

Stimulation through simulation. The use of simulators in gastrointestinal endoscopy training

I.A. Mouzas

Medical education, like any education that deals with operating skills, can become much more efficient and unrestricted to limits of time and space through appropriate use of technology, especially simulation methods. When talking about simulation, what is usually cited is its most successful implementation in aviation, where the concept of flight simulation as a training tool is a well established. In the aeronautical industry they refer to “transfer efficiency ratio” i.e. the correlation between the time spent training on a simulator and real in-flight training.¹ Experienced pilots are trained extensively on land-based flight simulators in order to be certified to fly a new aircraft. Some years ago, the US Navy adopted the commercially available, inexpensive “Flight Simulator” program of Microsoft as standard training for its new pilots, after trainees who practiced extensively on this program recorded highly on initial training flights.²

TRAINING IN ENDOSCOPY

Performing an endoscopy requires skills. Technical skills represent only one aspect of competency. Other important aspects such as informing the patient, interpreting the findings, deciding on therapeutic interventions during endoscopy, and planning the next steps are very important factors of competence. The minimum number of endoscopic procedures required for achieving technical competence, according to different organizations, is 100-300 for gastroscopy, 100-180 for colonoscopy and 100-200 for ERCP.³ However, there are data showing that real minimum numbers may be even

higher. Still, in real life, guidelines with recommendations on acquisition of endoscopic technical skills are very difficult to implement as proposed. These difficulties, in conjunction with the pressing demand for quality assurance in endoscopy, increase the grade of responsibility of everyone involved in training programs in endoscopy. Trainers are usually short of time and have to deal with a pressing workload; trainees are often too many so there is a lack of teaching time, and any contribution towards overcoming time and space limits has to be acknowledged. Simulation methods can reliably accomplish this.

In endoscopy training the rules of learning theory are implemented, according to which, students progress through three continuous phases of learning. They first go into a cognitive phase, in which they understand the basic steps of a task. Then, they progress to an assimilation or integrative phase, in which the basic steps are translated into psychomotor action. In the autonomous phase after tedious and repetitive practice, which may last for a shorter or longer period, the performance of the task becomes independent and skills are executed automatically with little cognitive contribution.⁴ Endoscopy simulators take advantage of the learning process. Although individual practice with real patients cannot be completely replaced by simulators, a realistic and didactic simulator is of great value for development of skills and technical progress prior to performing endoscopy in patients.

MECHANICAL AND ANIMAL SIMULATORS

Mechanical and animal simulators have been the first approach in simulation-assisted endoscopy training, as they are inexpensive and easy to build. However, the interaction between trainee and simulator is missing and multiple models, for the three main procedures - upper, lower endoscopy and ERCP - are needed.

University Hospital, Medical School, Heraklion, Greece

Author for correspondence

I. Mouzas, Metochi Vardari, P.O. box 1340, 71001 Crete,
Tel.: 2810 262405, e-mail: mouzas@med.uoc.gr

Mechanical models of historical importance are the “hair-dryer tube” (1975) and the “St Mark’s Colon Model” (1980), both developed by the St Mark’s group. The most advanced mechanical model for all three main procedures has been developed by the Tóbingen group. It is a life-like dummy, with artificial tissue for therapeutic intervention. This model is available for workshops of advanced training. As for the animal models, the assistance of specialized personnel is needed for the simulator’s set up.

Animal models provide a realistic feeling of tissue. Most used animal simulators are the two Erlangen models, “Endo-trainer” and “EASIE”, developed by the Erlangen group.⁵ In these models the gastrointestinal tract, liver and pancreas of slaughtered pigs are installed inside a synthetic radio-translucent dummy shaped as a human torso that is provided with a synthetic radiopaque spine. A perfusion system can generate realistic bleeding episodes and artificial stones can be placed in the desired position of the biliary tract during the preparation of the pig organs. These models reliably reproduce the conditions encountered during most diagnostic and therapeutic endoscopies in humans. The Erlangen “Endo-trainer” has been implemented in many endoscopy workshops, mainly for diagnostic and therapeutic ERCP procedures.

COMPUTER SIMULATORS

The rapid development in inexpensive computer power and advanced three-dimensional modelling software due to the demands of commercial computer games has dramatically changed the situation in endoscopy simulators. Several companies developing systems for endoscopy have applied these techniques in developing simulators. Hardware and software come together to suggest a sensation of a real endoscopic procedure. Audible feedback may be added, indicating patient’s annoyance. An apparently standard endoscope may be used, with physically activated air insufflation, water-wash, and suction buttons enforcing the feeling of a real endoscopic procedure. The mechanical part of these systems takes into account the real endoscopy sensation, using advanced algorithms that control special force feedback devices. The computer stores information concerning the movement and the location of the endoscope from the beginning of the procedure, through sensors located on it. The trainee receives the resistance sensation simultaneously with visual feedback displayed on the monitor.

There are currently three main computer-based simulators: Symbionix (Israel), Immersion (USA) and St Mark’s (UK) simulators. The Symbionix simulator (GI Mentor) uses all functions of an actual endoscope, as well as force feedback, and is real-time interactive. It provides training modules for upper and lower GI endoscopy, ERCP and diagnostic and therapeutic special procedures with gradual increase in performance.³ The Immersion simulator (PreOp and HT Immersion Medical Colonoscopy Simulator) is available, for the time being, only for lower GI endoscopy. It uses all functions of a colonoscope with force feedback. Modules of increasing complexity are available. There is user interaction with system-imposed events. The St Mark’s teaching simulator also uses an actual endoscope with force feedback for instrument controls and shaft movements. Interactive graphics and other teaching and assessment features are incorporated. However, this simulator is not yet commercially available.⁶ The cost of computer endoscopy simulators, including the basic platform, endoscopes and 10-50 modules, is in the range € 20000 - € 30000.

ENDOSCOPY SIMULATORS IN THE FUTURE

With computer simulated training, not only trainees, but also under performing as well as expert endoscopists could get new insights into problem cases and work out solutions. Continuous monitoring of competence will be easier through accurate recording of precise outcome measures.

However, at present, there is a need for validation of endoscopy simulators in terms of their capacity to distinguish between various levels of endoscopic expertise, decreasing the time needed to get competence in endoscopy novices, and enhancing the learning process in the short and in the long term.

It has already been shown in several studies that computer simulators are powerful and valid discriminants of operational skills in colonoscopy and gastroscopy, distinguishing between experienced, intermediate endoscopists and novices, by the use of several outcome measures.⁷⁻¹⁰

It remains for the endoscopic community to initiate a systematic evaluation and ascertainment of the impact of the endoscopy simulator on the learning process in the short and long term. In this way we could determine how simulators should be improved further and what their role will be in future training activities. In any case, simulators will be best implemented as part of an

integrated educational approach in institutions where also “hands-on” teaching is being carried out.

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