ADVANCES IN GERD

Current Developments in the Management of Acid-Related GI Disorders

Section Editor: Prateek Sharma, MD

Simulators in Training for Upper Gastrointestinal Endoscopy

Karen L. Woods, MD
Houston Methodist Gastroenterology Associates
Underwood Center for Digestive Disorders
Houston, Texas

G&H How has endoscopic training evolved over the years?

KW The method used to teach endoscopy has changed very little over the years. Training occurs in the endoscopy unit with live patients and attending physician supervision. Trainees rely on the teacher to be able to break down the component skills of the procedure and verbally communicate them to the trainees, who, with repetitive instruction, eventually master the procedure. It is now recognized that while this strategy has worked over the years, there has been no standardized mechanism for objectively assessing endoscopic competency of graduating trainees. To this end, significant advances have been made in this area with the development of validated competency assessment tools for esophagogastroduodenoscopy, colonoscopy, endoscopic retrograde cholangiopancreatography, and, most recently, endoscopic ultrasound. These direct observational tools can be used to monitor the learning curve and adapt teaching to the needs of the individual trainee. Incorporating this type of assessment into the teaching model should ensure competence of the graduate at fellowship completion.

G&H What is the role of gastrointestinal endoscopy simulators in training?

KW The major advantage of using a simulator, at least early on in training, is that the trainee has a chance to practice skills repetitively in a learner-centered, risk-free environment as opposed to a high-stress, real-life patient care environment. Maneuvering the endoscope can be mastered on any number of simulator models, which has been shown to help trainees reach proficiency sooner in some of the basic skills that are necessary to perform endoscopy.

> ... the benefit of simulator-based training for upper gastrointestinal endoscopy procedures is most pronounced when simulator models are used early in training ...

G&H What are the different types of simulator models that are available for learning upper gastrointestinal endoscopy procedures?

KW There are essentially 4 major types of simulators: mechanical models, which are made from various types of

nontissue materials such as plastic tubing and wires; live animal models; composite animal organ simulators using explanted organs; and virtual reality trainers.

G&H What are the benefits and limitations associated with each simulator model?

KW Mechanical models can simulate certain aspects of endoscopic procedures but cannot easily replicate realistic tissue simulation, also known as haptic feedback. These models are most useful in the early stages of learning.

Live animal models provide the most realistic experience in terms of haptic feedback and working with the same organs that would be encountered in humans. These models also offer the ability to create real-life scenarios wherein complications can occur requiring management, which lends itself to full immersion in the procedure. Swine are the most commonly used model; however, their anatomy is slightly different than that of humans, meaning some modifications to the procedure may be required. Additionally, live animal models are one of the most expensive and labor-intensive ways to perform simulation, and are likely the least commonly used model to teach basic upper gastrointestinal endoscopy procedures.

Explanted simulators use animal organs that are mounted onto a plastic base or model and set up to allow an endoscope to pass directly through. Explanted organ models exist for nearly every endoscopic procedure, provide better haptic feedback than mechanical models (although not as good as a live animal model), and allow for the use of actual endoscopic accessories. Explanted organ models are also less expensive than live animal models, although they do require some infrastructure in order to be able to have them readily available.

Virtual reality trainers incorporate haptic feedback along with a visual image of the procedure. They can be programmed to replicate many different types of procedures, as well as to reproduce looping of the endoscope, patient discomfort, and complication management. A universal catheter is used through the working channel of a replica endoscope that converts to the desired therapeutic instrument for the procedure. Virtual reality models are easier to access for training than are live animal models; however, they are expensive—approximately $100,000 for the more common ones that are available—which may limit their use.

G&H How are these simulators validated?

KW Simulators should replicate the look and feel of the content that is being taught and have the ability to both distinguish between a novice and an expert operator (ie, construct validity) and predict competence in the endoscopy suite upon completion of simulator training (ie, predictive validity). The majority of simulators can pass construct validity, but fewer have been able to note a correlation between mastery on the simulator and clinical endoscopic competence. In 2012, the American Society for Gastrointestinal Endoscopy published an assessment of endoscopic simulators with the goal of defining the necessary benefits to justify the incorporation of simulator-based training. Two metrics were provided: (1) simulator training should decrease by 25% or more the number of procedures necessary for a novice to reach minimal competency for that procedure, and (2) simulators should be able to meet minimal competency thresholds with a kappa value of at least 0.7. To date, there is limited validity evidence for simulation-based assessment of endoscopic skills, and no simulator assessment currently meets the above criteria for a skills assessment tool.

G&H How effective are simulators for training for upper gastrointestinal endoscopy procedures?

KW According to studies on this topic, the benefit of simulator-based training for upper gastrointestinal endoscopy procedures is most pronounced when simulator models are used early in training; any advantage of the training seems to disappear after approximately 50 procedures. However, virtual reality and explanted organ models are beneficial for replicating more advanced procedures that require skill and repetition to achieve competency.

G&H What are the barriers to incorporation of simulators in training programs?

KW Cost is a barrier to the incorporation of most simulators. The mechanical models are, relatively, the least expensive simulators and can be found in most laboratories. Both live animal and explanted organ models require costly infrastructure and support, which limits access to ongoing use for the learner. Virtual reality simulators have huge potential but a high upfront cost, and they still need some refinement on the realism conveyed during the procedure.

G&H Can simulation training supplement, or will it replace, early conventional endoscopy training?

KW Supplementing conventional training with simulators, especially in early training, is absolutely helpful. However, simulators are not likely to replace conventional

endoscopy training at this point in time. As new simulators come along, we may find something that will replicate reality in such a way that allows for competency or near competency to be achieved on the simulator before entering the clinical arena. Validity will be key.

G&H What research is needed in this field?

KW It would be beneficial to better understand the effectiveness of using a simulator for both the cognitive and technical aspects of performing a procedure. Guidelines are needed for specific procedures that would outline best practices as to where to incorporate a particular simulation in the training process. There may be some models that are better for use at the very beginning, some that are more suited for mid-fellowship training, and some that are more appropriate for the advanced endoscopic arena. We also need easily available avenues for practicing endoscopists to learn new techniques or improve the way they are performing older techniques, and through training or upskilling could improve the quality of care delivered.

Dr Woods has no relevant conflicts of interest to disclose.

Suggested Reading

Dubé C, Rostom A. Acquiring and maintaining competency in gastrointestinal endoscopy. *Best Pract Res Clin Gastroenterol*. 2016;30(3):339-347.

Ekkelenkamp VE, Koch AD, de Man RA, Kuipers EJ. Training and competence assessment in GI endoscopy: a systematic review. *Gut*. 2016;65(4):607-615.

Khan R, Plahouras J, Johnston BC, Scaffidi MA, Grover SC, Walsh CM. Virtual reality simulation training for health professions trainees in gastrointestinal endoscopy. *Cochrane Database Syst Rev*. 2018;8:CD008237.

Kim GH, Bang SJ, Hwang JH. Learning models for endoscopic ultrasonography in gastrointestinal endoscopy. *World J Gastroenterol*. 2015;21(17):5176-5182.

Mahmood T, Scaffidi MA, Khan R, Grover SC. Virtual reality simulation in endoscopy training: current evidence and future directions. *World J Gastroenterol*. 2018;24(48):5439-5445.

Singh S, Sedlack RE, Cook DA. Effects of simulation-based training in gastrointestinal endoscopy: a systematic review and meta-analysis. *Clin Gastroenterol Hepatol*. 2014;12(10):1611-1623.e4.

van der Wiel SE, Küttner Magalhães R, Rocha Gonçalves CR, Dinis-Ribeiro M, Bruno MJ, Koch AD. Simulator training in gastrointestinal endoscopy—from basic training to advanced endoscopic procedures. *Best Pract Res Clin Gastroenterol*. 2016;30(3):375-387.