# How We Do It: Creation of a Low-Cost Endoscopic Skills Model for Fundamentals of Endoscopic Surgery Training

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**OBJECTIVE:** To design a low cost, high fidelity endoscopic skills model to help surgical trainees pass the Fundamentals of Endoscopic Surgery (FES) testing.

**DESIGN:** A homemade synthetic colon model was designed using liquid silicon and other commercially available products. The construction and design of the model is described here. The model was then successfully integrated into our simulation curriculum and endoscopic skills training modules.

**SETTING:** Cleveland Clinic Foundation, Cleveland, Ohio; large academic quaternary referral institution.

**PARTICIPANTS:** PGY 1-5 general surgery residents preparing for Fundamentals of Endoscopic Surgery testing.

**RESULTS:** A versatile, high fidelity model was designed for a total cost of approximately 25 dollars per unit. The model can be used with clinical endoscopic towers and easily integrated into an institution's simulation and endoscopic training curriculum. The flexibility of design allows trainees to practice all of the key motor skills necessary for FES examination success.

**CONCLUSIONS:** A homemade endoscopic colon model can be constructed at an affordable price point using commercially available materials. These models have significant versatility, low cost, and flexibility of design allowing for easy incorporation into a surgical residency simulation training program. (J Surg Ed 76:1456–1459. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

**KEY WORDS:** Surgical simulation, Endoscopic training, Simulation model design, Fundamentals of Endoscopic Surgery

**COMPETENCIES:** Patient Care, Medical Knowledge

## INTRODUCTION

As a recent requisite of sitting for the American Board of Surgery (ABS) Qualifying Examination, general surgery trainees are required to complete the ABS Flexible Endoscopy Curriculum.[1] The curriculum culminates with passing the Fundamentals of Endoscopic Surgery (FES) examination provided by the Society of American Gastrointestinal and Endoscopic Surgeons. While acquisition of clinical experience has previously been the mainstay of training endoscopic skills, there is also literature to suggest that additional training modules may be necessary in order to pass the exam.[2] The ABS does not mandate the use of any specific training resources for exam preparation, and a variety of endoscopic simulators are commercially available to supplement clinical practice. Commercially available modules are limited in their practicality due to significant cost and allowance for only one user to practice at a time.[3,4] Recognizing the limitations of these models for larger residency classes, we designed a low-cost endoscopic simulator that provides high task fidelity at a low financial and time cost.

## MODEL DESIGN

Our endoscopic model consists of a flexible silicon sleeve that can be used with any standard endoscopic tower

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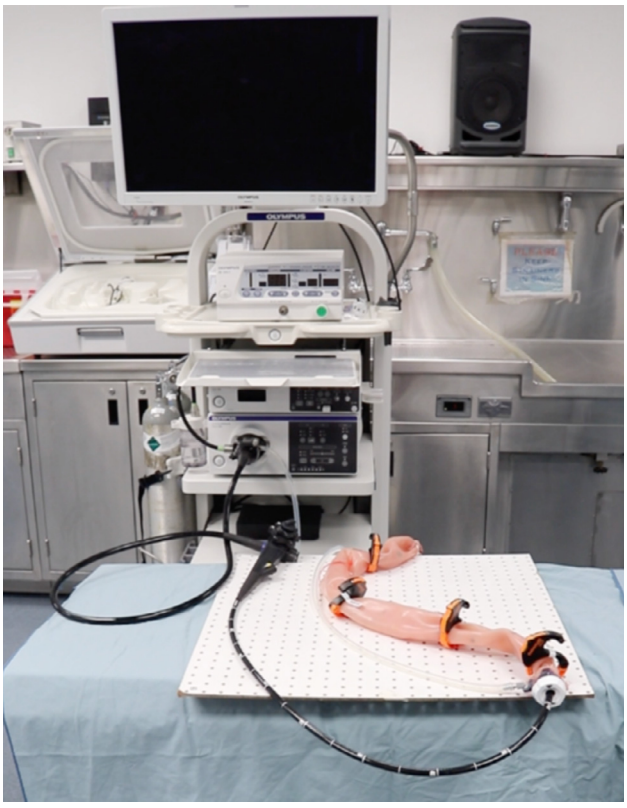

**FIGURE 1.** Fully assembled model connected to a standard endoscopic tower.

(Fig. 1). To create the silicon sleeve, a commercially available moderately quick curing silicon liquid is spread evenly over a hollow $1\frac{1}{4}$ inch PVC cylindrical tube in several coats and allowed to cure. Length of silicon application and resulting sleeve can be varied depending upon desired use. Mucosal lesions are created from colored quick curing silicon and are then dotted across the silicon sleeve using a syringe applicator. Once completely dried, the sleeve is carefully peeled from the tube, inverting the lesions to the inner lining. Mucosal lesions can be applied in a variety of patterns, sizes, and colors depending on the desired difficulty. The end of the sleeve is sealed with a zip tie and a 12 mm laparoscopic port is attached to the starting end. The sleeve is then attached to a hardboard peg board using a combination of anchoring Cable Clamps (QA Worldwide Inc, Clearwater, Florida) and zip ties, both of which are readily commercially available. The peg board and clips setup promotes versatility of sleeve positioning allowing the designer to create various shapes and turns mimicking the natural variability of intra-abdominal colonic attachments. Task difficulty can be readily modified by repositioning the silicon tube around the peg board. The silicon sleeve is then distended using the insufflation connection from the endoscopic tower through the insufflation port on the laparoscopic port. Silicon lubrication is sprayed down the sleeve and a standard endoscope can then be introduced through the laparoscopic port. Assembly and real time endoscopic video can be seen in Figure 2.

## MODEL BENEFIT

Similar to other endoscopic simulators, our model allows trainees to practice basic endoscopic navigation, tip deflection, and torqueing skills which are all necessary elements of the FES examination. Due to the pliability of the silicon sleeve, trainees are also able to practice retroflexion with the added benefit of haptic feedback not present in many simulators. Additionally with the use of insufflation, trainees are able to utilize all the functions of the endoscope including suction and irrigation, providing a more realistic user experience. Models can also be designed with mucosal lesions that can be biopsied using the variety of endoscopic tools, allowing practice of tool targeting, and lesion retrieval skills. A modification is also available using mesh netting and peg board anchors to create a loop reduction model.

Once use of the model is completed, the silicon sleeves can be easily exchanged for different versions providing the trainee with a variety of simulated scenarios. The models can also be easily disassembled and stored with no special considerations required. The sleeves are extremely durable and can be used dozens of times by multiple trainees without any impact on the functionality. Models designed specifically with biopsy lesions, however, are limited by the number of lesions placed a time of creation. Repeat use of these specific models would require replacement of the biopsy specimens after several uses.

The models are easily transportable and can be utilized with most existing endoscopic towers. Many institutions do not have extras of this type of equipment for training use. The model, however, is lightweight and can be readily moved to the endoscopy suite for practice. The model and lubricant do not impact the ability to use the endoscope on patients after processing. The sum of these various functions is a realistic and comprehensive endoscopic model that can be designed, created, and implemented with relative ease.

## MODEL LIMITATIONS

Limitations of the model include the upfront construction time and space requirement to create the model. Construction requires approximately 1 hour and an additional 3 to 4 hours to allow for silicon curing. While ease of creation improves with every model created, no specialized

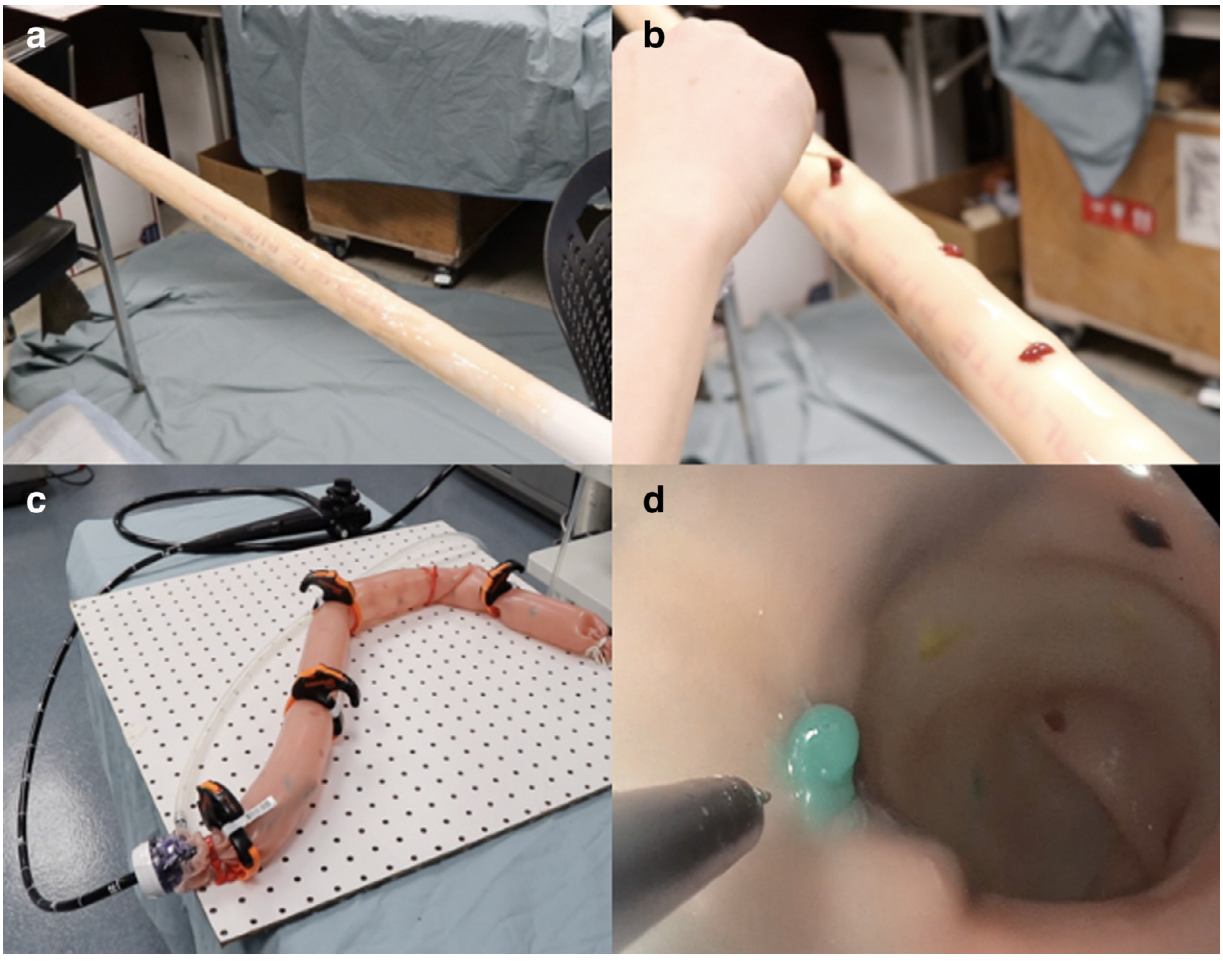


**FIGURE 2.** (a) Moderately quick curing silicon is spread evenly over PVC pipe. (b) Colored silicon is dotted across the dried sleeve to create internal mucosal lesions. (c) The fully assembled sleeve is anchored to a peg board and then attached to the endoscopic tower insufflation tubing. (d) Video images from the endoscope demonstrate the internal appearance of the model and ability for mucosal inspection and tool targeting.

expertise or skills are required for construction. All materials with the exception of the endoscope and associated tower are commercially available. Total supply cost is approximately 25 dollars per model with reduced cost per model once the upfront supplies have been purchased.

## CURRICULUM INTEGRATION

We have integrated the use of these models into our comprehensive endoscopic simulation curriculum. We have designed various levels of difficulty for each FES skill: basic navigation, mucosal evaluation, tool targeting, and loop reduction. These models are used as a supplement to practice time on the virtual reality simulator on which the FES examination is administered. The use of these models has allowed for larger group training and eliminated the bottleneck effect of training time on the virtual simulator.

While formal evaluation and validation of this model is pending, anecdotal feedback from both trainees and faculty has been overwhelmingly positive. The high visual and tactile fidelity, model versatility, and the use of real endoscopes instead of training models have all been cited as benefits of this new system. The ability for this feedback to be translated into testing success remains to be seen, but as others have demonstrated[5,6] despite their low costs, homegrown models have the ability to provide equal educational efficacy compared to cadaveric or commercial models.

## CONCLUSIONS

Resident preparation for the FES skills examination requires a multimodal trainee experience including clinical and simulation-based practice. The utility of many currently available endoscopic simulation models is limited by their cost. Our low-cost model fills a need for a

high-fidelity practice model that can be easily implemented at a variety of surgical training programs.

## REFERENCES


1. American Board of Surgery. 2014. *Flexible Endoscopy Curriculum for General Surgery Residents*. Available at: https://www.absurgery.org/xfer/abs-fec.pdf.
2. Gardner AK, Scott DJ, Willis RE, et al. Is current surgery resident and GI fellow training adequate to pass FES? *Surg Endosc*. 2017;31:352–358.
3. Triantafyllou K, Lazaridis LD, Dimitriadis GD. Virtual reality simulators for gastrointestinal endoscopy training. *World J Gastrointest Endosc*. 2014;6:6–12.
4. Ritter ME, Taylor ZA, Wolf KR, et al. Simulation-based mastery learning for endoscopy using the endoscopy training system: a strategy to improve endoscopic skills and prepare for the fundaments of endoscopic surgery (FES) manual skills exam. *Surg Endosc*. 2018;32:413–420.
5. AlJamal Y, Buckarma CN, Ruparel R, Allen S, Farley D. Cadaveric dissection vs homemade model: what is the best way to teach endoscopic totally extraperitoneal inguinal hernia repair? *J Surg Educ*. 2018; 75:787–791.
6. Jones MW, Deere JM, Harris JR, Chen AJ, Henning WH. Fabrication of an inexpensive but effective colonoscopic simulator. *JSLS*. 2017;21:e2017.


## SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jsurg.2019.06.005.