lessen the risk of cognitive overload during in-person sessions. The peer instructions provided

trainees with the opportunity to reinforce their newly acquired skills and identify potential knowledge gaps.

The trainees' grasp of fundamental cognitive and technical skills in endoscopy after just 2 weeks of intensive simulator training illustrates the feasibility of teaching a wide array of information within an abbreviated time period. Given the vast amount of information the trainees were able to learn over a short period, our experience demonstrates the powerful potential of using simulators with a comprehensive curriculum to supplement endoscopy training, heralding a safer and more effective learning paradigm. Future studies are needed to evaluate the clinical impact of simulation-based courses compared with traditional apprentice-based training.

DISCLOSURE

Dr Soetikno is a consultant for Olympus and Fujifilm. Dr Kaltenbach is a consultant for Olympus, Medtronic, and Aries Pharmaceuticals. All other authors disclosed no financial relationships relevant to this publication.

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Abbreviations: ASA, American Society of Anesthesiologists; UGI, upper gastrointestinal; EOE, eosinophilic esophagitis; IEE, image-enhanced endoscopy; GE, gastroesophageal; NVUGIB, nonvariceal upper GI bleeds; APC, argon plasma coagulation; TTS, through the scope; VUGIB, variceal upper GI bleeds; AASLD, American Association for the Study of Liver Diseases.

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