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Simulation-Based Mastery Learning With Virtual Coaching: Experience in Training Standardized Upper Endoscopy to Novice Endoscopists

The coronavirus disease-2019 (COVID-19) pandemic has caused an abrupt and significant disruption in training opportunities in endoscopy.[1] The health, financial, and social crises are likely to magnify the deficiencies of the apprentice-based method used in endoscopy training. It seems likely that there will be less training opportunities. To mitigate this, we need to modernize and enhance the efficiency and efficacy of endoscopy training by incorporating the mastery learning (ML) method into endoscopy training curricula.[2] Herein, we aim to describe the applications of ML in training novice endoscopists and demonstrate that trainees can acquire the necessary skills for standardized upper endoscopy and translate these skills into clinical practice. We share this critical evidence, which may serve as a tool for updating the fellowship curricula for the post-COVID endoscopy training.

Limitations of the "One-on-One" Method

More than 100 years ago, Sir William Osler and William Halsted introduced the apprentice-based method to teach medicine and surgery, respectively.[2] In this method, trainees learn the skills to become clinicians through exposure to patients. The hospital serves as a college wherein learners gradually acquire competence by practicing on patients over an extended time period. The apprentice-based method has continued to play a central role in gastrointestinal endoscopy training as "endoscopists predominantly train others in the relative isolation of a 'one-on-one' approach."[3]

The "one-on-one" approach has salient limitations. Trainees routinely learn the most basic maneuvers, such as endoscope tip deflection or examination of the upper gastrointestinal tract, for the first time on patients. Such a system, whereby the trainee is introduced to use an endoscopy skill in real-time patient care, limits the ability of trainees to learn and develop the best practices.[2] Although it may seem that any board-certified gastroenterologist is competent to teach endoscopy, it is highly recommended that trainers undergo formal training to become "consciously competent."[3] Such a training, which also uses a one-on-one approach, is often laborious and expensive (Valori RM, Personal Communication, May 28, 2019). The one-on-one approach also relies on giving direct feedback in clinical settings during or immediately after patient cases, which may be challenging for the trainee to simultaneously follow the instruction and deliberately practice on the patient. Moreover, training may be inefficient, because the opportunity to encounter a patient with the same anatomic or pathologic situation may take time.[4] The literature documents that trainees require more experience to meet the minimum quality standards at completion of training.[4–6] Another significant limitation with the apprentice-based method is that the learning opportunity stops after formal academic training, and thus practicing endoscopists have little chance to train, retrain, or maintain endoscopy techniques.[7]

Notably, there are contemporary methods of learning that are superior to the apprentice-based method.[2] In particular, ML has been shown to produce significant effects on skills and moderate effects on patient outcomes as compared to traditional methods.[8] Moreover, simulation-based ML (SBML) has been used routinely in critical care[9] and increasingly in surgery,[10] albeit, rarely in endoscopy.

ML and SBML

ML is a well-structured and strict form of competency-based education wherein all trainees become uniformly skilled and are required to reach the predefined goals.[11] The critical advantage with ML is the flexibility in time and provision of repeated feedback, which allows learners with varying skills to deliberately practice at their own pace until competency is attained. In addition, ML ensures all the learners meet a minimum passing standard (MPS) before advancing to the next phase of training. Implicit in ML is the use of simulators to provide trainees the platform to practice repeatedly and refine their technical skills before progressing to patients and compromising safety. In essence, SBML provides trainees the opportunity to gain competence in basic[12] and advanced endoscopic skills safely and efficiently.

Major Roadblocks in Implementing SBML to Train Novices Upper Endoscopy

The method of maneuvering the endoscope, which includes fine tip deflection and insertion/removal of the endoscope, either facilitates or hinders the development of expertise in endoscopy.[13] However, many trainees do not receive formalized training to develop these skills and train themselves directly through procedures. By self-learning, there is no assurance that the trainees develop the proper form and technique. The ability to learn these maneuvers early on using SBML can facilitate the development of good endoscopy practice.

Gaming Mindset for SBML training of Novice in Upper Endoscopy

Current trainees are composed of millennials, who are heavily influenced by digital innovation.[14] The majority of them have extensive experience in playing video games. Leveraging these

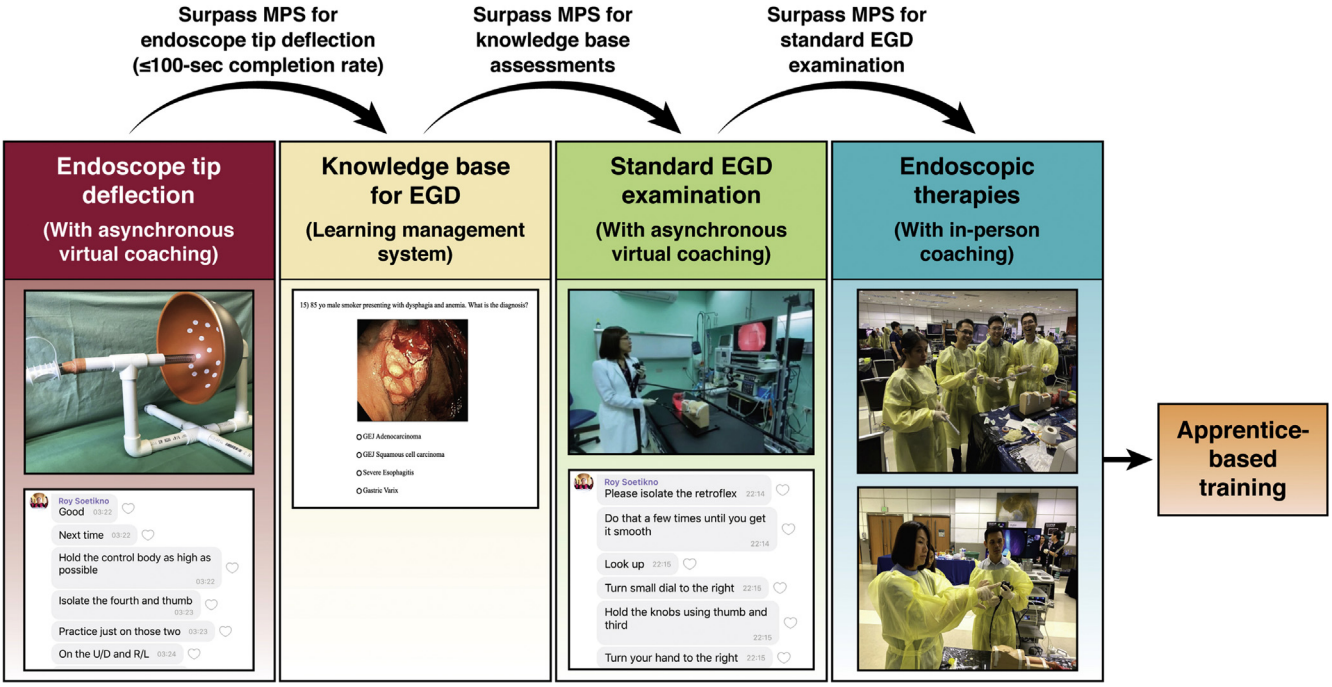

Figure 1. The relationship between simulation-based mastery learning (SBML) and performance on patients based on the pedagogical framework for procedural skill training in medicine (modified from Sawyer et al[21]). SBML will supplement, not replace, the current one-on-one training method to enhance the current state of endoscopy training. Our trainees' competency in endoscope tip deflection, standardized examination and their knowledge base provide them with both the skills and knowledge to steer the endoscope (rather than to push blindly). During their first procedures, we observed that the trainees maneuvered the endoscope more carefully and were more cognizant of potential injuries to the pyriform sinus, upper or lower esophageal sphincter, or the duodenum. After SBML, their local supervisors oversaw the trainees' performance on patients and taught techniques that could not be explained well by using the simulator, such as the appropriate use of air insufflation, cleaning the lens, and washing the mucosa.

skills may ease endoscopy training. In video games, they first master the control console. They practice deliberately with feedback until they complete the initial level before progressing to the next. Although their success is typically attributed to development of "muscle memory," gamers also develop strategic skills and collaboration. This experience in playing video games parallels the SBML structure: first, master the control console; second, learn the structured examination; and, last, learn the therapeutic skills to complete the procedure. Using the gaming strategy, we may make them learn endoscopy more efficiently.

Early Development of the Capacity for Endoscopic Diagnosis

Acquiring knowledge on endoscopy findings has remained a "learn on the job" experience. Most focus on gaining technical competence in endoscopy before learning to make appropriate diagnoses.[13] This poses significant risks and may lead to missed or incorrect interpretation of findings. It is, therefore, imperative that trainees acquire baseline knowledge and endoscopy skills concurrently for effective delivery of care. The ability to train maneuvering skills efficiently would create the time to incorporate the development of cognitive knowledge early in the training program. Given the significant potential of applying SBML in endoscopy, we aimed to develop such a program.

Steps to Creating our SBML Program

We used an extensive curriculum in the Philippines that was a compilation of several SBML programs that have been iteratively developed, tested, and delivered since mid 2018.[11,12] We delivered the prototypes used in the training course to 6 novice first-year fellows at the San Francisco Veterans Affairs Medical Center and Singapore General Hospital.[12] The experiences gained allowed us to refine the curriculum and scale it to train a larger group using virtual coaching. Approximately 4 months before the current SBML course, we introduced the curriculum in a 2-day Train the Trainer course in the Philippines to gain acceptance of the concept, materials, and method of the SBML training.

SBML for the Endoscopy Trainees in the One-on-One Training Environment

SBML will not replace the one-on-one method. Rather, we envision that SBML will simply complement and significantly enhance the current one-on-one training method.[15] In our previous experience, we observed that trainees who have completed the SBML curriculum had a higher endoscopy skill to begin with and progressed

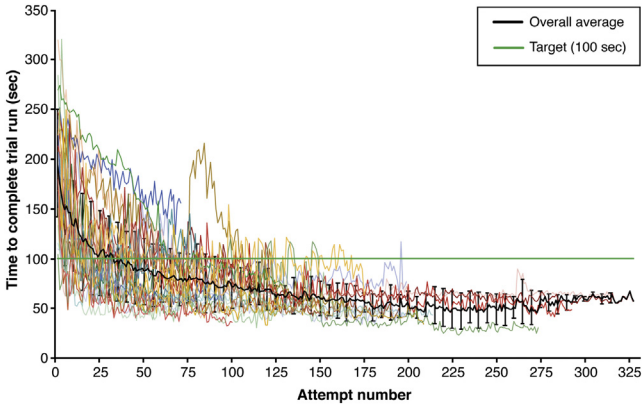

Figure 2. Results from using the Endoscope Tip Control simulator. The more the learners are able to maneuver the control knobs of the endoscope using all fingers, the faster they complete the activity. The minimum passing standard (MPS) was set to values derived from expert endoscopists (<100 seconds).[18] All except 1 trainee met the MPS.

at a faster rate to attain competence. Notably, mastering tip deflection control and performing structured esophagogastroduodenoscopy examinations equipped them to rapidly develop proficiency in the basic therapeutic maneuvers. In the pilot program, we have demonstrated that trainees who successfully completed our SBML program for upper endoscopy achieved competency at a rate 2.5 time faster than trainees who underwent traditional training. Herein we describe our approach in further developing and remotely facilitating our SBML program for standardized upper endoscopy to a larger cohort.

Methods

Delivery of the SBML Course

We conducted a 6-week SBML mandatory upper endoscopy training for first-year gastroenterology fellows (n = 28) for the Philippines Society of Digestive Endoscopy starting August 2019. The SBML involved (a) learning fine-tip control, (b) structured upper endoscopy examination, and (c) endoscopic therapies. Simultaneously, they learned the appropriate knowledge base underlying these skills and, equally important, the interpretation of endoscopy findings: understanding what they were seeing, diagnosing it, and knowing proper nomenclature. The knowledge base materials were delivered through an interactive online learning management system (Canvas, Instructure, Salt Lake City, UT) that features atlases on common gastrointestinal pathologies, classification systems, anatomy, treatment plans, perioperative assessments, endoscopic therapies and procedural instructional videos.[16–19] The course was delivered in a sequential fashion (Figure 1*A*). We then used tip deflection simulators (Academy of Endoscopy, Woodside, CA) and upper gastrointestinal tract models (Koken Co., Ltd, Tokyo, Japan) for training 1-hand fine tip control and upper endoscopy examination (Figure 1*B*, *C*). We delivered the simulators to their respective training centers at the start of training.

In the first 5 weeks, we conducted the training through virtual coaching at regular time intervals using a secure messaging application (Viber; Rakuten Inc, Luxembourg). A dedicated instructor (RS) observed their performance, provided feedback, and monitored their progress. We set a MPS for 1-hand fine tip control based on the scores reported for experienced endoscopists in a prior study. Trainees learned fine tip control at their own pace over a 4-week period; they video recorded their performances weekly for assessment and registered the number of attempts and completion time for each attempt. Once they met the MPS, they progressed to standard upper endoscopy examination in the dedicated simulator. The trainees practiced deliberately with virtual guidance from the instructor until the MPS was reached.

In the last week, we conducted a 2-day small group (4 per team) in-person hands-on experiential training using the silicone model and explant tissues. In this session, we first conducted a simulation-based assessment to verify if the trainees were able to apply the learned skills and perform a structured upper endoscopy examination in a stepwise fashion. Once verified, they learned endoscopic therapies (biopsy, photo documentation, endoscopic clipping, dilation, electrosurgery, coaptive coagulation, argon plasma coagulation, band ligation, application of hemospray, and transnasal endoscopy). Trainees were required to demonstrate competence in all the sections of the endoscopy hands-on curriculum, tip deflection, structured examination, biopsy and clipping techniques, and proficiency in performing and assisting the remaining therapeutic procedures. The instructors evaluated their technical skills by using a 10-point Likert scale (1 [need repeat training] to 10 [ready to perform in patient settings]). At the end of the session, we administered a 20-question final knowledge assessment, based on their assigned readings and lectures, and compared their scores with our prior pilot study from a different cohort.

Results

Demographics

We enrolled 28 fellows (17 male, 11 female; mean age, 30.8 ± 1.7 years) from 18 institutions across the Philippines. The majority of the fellows were right handed (n = 23 [82%]), 4 (11%) were left handed, and 1 (4%) was ambidextrous. They reported significant video game experience (n = 14 [50%]), athletic performance (n = 11 [39%]), and musical instrument training (n = 8 [29%]). Before the SBML course, the fellows had performed 11.5 ± 10.0 esophagogastroduodenoscopies (range, 0–30) and 1.1 ± 1.9 colonoscopies (range, 0–5).

Endoscopy Fine Tip Control and Virtual Coaching Sessions

All except 1 fellow (96%) met the MPS for endoscopy fine tip control and developed one-hand handling capability with speed and form similar to those of expert endoscopists (Figure 2). The instructor hosted 7.9 ± 3.1 virtual coaching sessions on average for each trainee.

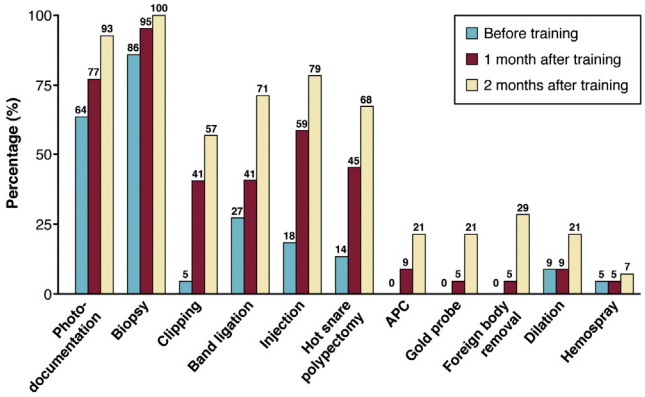

Figure 3. Adoption rate of the trained techniques.

Knowledge Base Assessment

A majority (n = 25 [89%]) met the MPS (14 of 20 points [70%]) for the knowledge base assessments. The mean score was 15.4 ± 2.0 (76.7% ± 10.02%; range, 9–19), which was comparable with the score of the pilot group (15.1 ± 1.9; $P = .7$).

Structured Esophagogastroduodenoscopy and Therapies

In the hands-on session, the instructors rated the fellows' technical skills highest for structured examination (8.2. ± 0.74 out of 10; 10 being the highest) and lowest for coaptive coagulation (7.30 ± 0.67). The remaining therapies were rated highly: biopsy (7.9 ± 1.1), argon plasma coagulation (APC) (7.8 ± 0.9), band ligation (7.8 ± 1.2), hemospray (7.8 ± 1.0), and balloon dilation (7.4 ± 0.9).

Feedback

We collected feedback on our SBML training program at the end of the course. The fellows rated their satisfaction highly (5 highest): endoscope handling simulator (4.5 ± 0.5), virtual coaches (4.5 ± 0.6), online modules (4.6 ± 0.5), and the overall training system (4.9 ± 0.2). Eleven fellows (42.3%) suggested more time for the hands-on sessions. All fellows indicated that they would recommend this course to others. One of the fellows remarked how, "instructors were dedicated to teach every step of the workshop. No time wasted, every minute was a learning experience," with another indicating because of the course, "[they] got to try and practice most therapeutic interventions that [they] only read in books and seldom do in [their] hospital."

Adoption Rate

We monitored fellows' adoption of learned skills in clinical practice 2 months after SBML program using an online survey. We found a majority have used the techniques coached in the SBML program (Figure 3). They reported that they incorporated the various techniques taught in the course into their clinical practice. They reported no complications.

Limitations

Our observations ought to spur further development of other SBML programs in endoscopy and creation of low-cost biorealistic simulators. Although there is limited availability of lifelike high-fidelity endoscopy simulators, and those currently available have allowed us to conceptualize SBML into the training programs. The development of the SBML curriculum requires significant time and effort, although the payoff also seems to be significant. We envision that SBML programs for more advanced procedures will be developed over time. Our early experience with SBML using explant tissues suggests that trainees and practicing endoscopists can learn complex techniques, such as clipping over the scope,[20] percutaneous gastrostomy placement, esophageal and enteral stent placement, and endoscopic cyanoacrylate injection into gastric varices.

The translational science of educational outcomes cannot be achieved from a single study, but rather it requires programs that are thematic, sustained, and cumulative.[15] Objectively measured translation science in this study is limited to the simulated setting as our report on the adoption rate of the skills might be subjective. However, given that SBML is a new concept in endoscopy, we had to rely on several international faculty to conduct the course. They were not able to directly measure the transfer to downstream patient care. Future efforts will need to educate and standardize the methods to evaluate competency in endoscopy.

Summary

COVID-19 brings vulnerability, uncertainty, complexity, and ambiguity to endoscopy education. The opportunities for fellows to hone their skills and prepare for independent practice may become limited. To optimize and improve their learning opportunities, we will need to adapt contemporary methods of learning: ML and SBML. These methods allow for structured training by deliberate practice with feedback. We need to require learners to demonstrate mastery of endoscopic skills on the simulators prior to performing procedures in clinical care. In doing so, we ensure safety and deliver quality treatment for our patients. The collective enthusiasm observed among the trainees, their interest to learn endoscopy through virtual SBML, and the rewarding outcome witnessed as never before, lends support to widespread renewal of endoscopy training methodology in the post-COVID era.

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Acknowledgments
The authors thank Dr. Carlo Lazaro, Dr. Angela Djajakusuma, and Dr. Eric Yasay for lending their time and expertise during the hands-on workshop. The authors thank Mr. Steven Chan from Whizlink, PTE, Singapore for his administrative and technical support.

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Funding
The study was supported in part by the Asian Novel Bio-Imaging and Intervention Group (ANBIIG).
Funding for the Mastery Learning program used in this report was supported, in part, by a gift from the Academy of Endoscopy and a grant from The Asian Endoscopy Research Forum. The authors thank the Philippines Society of Endoscopy President 2019 and Board staff for their immense support.

Conflicts of interest
The authors have made the following disclosures: Dr Soetikno is a consultant for Olympus Corp. and Fuji Corp. Dr Kaltenbach is a consultant for Olympus Corp., Medtronic, and Aries Pharmaceuticals. Dr De Lusong and Dr Cabral-Prodigalidad have nothing to disclose.

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0016-5085/$36.00
https://doi.org/10.1053/j.gastro.2020.06.096