Pre-clinical Training for New Notes Procedures

From Ex-vivo Models to Virtual Reality Simulators

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KEYWORDS

• NOTES • New NOTES • Endoscopic surgery • Simulation • Training

KEY POINTS

- The field of natural orifice transluminal endoscopic surgery (NOTES) has evolved over the past decade.
- There is immense clinical and research interest in the current new NOTES procedures, and this version of NOTES is likely here to stay.
- With that comes the responsibility to inform health practitioners and effectively train those who may perform these procedures now and in the future.
- Given the complexity and distinct skills required of NOTES, simulation will continue to play a prominent role in the training paradigm for NOTES.
- It is likely that simulation will decrease the lengthy learning curves for these procedures. Simulation research will also continue to advance the developmental endoscopy field.

INTRODUCTION

Natural orifice transluminal endoscopic surgery (NOTES) is a relatively new field of advanced endoscopic surgery that has undergone dramatic development and evolution since its inception in 2004 with the seminal description of a transgastric peritoneal

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access by Kalloo and colleagues.[1] The history of NOTES has been described elsewhere, and thus is not addressed within this paper.[2]

Early in the evolution of NOTES, there was a vigorous interest in NOTES approaches to standard and frequent laparoscopic operations, such as the cholecystectomy and appendectomy. Perhaps predictably, given the high standards for safety and efficacy of existing laparoscopic techniques for those common operations, many have not been convinced that moving to a NOTES approach can improve upon the current gold standard laparoscopic approaches. Those traditional procedures are referred to as "first-generation NOTES." The field in general has pivoted to concentrating research and clinical efforts on novel minimally invasive approaches to pathology within the luminal wall and adjacent to the luminal wall. Peroral endoscopic myotomy (POEM), submucosal endoscopy, full-thickness endoscopic resection (EFTR) of subepithelial tumors and peroral pyloromyotomy are examples of this new paradigm, which has been called new NOTES or "near NOTES."

As with any emerging technology, simulation provides a safe introduction of the technique to the clinic. This is important for new NOTES for several reasons. First, new NOTES procedures requires unique skills that are distinct from standard advanced endoscopic procedures, such as a requirement to have expertise of transluminal anatomy, and mastery in submucosal dissection and various novel endoscopic tools. Furthermore, there needs to be crisp and collegial communication and teamwork between endoscopic and surgical interplay (or backup) for such procedures. Some procedures treat relatively rare pathologic entities (such as achalasia for POEM). Other new NOTES procedures that require submucosal tunneling are born out of endoscopic submucosal dissection (ESD) techniques that were developed in Asia. The training ground is completely different there given the vastly higher number of superficial gastric malignancies that are treated endoscopically there. For these, simulation is critical to supplement low case volumes for new NOTES procedures.

In this review of simulation and training in NOTES, we discuss the importance of simulation in NOTES, describe available simulators and comment on the need for multimodal training. We emphasize developments in ex vivo simulation in new NOTES techniques and also development of virtual reality (VR) NOTES platforms, the 2 most dynamic aspects of NOTES simulation training currently.

OVERVIEW OF NATURAL ORIFICE TRANSLUMINAL ENDOSCOPIC SURGERY SIMULATION

NOTES procedures are universally complex and advanced. They have been developed and studied by world-renowned endoscopists and surgeons, and require exceptional endoscopic skill to be accomplished safely and effectively. Given that NOTES procedures are complex endoscopic tasks that require the development and modification of endoscopic skills that even general experienced endoscopists do not carry, simulation carries an important role in the training environment of NOTES.

Unlike using a novel endoscopic accessory such as a snare that requires little if any specific training before using in clinical practice, NOTES requires mastery of specific skills, such as detailed anatomic understanding, expertise in needle knives and electrosurgery, familiarity with novel endoscopic devices, comfort with closing full-thickness luminal defects and submucosal endoscopy, all of which require practice and dedicated study. The training environment requires repeated skills building with expert guidance, all of which lends well to simulation training.

Available simulation options for NOTES include mechanical simulators including part task trainers to fine tube basic endoscopic skills and full procedure NOTES