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Fundamentals of Anorectal Technical Skills: Using Deliberate Practice with Adaptive and Perceptual Learning for Surgical Education

By

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Thesis submitted to the Faculty of the Health Professions Education Graduate Program, Uniformed Services University of the Health Sciences, in partial fulfillment of the requirements for the degree of Master's in Health Professions Education 2020

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February 25, 2020

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02/25/2020

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ACKNOWLEDGEMENTS

I would like to begin by thanking Dr. W. Brian Sweeney for the inspiration to begin this project. In addition to helping me grow as an educator, Dr. Sweeney has been instrumental my development as a surgeon. He is the epitome of a surgical innovator, and I am forever grateful for his mentorship, both in the lab and in the operating room.

I would also like to take the opportunity to thank Dr. E. Matthew Ritter, who has been my program director both for my general surgery residency and for my surgical simulation and education fellowship. His example as a surgical educator jumpstarted my own interest in education, and his expert guidance through constructing research questions and developing programs of research has made me a better researcher and a better writer.

Finally, I would like to thank Dr. Steven Durning, Dr. Anthony Artino, and the rest of the Health Professions Education faculty for their mentorship and guidance through the process of this thesis and degree. Learning how better to instruct students and junior residents has been an important step for me in transitioning to my current role as a chief resident and in preparing for my future role as staff. I would especially like to express my gratitude for Dr. Durning, Dr. Artino, and Dr. Holly Meyer for their continued encouragement for finishing this thesis and completing my degree. Thank you all for your help; it has been greatly appreciated.

DEDICATION

This thesis is dedicated to my wife, Caitlin. I am eternally grateful for your love, support, and patience, not only through the process of writing this thesis, but throughout the last six years through residency. I know this process has not been easy at times, but I could not have done any of this without you. Thank you, and I love you.

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Walter Kucera, MD
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23 March 2020

ABSTRACT

Fundamentals of Anorectal Technical Skills: Using Deliberate Practice with Adaptive and Perceptual Learning for Surgical Education

Walter B Kucera, MD, 2020

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Purpose: This thesis seeks to evaluate the efficacy of this course through the lens of adaptive and perceptual learning theory and deliberate practice theory. The course is a low-cost solution to the current curricular gap through repurposing equipment and minimal use of disposable items.

Methods: Using the theory of deliberate practice examined through the lens of competency-based education, we divide learners into groups of novice and experienced practitioners. Effects of the training on the groups were then assessed before and after the course.

Results: Previous anorectal procedural experience provides a better performance predictor on multiple-choice quizzes for diagnosis and management of anorectal conditions than did training level or departmental affiliation. Novices approached the experienced group's confidence level following training.

Conclusions: This course provides a low-cost way to teach basic anorectal pathology and procedures in a concise time period leveraging adaptive and perceptual learning theory as well as deliberate practice theory.

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CHAPTER 1: Introduction

BACKGROUND

Benign anorectal diseases (BAD) are common amongst the general population. Although the exact incidence and prevalence has been difficult to establish, recent estimates put the prevalence of internal and external hemorrhoids around 4-36% of the total population.[1] The majority of patients, if found incidentally, for example during colonoscopy, will not go on to seek care, but of those that do, approximately 55% will be seen by a specialty other than surgery.[1, 2] In addition to hemorrhoids, in the United States alone, the incidence of anal fissures has been estimated at 235,000 per year, and the incidence of peri-anal abscess and fistulas exceeds 100,000 per year.[3, 4] While not all of these cases will present to care, in a recent analysis of surgical cases performed aboard US Navy ships, up to 18% of cases were for anorectal conditions.[5]

Despite being common conditions, the diagnosis and management of BAD represent only small portions of medical school and residency curricula. While most curricula are not readily available, exam blueprints for tests administered in medical school and residency can provide clues to the relative weight of instruction placed on different subject areas. For the National Board of Medical Examiners (NBME) Clinical Science: Surgery Subject Exam, which is given to 3rd year medical students completing their surgery clerkships, only 20-25% of the questions are devoted to the gastrointestinal (GI) tract as a whole, with only a fraction of those specifically concerning the anus and rectum.[6] The proportion of GI-directed questions declines as learners proceed through training, with only 5-11% of the exam content for the United States Medical Licensing Exam concerning GI-related conditions.[7-9] Amongst internal medicine and family medicine residency licensing exams, the colon and rectum represent less than 2% of the exam

content.[10, 11] Even when considering representation in general surgery training, the American Board of Surgery makes anorectal conditions 2% of the Certifying Exam and recommends that trainees devote only 20 of their 850 cases performed (2.3%) to anorectal procedures.[12, 13]

In light of the prevalence of these conditions in the general population, a structured curriculum to improve familiarity with these disease processes is warranted. The Fundamentals of Anorectal Technical Skills course utilizes didactic and hands-on training to begin filling this gap. The course uses repurposed simulators that are retrofitted with a minimal amount of low-cost disposable items to develop transferable skills for the treatment of BAD. Moving forward, this course can be used both for instruction of less experienced trainees and for a refresher of anorectal conditions for surgeons prior to deployment.

THEORETICAL AND CONCEPTUAL FRAMEWORKS

The training course presented in this thesis utilizes the theories of perceptual and adaptive learning as a framework for content delivery. By using a large volume of examples in order to build pattern recognition skills, this course aims to build a robust toolbox for learners that is generalizable to future iterations of the problem. In keeping with recent trends towards competency-based medical education (CBME), I have chosen to use deliberate practice theory as a lens to examine the efficacy of this course for different levels of learners.

PERCEPTUAL AND ADAPTIVE LEARNING

Pattern recognition and information extraction by means of "perception", or the interpretation of the environment, forms the basis of perceptual and adaptive learning.[14-16] Pattern recognition techniques have been used previously in undergraduate medical education for

histopathology and dermatology and have been shown to improve diagnostic accuracy.[16, 17] In these trainings, learners were exposed to large number of examples of common pathologic entities in order to improve their capacity to recognize the common features of these conditions in future iterations. Similar training programs have been used in graduate medical programs, such as anesthesia, to promote diagnostic and procedural skills.[18]

In line with these other iterations of perceptual and adaptive learning, the Fundamentals of Anorectal Technical Skills course leverages recognition of patterns in visual and written sources, analogous to physical exam and history taking or chart review, to improve readiness for learners in various training capacities to care for common anorectal conditions.

Importantly, there is minimal data for the durability for most perceptual learning modules. Some assessments, like Krasne's histopathology study, employ relatively short-term follow-up periods.[16] Other assessments of the durability of perceptual and adaptive learning modules have methodologic flaws, such as in Rimoin's work with skin lesions where the curriculum was re-administered immediately before the retest.[17] While this thesis does not present the long-term durability of the course, it does establish a pool of learners that I am continuing to follow.

Deliberate Practice Theory

Increasingly there is a trend in medical education towards competency-based, rather than time-based, curricula.[19] Although the concept of competence in the setting of proctology can be difficult to define, case volume is often used as a surrogate marker, as defined by Messick.[20] In current surgical education, however, ethical and logistic concerns can limit the number of clinical cases an individual trainee can encounter. To counteract this trend, there is now an

increasing move towards using simulation to replace at least part of the training curriculum, and recent studies have demonstrated that simulation-based training results in skills transfer that is at least equivalent to patient-based training.[21] For this course, we used deliberate practice theory, where novice learners achieve expert performance through deliberate (effortful) practice, which is, at least initially, under the guidance of an expert mentor, as the theoretical underpinning to the hands-on portion of the course.[22] By using deliberate practice in the simulation setting, we sought to close the gap between the novice and experienced learner groups.

PURPOSE AND RESEARCH QUESTIONS

This thesis seeks to evaluate the efficacy of a proctology training program based on the theories of perceptual and adaptive learning and deliberate practice. During the course of this evaluation, validity evidence, including the utility of using prior procedural volume as a surrogate marker for deliberate practice, for our assessment tool was collected and examined. Ultimately, this Master's thesis aims to provide evidence for the inclusion of this low-cost training program into both surgical and non-surgical residency curricula, as well as pre-deployment trainings. Additionally, there is a paucity of literature surrounding the use of perceptual and adaptive learning for surgical education, and this thesis will help to bolster the use of this educational framework in surgical training. The specific research questions explored are:

- What is the validity evidence for our assessment tool, specifically the multiple-choice items?
- Does previous anorectal procedural volume provide a better method of learner stratification than department of training or post-graduate year (PGY) level?

- Does this training platform provide statistically and educationally significant improvements in confidence and knowledge?

CHAPTER 2: Fundamentals of Anorectal Technical Skills: A Concise Surgical Skills Course

This chapter's content was accepted by *Military Medicine* on 23 March 2020.

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Acknowledgements: The authors would like the thank Carolyn Gosztyla, MD, Patrick Benoit, DO, and Alex Peters, MD, for assistance with course instruction. We would additionally like to acknowledge and thank James E Duncan, MD, and Michael McNally, MD, for assistance with development of the multiple-choice questions.

Funding Sources: None

Conflicts of Interest: None

Ethical Approval: This study was approved by the IRB at Walter Reed National Military Medical Center

Disclaimer: The opinions or assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Department of Defense, the Uniformed Services University of the Health Sciences, or any other agency of the U.S. Government.

ABSTRACT

Introduction: Anorectal diseases, among the most common surgical conditions, are underrepresented in medical training. The Fundamentals of Anorectal Technical Skills course was developed to provide cost-effective formal training in diagnosis of common anorectal conditions and in commonly performed anorectal procedures using the theories of deliberative practice and perceptual and adaptive learning.

Materials and Methods: First- through third-year general surgery and internal medicine residents and third- and fourth-year medical students participated in a course consisting of didactic instruction and hands on skills stations. The course covered common anorectal conditions, including internal and external hemorrhoids, fissures, condylomata, abscesses, fistula-in-ano, rectal prolapse, pilonidal disease, pruritis ani, and anal and rectal cancer, as well as common procedures such as anoscopy, excision of thrombosed external hemorrhoids, banding of internal hemorrhoids, rigid proctoscopy, incision and drainage of an abscess, administration of local anesthesia, and reduction of rectal prolapse. Prior to the course, participants completed a questionnaire consisting of demographics; previous anorectal experience, as measured by procedural case volume; confidence diagnosing and treating anorectal conditions; and a clinical knowledge multiple-choice quiz. Immediately following the course, participants took an additional survey re-assessing their confidence and testing their clinical knowledge. This study was granted an educational exception by the Institutional Review Board at Walter Reed National Military Medical Center.

Results: Forty-three learners participated in this course. Forty-six percent of participants had not participated in any anorectal cases, 26% had participated in 1-5 cases, 17% had participated in 6-10 cases, 6% had been involved with 11-15 cases, and 6% had been involved with more than 15 cases. For learners who had no prior experience, 1-5 prior cases, or 6-10 cases, there were statistically and educationally significant increases in confidence for all diagnoses and procedures. Additionally, there were statistically and educationally significant increases between pre-course and post-course quiz scores for learners who had no prior experience (7.8 ± 2.0 vs 11.8 ± 2.5, $p<0.01$, Cohen's $d=1.8$) and for those who had only participated in 1-5 cases (11.0 ± 3.7 vs 14.2 ± 2.0, $p=0.04$, Cohen's $d=1.1$). The changes in quiz scores for learners who previously had been involved with 6 or more cases were not statistically significant.

Conclusion: This course provides a cost-effective training that significantly boosts learners' confidence in diagnosis of common anorectal procedures and confidence in performance of common anorectal procedures, in addition to improving objectively measured anorectal clinical knowledge.

INTRODUCTION

Anorectal diseases represent one of the most common reasons for presenting to surgical care, particularly in a military setting. In a recent analysis by Nealeigh, *et al*., up to 18% of surgical cases performed on ships by surgeons in the US Navy were anorectal cases.[1] While these numbers reflect surgeon procedural volume, other medical disciplines, such as primary care, will also interact with these patients as they seek care. Despite the prevalence of these cases in clinical practice, these disease processes often receive little attention within medical education. For example, the Clinical Science: Surgery Subject Exam produced by the National Board of Medical Examiners (NBME) for medical students completing their surgical clerkship rotation assigns 20-25% of the questions on the exam to the gastrointestinal (GI) system.[2] A more thorough breakdown is not available from the NBME, but, as this section also includes the stomach, small bowel, hepatobiliary system, pancreas, and colon, only a small fraction of these questions are specifically related to the anus and rectum. Further, as medical students subsequently take licensing exams (United States Medical Licensing Exam Step 1 and Step 2 Clinical Knowledge), the relative weight of the overall GI system decreases to 5-11% of the exam.[3-5]

For medical students progressing to residencies in Internal Medicine or Family Medicine, GI conditions represent a similar proportion of their certification exams, with 7-9% of the overall exam related to GI and <2% specifically related to the colon and rectum.[6, 7] In comparison, the American Board of Surgery (ABS) devotes 2% of the Inservice Training Exam (ABSITE) and Qualifying Exam specifically to anorectal conditions.[8, 9] In addition to the cognitive domain, the ABS promotes psychomotor training in this area by recommending that 20 of the 850 cases

performed during residency be anorectal cases (2.3% of total cases). In academic year 2018-2019 the average graduating resident devoted 3.5% of their case volume to anorectal cases (37.7 anorectal cases in 1070.5 total cases).[1, 10]

The Fundamentals of Anorectal Technical Skills course is predicated on using adaptive and perceptual learning to take advantage of pattern recognition and information extraction to improve task performance in an area that is not included otherwise in formal curricula.[11] Previous work in the domains of histopathology and dermatology have shown the positive effects of pattern recognition strategies drawn from exposure to large numbers of examples on diagnostic accuracy and procedural skills in future iterations.[12-14] The use of pattern recognition also presents the opportunity to keep costs low as pictures can be used for the training. While this approach to learning has been utilized in many fields, there has been a paucity of work exploring the use of this framework for surgical education. Additionally, this course functions using the concept of deliberate practice. In this educational theory, learners achieve expert performance through deliberate, effortful practice of the component parts of an activity, with the initial forays into that activity being guided by an expert mentor.[15]

The goal of the current study is to evaluate the effectiveness of combined didactic and hands-on course in improving the learner's confidence in diagnosing and treating common anorectal procedures, as well as objectively assessing their knowledge of anorectal topics before and after the course. Specifically, this study sought to evaluate procedural volume as a predictor of anorectal diagnostic and procedural confidence, as well as how the course impacted learners of various levels.

MATERIALS AND METHODS

First- through third-year residents from the departments of general surgery and internal medicine and third- and fourth-year medical students who participated in a Fundamentals of Anorectal Technical Skills course between 2018 and 2019 were included in this study. All participants who returned both a pre-course and post-course survey were included. Participants who did not return one or both of the surveys were excluded. This study was granted an educational exemption by the Institutional Review Board at Walter Reed National Military Medical Center (WRNMMC).

Prior to the Fundamentals of Anorectal Technical Skills course, participants completed a questionnaire consisting of demographic information; level of confidence diagnosing common anorectal conditions and performing anorectal procedures; and previous procedural experiences with anorectal cases, as measured by estimated number of procedures performed. Procedural experience was divided into groups who had no prior experience, as well as 1-5, 6-10, 11-15, and >15 previous procedures in order to estimate even steps between no experience and the ACGME-recommended 20 procedures during residency. Measured procedures were anoscopy, banding of internal hemorrhoids, excision of thrombosed external hemorrhoids, abscess incision and drainage, and rigid proctoscopy.

Previous procedural volume was chosen to sub-divide the groups in keeping with the concept of competency-based education. In competency-based education, there is a greater emphasis placed on defined outcomes, thereby focusing on specific skills to be acquired to allow learners to effectively practice. An additional element of this educational system is a decoupling of time in training with readiness for practice.[16, 17] In keeping with the concept of competency-

based education, we presumed that learners with no or little experience would have similar starting confidence levels and quiz scores and that they would have similar improvements from the course, regardless of their department of training. Furthermore, competency-based education emphasizes synthesis of knowledge and skills.[17] This type of synthesis is reflected in this course in the multiple-choice items that have learners select management decisions based on anatomic and symptomatology stems.

Confidence was measured on a 5-point Likert scale (1- not at all, 2- minimally, 3- somewhat, 4- moderate, 5- very). To assess readiness for practice, confidence scores of at least "somewhat confident" (Likert score 3, 4, or 5) were determined to be confident enough to incorporate these procedures into practice, as has been described in other work exploring the effects of surgical training on confidence.[18]

Additionally, participants completed a 20-question multiple-choice quiz assessing the anatomy and physiology of the anus and rectum, diagnosis of common anorectal conditions, and management of these conditions. The questions for this quiz were developed by the authors (WBK, MDN, EMR, WBS), with the assistance of the section of Colon and Rectal Surgery at WRNMMC (JED, MPM).

Content validity was evaluated during the development of these questions through blueprinting, use of subject-matter experts, and linkage of items to knowledge and skill areas. Additionally, during the administration of these questionnaires, these questions were assessed for relationship to other variables, namely previous anorectal procedural volume, as validity evidence.

The course consisted of a 45-minute didactic session covering the anatomy and physiology of the colon, rectum, and anus; pathophysiology and presentation of common anorectal conditions; and treatments of these conditions. The disease processes included were internal and external hemorrhoids, anal fissures, peri-anal abscesses, rectal prolapse, fistula-in-ano, condylomata, pilonidal disease, pruritis ani, and anal and rectal cancer. Following the didactic portion, there was a 90-minute hands-on skills training portion covering common anorectal procedures. During this portion of the course, learners were instructed in anoscopy, rigid proctoscopy, excision of thrombosed external hemorrhoids, banding of internal hemorrhoids, incision and drainage of abscesses, and administration of local anesthesia.

Immediately following the course, participants were asked to complete an additional questionnaire rating their post-course confidence in diagnosing these conditions and performing these procedures. Additionally, they were given a post-course quiz consisting of 20 *different* multiple-choice questions covering different presentations of the same content.

A comparison of the participant's pre-course and post-course confidence levels and quiz scores were conducted using a paired-samples *t*-test. Pre- and post-course measures of sufficient confidence to incorporate into practice were compared using McNemar tests. To compare the course effects for novice learners of different departments, an independent-samples *t* test comparison was used. Validity evidence for the quiz questions' relationship to other variables, notably to previous experience in anorectal cases and post-graduate year (PGY) level, was assessed with simple linear regression. A Cohen's *d* of 0.8 or greater for a paired *t* test and a Cohen's f^2 of 0.35 for linear regression models are considered to be a large effect size.[19] These values were used to assess the educational impact of this course on the learners. Analysis was conducted with SPSS version 25 (IBM; Chicago, IL).

Cost-effectiveness is built into the course design. For example, simulators for these tasks were created using repurposed, commercially available trainers. The anoscopy trainer was an adapted episotomy model (Limbs and Things, Bristol, UK) (Fig 1a). A digital rectal exam (DRE) trainer (Limbs and Things, Bristol, UK) that was retrofitted with a pilonidal abscess model made of an orange peel and toothpaste enclosed in Ioban™ sheets (3M, Maplewood, MN) was used to construct the abscess incision and drainage model (Fig 1b). Further, the same DRE trainer was used to construct the thrombosed external hemorrhoid model by attaching reusable balloons filled with expired compressed absorbable gelatin sponges and red dye to the trainer using a transparent film dressing (Fig 1c). The rigid proctoscopy model had previously been purchased from Olympus (Tokyo, Japan) (Fig 1d). The internal hemorrhoid banding trainer was created by attaching a piece of fabric to an anorectal pathology model (Fig 1e). Durable equipment, including anoscopes, rigid proctoscopes, scalpels, forceps, and the banding gun had previously been retired from the hospital's inventory. Finally, the only disposable materials used for this course were oranges (to create the abscess "skin"; six abscesses per orange), toothpaste (to create the abscess "pus"; 0.5oz per abscess), expired 60x60cm Ioban™ sheets (to secure abscesses; 64 abscesses per sheet), and expired 6x7cm transparent film dressings (to secure "external hemorrhoids" to the model).

RESULTS

DEMOGRAPHICS

Forty-three learners participated in five iterations of the Fundamentals of Anorectal Technical Skills courses through 2018 and 2019. This sample included all participants of this

course during the time period who completed both a pre-course and a post-course assessment. Ten participants were general surgery residents (23.2%): five PGY-1s (11.6% of total participants), four PGY-2s (9.3%), and one PGY-3 (2.3%) (Table 1). Sixteen participants were internal medicine residents (37.2%): five PGY-1s (11.6%), nine PGY-2s (20.9%), and two PGY-3s (4.7%). There were additionally seventeen medical students (MS) (39.5%): nine MS-3s (20.9%) and eight MS-4s (18.6%). Three of the participants had previously completed a General Medical Officer (GMO) tour (7.0%), with all three having deployed in a medical context.

Self-reported procedural experience estimates were available for thirty-five of the forty-three participants (81.4%). Sixteen participants (45.7%) had never been involved with an anorectal case. Nine (25.7%) had participated in 1-5 cases. Six (17.1%) had participated in 6-10 cases. Two participants (5.7%) had participated in 11-15 cases, and another two (5.7%) had participated in more than 15 cases.

Multiple-Choice Item Validity Evidence

The quiz items for this course were developed by members of the Division of General Surgery and the Section of Colon and Rectal Surgery from WRNMMC. Four of the item writers were board-certified general surgeons, three of whom were also board certified in Colon and Rectal Surgery, and two were senior general surgery residents. The questions were reviewed by two members of the Health Professions Education faculty (AA, SJD) at the USUHS to assess for construct-irrelevant variance. Based on the desired content of the course, the forty-item question bank was developed to contain nine questions on general anatomy and physiology, nine questions on internal and external hemorrhoids, five questions on anal fissures, two questions on rectal prolapse, four questions for perianal abscesses and fistula-in-ano, four questions on

pilonidal disease, three questions on condylomas, and two questions on pruritis ani. The pre- and post-course quizzes were blueprinted in order to ensure an even division of these content areas between the two quizzes. The test developers felt that this blueprint adequately represented the construct being assessed.

When quiz score was regressed on training level of the participant, the overall model was not statistically significant, $F(1, 42)=0.63$, $p=0.803$. When the score was regressed on prior anorectal case volume, however, the overall model was significant, $F(1, 34)=27.41$, $p<0.01$ (adjusted $r^2=0.437$, Cohen's $f^2=0.78$). This model accounted for 43.7% of the variance in participant quiz scores. Previous procedural volume was positively associated with quiz score, $\beta=0.67$, $p<0.01$.

Impacts of the Course

When examining changes in confidence for all participants for diagnosis of the included anorectal conditions and performing the included anorectal procedures, there was a statistically and educationally significant increase for all conditions and procedures (Supplemental Table 1).

When dividing participants based on their self-reported case volume, there were statistically significant increases in diagnosing all conditions and performing all procedures for participants with no previous anorectal procedure experience, those with 1-5 cases, and those with 6-10 cases (Table 2, Table 3). Participants with 11 or more prior anorectal cases did not have statistically discernable differences for any of the diagnoses or procedures (Table 3).

When evaluating changes in confidence to make these diagnoses and to perform these procedures in clinical practice, as defined by a confidence score of at least 3, for all participants, there were statistically significant increases for all diagnoses and procedures.

For participants that did not have any previous anorectal case experience, there were statistically and educationally significant increases in confidence to diagnose internal hemorrhoids (93.8% vs 18.8%, $p<0.01$), anal fissures (100% vs 56.2%, $p=0.02$), rectal prolapse (100% vs 50.0%, $p=0.01$), perianal abscesses (100% vs 56.3%, $p=0.02$), fistula-in-ano (87.5% vs 18.8%, $p<0.01$), pilonidal disease (100% vs 37.5%, $p<0.01$), and pruritis ani (93.8% vs 37.5%, $p=0.01$) (Table 2). They additionally had significant increases in confidence to perform anoscopy (87.5% vs 0.0%, $p<0.01$), banding of internal hemorrhoids (87.5% vs 0.0%, $p<0.01$), excision of thrombosed external hemorrhoids (100% vs 0.0%, $p<0.01$), incision and drainage of abscesses (93.7% vs 6.3%, $p<0.01$), and rigid proctoscopy (68.8% vs 0.0%, $p<0.01$) (Table 2). Administration of local anesthetic did not reach the level of statistical significance (100% vs 68.8%, $p=0.06$), as did diagnosing external hemorrhoids (100% vs 81.3%, $p=0.25$), and condylomata (93.8% vs 56.3%, $p=0.07$).

For participants with 1-5 prior anorectal cases, there were statistically and educationally significant increases in diagnosing rectal prolapse (100% vs 22.2%, $p=0.02$), fistula-in-ano (100% vs 33.3%, $p=0.03$), condylomata (100% vs 33.3%, $p=0.03$), and pruritis ani (100% vs 22.2%, $p=0.02$). These learners additionally had significant increases in performing anoscopy (100% vs 22.2%, $p=0.02$), banding (100% vs 11%, $p=0.01$), excision of thrombosed external hemorrhoids (100% vs 0.0%, $p<0.01$), incision and drainage of perianal abscesses (100% vs 33.3%, $p=0.03$), and rigid proctoscopy (100% vs 0.0%, $p<0.01$) (Table 2). There were no statistically discernable differences for administration of local anesthesia (100% vs 77.8%,

p=0.50) or diagnosis of internal hemorrhoids (100% vs 44%, p=0.06), external hemorrhoids (100% vs 66.7%, p=0.25), anal fissures (100% vs 77.8%, p=0.50), perianal abscesses (100% vs 55.6%, p=0.13), and pilonidal disease (100% vs 55.6, p=0.13). Of note, following the course, all participants reported sufficient confidence to incorporate these conditions and procedures into their practices.

Participants with 6-10, 11-15, or more than 15 cases, there were no statistically evident differences in confidence for practice (Table 3). Similar to the group with 1-5 cases, all diagnoses and procedures had 100% of participants with at least 6 previous cases feeling on the post-course survey confident enough to incorporate into practice.

When looking at the effect of the course on the scores of the multiple-choice quiz, there was a statistically significant increase when taking all participants together (9.5 ± 3.1 questions answered correctly vs 13.6 ± 2.6, p<0.01, Cohen's d=1.4) (Supplemental Table 1).

When examining quiz scores based on previous anorectal case volume, there were statistically significant increases for learners who had no prior experience (7.8 ± 2.0 vs 11.8 ± 2.5, p<0.01, Cohen's *d*=1.8) and those who had only participated in 1-5 cases (11.0 ± 3.7 vs 14.2 ± 2.0, p=0.04, Cohen's *d*=1.1) (Table 2). Participants who had 6-10 previous cases trended towards, but did not reach, the level of statistical significance for quiz scores (10.7 ± 2.5 vs 14.8 ± 2.9, p=0.06). There were no statistically discernable differences for participants with 11-15 cases (11.5 ± 0.7 vs 14.5 ± 0.7, p=0.21). There were insufficient participants with more than 15 cases to draw statistical conclusions (Table 3).

For the groups with no anorectal procedural experience, there was only one general surgery participant, while there were 28 internal medicine participants in this group. In light of the small general surgery subgroup, there was a statistical difference between learners from general surgery or internal medicine for pre-course confidence scores only for pruritis ani (4.0 ± 0.0 vs 2.3 ± 0.8, $p=0.05$). There were no statistically significant differences for any other pre-course confidence rating or difference in confidence score following the course. Pre-course quiz scores and differences for pre- and post-course scores were also not significantly different between learners from the two departments.

Amongst the learners with 1-5 reported anorectal procedures, there were 3 participants from general surgery and 9 participants from internal medicine. In this subgroup, there were significant differences between pre-course quiz score (15.7 ± 2.5 vs 9.3 ± 2.1, $p<0.01$) and for confidence scores for pruritis (3.3 ± 0.6 vs 1.6 ± 0.5, $p<0.01$), anoscopy (3.3 ± 1.2 vs 1.4 ± 0.7, $p=0.01$), banding (2.3 ± 1.5 vs 1.4 ± 0.7, $p=0.02$). There were additionally statistically significant differences between the pre- and post-course scores for general surgery and internal medicine participants in pilonidal disease ($+0.5 \pm 0.7$ vs $+2.7 \pm 0.6$, $p=0.03$), pruritis ani ($+0.5 \pm 0.7$ vs $+2.7 \pm 0.6$, $p=0.03$), anoscopy ($+0.5 \pm 0.7$ vs $+2.7 \pm 0.6$, $p=0.03$), and quiz scores (-2.0 ± 0.0 vs $+4.0 \pm 2.0$, $p=0.03$).

DISCUSSION

The Fundamentals of Anorectal Technical Skills course provides a condensed surgical skills training through a 135-minute course that increases the clinical knowledge of common anorectal diseases and improves diagnostic and procedural confidence in these conditions. Regardless of specialty or level of training, learners who have not had much previous procedural

contact with anorectal disease show the greatest increase in knowledge and confidence, as would be expected with deliberate practice theory. Additionally, the association between the learner's previous procedural volume and their pre-course quiz scores aligns with the principle of deliberate practice theory that performance is primarily dependent on prior practice. [15, 20] From an educational perspective, as the Cohen's *d* is greater than 1 for all of the content areas examined, this course has shown a high level of initial efficacy.

Additionally, this course utilizes minimal disposable equipment, all of which is low cost. The reusable task trainers are typically already present in any hospital or clinic that conducts simulation training and are all portable, allowing for easy transportation between training sites. These factors combine to create a low cost per learner per course and likely represents a good value for military medical training.

MILITARY RELEVANCE

Given that military physicians can often find themselves in austere environments without ready access to surgical support, the skills gained from specific training in proctology can help these providers care for many anorectal patients without needing to evacuate them to higher levels of care. Additionally, for staff surgeons who are subspecialty trained in areas other than colorectal surgery or those who do not currently have anorectal procedures as a past of their practice, this course can serve as a refresher for a cluster of disease processes that may encompass almost 20% of their case volume.[1] While there was no statistically significant differences following the course for fully-trained surgeons, the sample size of this learner group in this study is small. With larger sample sizes, we hypothesize that while there may not be statistical differences in confidence scores, there may be discernible differences in the objective

measures, such as the MCQs and objective psychomotor assessments. Based on course feedback comments from sub-specialist surgeons at our institution who do not routine have anorectal patients, there is likely a benefit for these learners that is not being fully captured by our current assessment tools. Such a benefit would be most pronounced for sub-specialist reservists and active duty sub-specialist surgeons who practice at tertiary-care hospitals.

Beyond increasing the effectiveness of physicians in deployed environments, skills learned from this course can help primary care physicians while in garrison. As many of these conditions are often managed medically at first, by improving diagnostic skills, non-surgeons can initiate treatment plans for patients at their initial visit. Such changes have the potential to improve patient satisfaction and decrease healthcare costs by decreasing unnecessary referrals and improving system efficacy.

Future Directions

While this work has demonstrated a significant effect in improving the confidence and diagnostic skills of learners immediately following the course, additional follow-up studies could assess the durability of this training. Previous work examining training modules and bootcamp-style instruction have shown mixed results in terms of durability of training effects out to 12 months.[21-25] Courses in other domains such as pathology and radiology that are based in perceptual learning, however, either have not looked at long-term durability past a few weeks or have included a refresher course immediately prior to the follow-up assessment.[12, 13] As such, long-term durability information from this course will add to the educational body of literature in addition to adding to the cost-effectiveness argument for this training. Beyond reexamining confidence levels and quiz performance, learners also will be scored on procedure performance

based on previously developed scoring rubrics in order to objectively measure psychomotor skills.

LIMITATIONS

This study had several important limitations, including that fact that it was conducted in a single institution and solely examined the immediate effects of a training course with a relatively small number of multiple-choice items used to assess clinical knowledge. Although there were not apparent differences for novice learners, many of the learners in this study are also enrolled in a general surgery residency where they are exposed to anorectal disease in the clinical setting on a regular basis, it will be important during the follow-up survey to also examine the training effect of residency by itself. Furthermore, given the population available for study at our institution, the participants skewed towards more novice learners. Moving forward with the course, additional populations will be targeted, including more advanced learners and learners from other disciplines.

Additionally, this study was limited in that procedural skills were measured with subjective confidence scores rather than with objective criteria. Given the deliberate practice elements of the course design, learners achieved a quantifiable level of performance based on pre-established checklists by the end of the course, which limits the utility of assessing cognitive skills in the immediate post-course period. Future work will include objective measures of psychomotor skills in addition to the multiple-choice quizzes to evaluate the durability of the course and will be directed at comparing the effects of this course with effects seen from the normal residency education without explicit training in anorectal conditions.

Finally, as this is a single institution study in which the learners know the instructors, it is possible that learners may have inflated their confidence responses due to their desire to please the faculty. The multiple-choice quiz results, however, do not support this limitation.

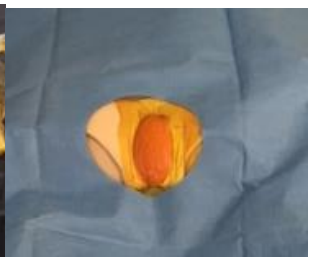
CONCLUSIONS

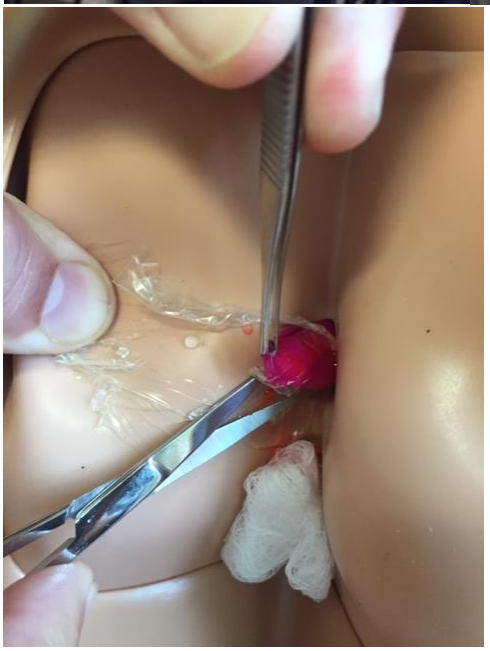
The Fundamentals of Anorectal Technical Skills course appears to be a valuable training that significantly improves not only objectively measured diagnostic ability and management planning, but also confidence in diagnosing common anorectal conditions and performing related procedures. These effects are most pronounced for learners who have not had much previous exposure to anorectal diseases.

FIGURE 1. SIMULATOR SET UP

A) 

B) 



C) 

D) 

E) 

A)Anoscopy trainer repurposed from episiotomy trainer B) Pilonidal abscess incision and drainage and local anesthesia administration model from digital rectal exam trainer retrofitted with “abscesses” made from Ioban ™, orange peels, and toothpaste C) Excision of external hemorrhoid trainer from DRE trainer with balloons as “thrombosed external hemorrhoids” D) Rigid proctoscopy trainer E) Banding of internal hemorrhoid trainer with cloth inside anorectal pathology cut-away model

TABLE 1. DEMOGRAPHICS

		N (%)
Gender		
Male		27 (62.8)
Female		14 (32.6)
Prefer Not to Answer		2 (4.7)
Branch		
Army		23 (53.5)
Navy		13 (30.2)
Air Force		6 (14.0)
Public Health Service		1 (2.3)
Department		
General Surgery		10 (23.3)
	PGY-1	5 (11.6)
	PGY-2	4 (9.3)
	PGY-3	1 (2.3)
Internal Medicine		16 (37.2)
	PGY-1	5 (11.6)
	PGY-2	9 (20.9)
	PGY-3	2 (4.7)
Medical Student		17 (39.5)
	MS-3	9 (20.9)
	MS-4	8 (18.6)
Prior GMO		3 (7.0)
Prior Deployment		3 (7.0)
Previous Case Experience		
	None	16 (45.7)
	1-5	9 (25.7)
	6-10	6 (17.1)
	11-15	2 (5.7)
	>15	2 (5.7)

Distribution of participants for Fundamentals of Anorectal Technical Skills courses

SUPPLEMENTAL TABLE 1. OVERALL IMPACT OF THE COURSE

	Pre-Course Average (Std Dev)	Post-Course Average (Std Dev)	p Value	Cohen's *d*		Pre-Course Confidence	Post-Course Confidence	p Value
Overall (43 participants)								
Internal Hemorrhoids	2.5 (0.9)	4.0 (0.6)	<0.01	2.0		47	98	<0.01
External Hemorrhoids	3.2 (0.8)	4.3(0.7)	<0.01	1.5		81	100	<0.01
Anal Fissures	3.2 (1.0)	4.2 (0.7)	<0.01	1.2		74	100	<0.01
Rectal Prolapse	2.8 (0.9)	4.3 (0.7)	<0.01	1.9		53	100	<0.01
Perianal Abscess	2.9 (0.9)	4.0 (0.7)	<0.01	1.4		67	100	<0.01
Fistula-In-Ano	2.3 (1.1)	3.7 (0.7)	<0.01	1.5		35	95	<0.01
Condyloma	3.8 (1.1)	4.2 (0.7)	<0.01	0.4		56	98	<0.01
Pilonidal Disease	2.9 (1.2)	4.2 (0.6)	<0.01	1.4		58	100	<0.01
Pruritis Ani	2.4 (1.0)	4.0 (0.7)	<0.01	1.9		40	98	<0.01
Anoscopy	2.1 (1.3)	4.0 (0.8)	<0.01	1.8		33	95	<0.01
Banding	1.4 (0.9)	3.6 (0.8)	<0.01	2.6		12	95	<0.01
Excision of External Hemorrhoids	1.5 (0.9)	3.7 (0.8)	<0.01	2.6		16	95	<0.01
Incision and Drainage	2.0 (1.2)	3.9 (0.8)	<0.01	1.9		33	98	<0.01
Local Anesthesia	3.2 (1.2)	4.4 (0.7)	<0.01	1.2		72	100	<0.01
Rigid Proctoscopy	1.2 (0.5)	3.5 (0.9)	<0.01	3.2		5	86	<0.01
Quiz Score	9.5 (3.1)	13.6 (2.6)	<0.01	1.4				

Changes to diagnostic and procedural confidence in addition to quiz scores from before and after the course for all participants.

TABLE 2. IMPACT OF COURSE ON NOVICE LEARNERS

	Pre-Course Average (Std Dev)	Post-Course Average (Std Dev)	p Value	Cohen's *d*		Pre-Course Confidence	Post-Course Confidence	p Value
No Prior Experience (16 participants)								
Internal Hemorrhoids	2.1 (0.8)	3.9 (0.7)	<0.01	2.4		18.8	93.8	<0.01
External Hemorrhoids	2.9 (0.6)	4.1 (0.7)	<0.01	1.8		81.3	100	0.25
Anal Fissures	2.7 (0.9)	3.9 (0.6)	<0.01	1.6		56.3	100	0.02
Rectal Prolapse	2.7 (0.9)	4.1 (0.6)	<0.01	1.8		50	100	0.01
Perianal Abscess	2.6 (0.9)	3.9 (0.5)	<0.01	1.8		56.3	100	0.02
Fistula-In-Ano	1.8 (0.9)	3.5 (0.7)	<0.01	2.1		18.8	100	<0.01
Condyloma	2.8 (1.1)	4.0 (0.8)	<0.01	1.2		56.3	93.8	0.07
Pilonidal Disease	2.4 (1.0)	4.0 (0.5)	<0.01	2.0		37.5	100	<0.01
Pruritis Ani	2.4 (0.9)	3.8 (0.7)	<0.01	1.7		37.5	93.8	0.01
Anoscopy	1.1 (0.3)	3.5 (0.8)	<0.01	4.0		0	87.5	<0.01
Banding	1.0 (0.0)	3.3 (0.8)	<0.01	4.1		0	87.5	<0.01
Excision of External Hemorrhoids	1.0 (0.0)	3.3 (0.8)	<0.01	4.1		0	87.5	<0.01
Incision and Drainage	1.1 (0.5)	3.5 (0.8)	<0.01	3.6		6.3	93.8	0.06
Local Anesthesia	2.9 (1.2)	4.0 (0.7)	<0.01	1.1		68.8	100	<0.01
Rigid Proctoscopy	1.0 (0.0)	3.0 (0.9)	<0.01	3.1		0	68.8	
Quiz Score	7.8 (2.0)	11.8 (2.5)	<0.01	1.8				
One to Five Prior Procedures (9 participants)								
Internal Hemorrhoids	2.3 (0.7)	3.9 (0.6)	<0.01	2.5		44.4	100	0.06
External Hemorrhoids	2.9 (0.8)	4.4 (0.7)	<0.01	2.0		66.7	100	0.25
Anal Fissures	3.3 (0.9)	4.2 (0.8)	0.01	1.1		77.8	100	0.50
Rectal Prolapse	2.4 (0.9)	4.1 (0.8)	<0.01	2.0		22.2	100	0.02
Perianal Abscess	2.8 (0.8)	4.0 (0.7)	<0.01	1.6		55.6	100	0.13
Fistula-In-Ano	2.3 (1.1)	3.8 (0.8)	0.01	1.6		33.3	100	0.03
Condyloma	2.2 (1.0)	4.0 (0.9)	<0.01	1.9		33.3	100	0.03
Pilonidal Disease	2.9 (1.3)	4.1 (0.8)	<0.01	1.1		55.6	100	0.13
Pruritis Ani	2.0 (1.2)	3.9 (0.8)	<0.01	1.9		22.2	100	0.02
Anoscopy	2.0 (1.2)	4.0 (0.5)	<0.01	2.2		22.2	100	0.02
Banding	1.3 (1.0)	3.4 (0.7)	<0.01	2.4		11.1	100	0.01

Excision of External Hemorrhoids	1.0 (0.0)	3.4 (0.7)	<0.01	4.8		0	100	<0.01
Incision and Drainage	2.2 (1.3)	3.6 (0.7)	<0.01	1.3		33.3	100	0.03
Local Anesthesia	3.2 (1.0)	4.1 (0.6)	0.02	1.1		77.8	100	0.50
Rigid Proctoscopy	1.0 (0.0)	3.6 (0.5)	<0.01	7.4		0	100	<0.01
Quiz Score	11.0 (3.7)	14.2 (2.0)	0.04	1.1				

Changes to diagnostic and procedural confidence in addition to quiz scores from before and after the course for participants with either no prior procedural experience or 1-5 previous cases.

TABLE 3. IMPACT OF THE COURSE ON EXPERIENCED LEARNERS

(**-standard error of difference is 0; *p* value cannot be computed)

	Pre-Course Average (Std Dev)	Post-Course Average (Std Dev)	p Value	Cohen's *d*		Pre-Course Confidence	Post-Course Confidence	p Value
Six to Ten Prior Procedures (6 participants)								
Internal Hemorrhoids	2.3 (0.8)	4.2 (0.4)	0.01	3.0		50	100	0.25
External Hemorrhoids	3.3 (0.8)	4.7 (0.5)	0.01	2.1		83.3	100	1.00
Anal Fissures	3.2 (1.2)	4.3 (0.5)	0.03	1.2		83.3	100	1.00
Rectal Prolapse	2.8 (0.8)	4.5 (0.5)	<0.01	2.5		66.7	100	0.50
Perianal Abscess	3.0 (0.9)	4.5 (0.5)	0.02	2.1		66.7	100	0.50
Fistula-In-Ano	2.3 (0.8)	4.2 (0.4)	<0.01	3.0		50	100	0.25
Condyloma	2.8 (0.4)	4.3 (0.5)	0.04	3.3		83.3	100	1.00
Pilonidal Disease	3.5 (0.5)	4.5 (0.5)	0.01	2.0		100	100	**
Pruritis Ani	2.3 (1.2)	4.3 (0.5)	0.03	2.2		50	100	0.25
Anoscopy	2.5 (1.0)	4.5 (0.5)	<0.01	2.5		16.7	100	0.25
Banding	1.7 (0.8)	4.3 (0.5)	<0.01	3.9		16.7	100	0.06
Excision of External Hemorrhoids	2.3 (0.8)	4.2 (0.8)	<0.01	2.4		50	100	0.25
Incision and Drainage	2.5 (0.8)	4.5 (0.5)	<0.01	3.0		66.7	100	0.50
Local Anesthesia	3.7 (1.4)	4.8 (0.4)	0.03	1.1		83.3	100	1.00
Rigid Proctoscopy	1.7 (0.8)	4.2 (0.4)	<0.01	4.0		16.7	100	0.06
Quiz Score	10.7 (2.5)	14.8 (2.9)	0.06	1.5				
Eleven to Fifteen Prior Procedures (2 participants)								
Internal Hemorrhoids	3.5 (0.7)	4.0 (0.0)	0.50	NA		100	100	**
External Hemorrhoids	4.0 (0.0)	4.0 (0.0)	**	NA		100	100	**
Anal Fissures	4.0 (0.0)	4.0 (0.0)	**	NA		100	100	**
Rectal Prolapse	3.0 (1.4)	4.0 (0.0)	0.50	NA		50	100	1.00
Perianal Abscess	3.5 (0.7)	3.5 (0.7)	**	NA		100	100	**
Fistula-In-Ano	3.0 (1.4)	3.5 (0.7)	0.50	NA		50	100	1.00
Condyloma	2.5 (2.1)	4.0 (0.0)	0.50	NA		50	100	1.00
Pilonidal Disease	4.5 (0.7)	4.0 (0.0)	**	NA		100	100	**
Pruritis Ani	2.5 (0.7)	4.0 (0.0)	0.50	NA		50	100	1.00

Anoscopy	2.5 (2.1)	4.0 (0.0)	0.50	NA		50	100	1.00
Banding	2.5 (2.1)	3.5 (0.7)	0.50	NA		50	100	1.00
Excision of External Hemorrhoids	2.5 (2.1)	3.5 (0.7)	0.50	NA		50	100	1.00
Incision and Drainage	2.5 (2.1)	3.5 (0.7)	0.50	NA		50	100	1.00
Local Anesthesia	4.0 (0.0)	4.5 (0.7)	0.50	NA		100	100	**
Rigid Proctoscopy	1.5 (0.7)	3.5 (0.7)	**	NA		0	100	0.50
Quiz Score	11.5 (0.7)	14.5 (0.7)	0.20	NA				
More than Fifteen Prior Procedures (2 participants)								
Internal Hemorrhoids	4.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
External Hemorrhoids	4.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Anal Fissures	4.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Rectal Prolapse	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Perianal Abscess	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Fistula-In-Ano	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Condyloma	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Pilonidal Disease	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Pruritis Ani	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Anoscopy	5.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Banding	4.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Excision of External Hemorrhoids	4.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Incision and Drainage	4.0 (0.0)	5.0 (0.0)	**	NA		0	100	**
Local Anesthesia	5.0 (0.0)	5.0 (0.0)	**	NA		100	100	**
Rigid Proctoscopy	3.0 (0.0)	4.0 (0.0)	**	NA		0	100	**
Quiz Score	15.5 (2.1)	14.5 (2.1)	**	NA				

Changes to diagnostic and procedural confidence in addition to quiz scores from before and after the course for participants who had performed more than 6 prior anorectal procedures.

CHAPTER 3: Discussion

Anorectal diseases represent one of the more common reasons for seeking medical care, especially in the military setting. Despite the prevalence of these conditions, there is a paucity of formal education in these conditions in most training programs. This thesis explores the use of a training course grounded in a framework of perceptual and adaptive learning and deliberate practice theory to close the training gap. In this thesis, I chose to examine the efficacy of this particular course, using prior procedural volume (consistent with deliberate practice theory), instead of PGY level or discipline (consistent with traditional training approaches), to stratify learners. While evaluating the course, we examined validity evidence for the assessment tool that was purpose built for this course, also using the theory of deliberate practice to inform the interpretation of the tool's utility.

Returning to the research questions, the validity evidence for the assessment tool designed for this course is predominantly in the form of content validity and relationship to other variables. In the content validity realm, this assessment tool makes use of subject matter experts and blueprinting to ensure a linkage of items to knowledge and skill areas.

When evaluating the relationship to other variables, both traditional training metrics, such as PGY level and departmental affiliation, and metrics consistent with deliberate practice theory, such as previous procedural volume, were used. For the traditional training stratification tool of PGY level, there was a positive, but not statistically significant, correlation between the learner's PGY level and quiz score. Similarly, there was a significant difference between general surgery resident participants and those who were either medical students or internal medicine residents, but there was not a statistical difference between medical students and internal medicine residents. The utility of using departmental affiliation as a method of stratification for learners

was also confounded by general surgery residents entering the program with more prior procedures than the other groups. These findings indicate that traditional markers of readiness are

As expected based on deliberate practice theory, however, previous procedural volume had a positive correlation to quiz score that was statistically significant. Additionally, when stratifying learners by previous procedural volume, there were no significant differences between general surgery participants of a particular level and learners of the other groups at the similar experience level. These findings indicate that learners who have never engaged in a specific task will perform similarly, despite how far they have chronologically progressed in training, as would be expected from deliberate practice theory. As such, the traditional metrics for predicting performance were not as useful discriminators between learners as were metrics based in deliberate practice theory, such as previous procedural volume.

This course, with its emphasis on effortful practice under the guidance of more experienced mentors, is able to generate statistically and educationally significant improvements in confidence novice learners, specifically who had participated in less than 10 previous procedures, in keeping with the theory of deliberate practice. In addition to their confidence improvements, novice learners also had significant increases in their objectively measured knowledge of anorectal diseases and their management. While more experienced learners likely gained from participation in the course in ways that were not captured by our metrics, the measurable objective and subjective gains for novices likely results from increased exposure to the topic and ability to practice the procedures. Given that the ACGME considers 20 anorectal cases to be the marker for competence in a graduating general surgery resident, there would be an expected leveling of the learning curve as learners approach that level.

Deliberate Practice for Surgical Education

The examination of the "relationship to other variables" validity evidence for the multiple-choice items used for the pre- and post-course quiz provides the argument that prior procedural volume provides a better predictor of knowledge of anorectal diseases and the management thereof, as would be expected from a competency based approach to training. Using previous experience to stratify learners, this work demonstrates different levels of effect between novice and experienced learners. Through the use of deliberate practice during the course, the gap between novice and experienced learners closes.

Adaptive and Perceptual Learning

The didactic portion of the course is designed around the theory of adaptive and perceptual learning. Following brief discussions of the anatomy and physiology of the anus and rectum, the majority of the didactics consist of repeated visual examples of different disease processes to allow learners to recognize the patterns that discriminate between the different pathologies. This pattern recognition is then reinforced during the hands-on portion of the course at the different skill stations before being assessed with the post-course quiz. This transfer of pattern recognition to new photo examples, as evidenced by improvements between the pre- and post-course quizzes, is analogous to the learners' ability to make diagnoses in clinical practice.

Military Relevance

Given the nature of military medicine, physicians in the armed forces are often in austere environments at aid stations or directly embedded with line units without easy access to subspecialty or even surgical support. Especially for primary care providers (PCPs) and general medical officers (GMOs), knowledge and skills gained from specific training in proctology can facilitate accurate diagnosis and initiation of management for many anorectal conditions. Given that the first line medical treatments often are the definitive management strategies for these patients, the training presented in this thesis may help to avoid the need for evacuation to higher levels of care. For military surgeons who are not subspecialty trained in colon and rectal surgery and who do not have anorectal procedures included in their usual practice, this course can serve as a useful refresher for a spectrum of disease that will be up to 20% of their case volume while downrange.[5] While the pre-deployment period has many mandatory trainings, this work presents evidence that specific training in proctology provides a benefit to both surgeons and non-surgeon providers.

In addition to improving the efficacy of military physicians in the deployed environment, improved proctology skills can also help PCPs while in garrison. Similar to the deployed environment, starting medical therapy prior to a visit with a surgeon not only can provide symptomatic relief while awaiting definitive surgical management, but, in some cases, can itself be the definitive management. Such a change in practice has the potential to improve patient satisfaction and to decrease healthcare costs by reducing redundant visits.

LIMITATIONS

Currently, this programmatic evaluation has several notable limitations. When examining the immediate effects of the training there was no control arm. As the pre-course

multiple-choice quiz provided immediate feedback, including an explanation of the correct answer, there may have been an educational effect of the quiz, independent of the course, which was not measured. While examining the durability of the training there is a control arm, which will measure the training effects of residency training alone as compared to the effects of the course superimposed on standard residency training. The control arm will contain both internal medicine and general surgery learners in order to examine and account for potential differences between the different residency curricula.

This study is also limited in that procedural skills were only measured with subjective confidence scores during the immediate evaluation of course efficacy. Learners were given the opportunity to practice with the models until they were able to consistently perform all elements of the procedure, which meant that all learners were performing all of the components of the procedural checklist at the end of the training. During the follow-up phase, the durability of procedural skills will be assessed by comparing trainee performance to the same checklists without coaching.

An additional limitation of the course in the context of deliberate practice theory is that it can be difficult to differentiate between the effects of the course and the effects of residency training alone, especially as learners amass additional experience. In particular, this can make the utility of the course in the pre-deployment period for surgeons difficult to evaluate. Despite this potential difficulty for surgical participants, given that there is little pre-course anorectal procedural experience for both medical students and internal medicine residents, the framework of deliberate practice theory still has some ability to detect training effects from the course.

In the lens of adaptive and perceptual learning, this course has a theoretical limitation in that, as the number of pathologic variants increases, the number of needed photographs to

demonstrate the relevant conditions also increases. While pictures are low cost and relatively easy to obtain, there is a risk that learners can become oversaturated with the images.[16] This limitation will be important to keep in mind as future iterations of this course are developed.

FUTURE RESEARCH AND PRACTICE IMPLICATIONS

Moving forward with this project, the next steps will be to examine the durability of this course. As previously stated, previous studies into the durability of adaptive and perceptual learning have been limited by a combination of short-term follow up and poor methodological design.[16, 17] While the immediate effects of the course presented in this thesis provide a strong argument for incorporating this training into medical school and early residency where learners have an ample support system, evidence that its effects persist over several months will be needed before being relied on fully for providers preparing to enter an austere environment. Additionally, the incorporation of objective procedural skills testing in the follow up surveys, and the validation of those assessment tools, will add to the argument for building this training into the pre-deployment period.

CONCLUSIONS

Anorectal pathology and procedures are an important part of military medicine that is often underrepresented in training. Low-cost, effective training in proctology, as outlined in this work, can help to close this training gap and allow for better and more efficient care of patients in both deployed and garrison environments.

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