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Exploring Senior Residents' Intraoperative Error Management Strategies: A Potential Measure of Performance Improvement

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OBJECTIVE: The study aim was to determine whether residents' error management strategies changed across 2 simulated laparoscopic ventral hernia (LVH) repair procedures after receiving feedback on their initial performance. We hypothesize that error detection and recovery strategies would improve during the second procedure without hands-on practice.

DESIGN: Retrospective review of participant procedural performances of simulated laparoscopic ventral herniorrhaphy. A total of 3 investigators reviewed procedure videos to identify surgical errors. Errors were deconstructed. Error management events were noted, including error identification and recovery.

SETTING: Residents performed the simulated LVH procedures during a course on advanced laparoscopy. Participants had 30 minutes to complete a LVH procedure. After verbal and simulator feedback, residents returned 24 hours later to perform a different, more difficult simulated LVH repair.

PARTICIPANTS: Senior ($N = 7$; postgraduate year 4-5) residents in attendance at the course participated in this study.

RESULTS: In the first LVH procedure, residents committed 121 errors ($M = 17.14$, standard deviation = 4.38). Although the number of errors increased to 146 ($M = 20.86$, standard deviation = 6.15) during the second procedure, residents progressed further in the second procedure. There was no significant difference in the number of errors committed for both procedures, but errors shifted to the late stage of the second procedure. Residents changed the error types that they attempted to recover (χ^2_5=24.96, $p < 0.001$). For the second procedure, recovery attempts increased for action and procedure errors, but decreased for strategy errors. Residents also recovered the most errors in the late stage of the second procedure ($p < 0.001$).

CONCLUSION: Residents' error management strategies changed between procedures following verbal feedback on their initial performance and feedback from the simulator. Errors and recovery attempts shifted to later steps during the second procedure. This may reflect residents' error management success in the earlier stages, which allowed further progression in the second simulation. Incorporating error recognition and management opportunities into surgical training could help track residents' learning curve and provide detailed, structured feedback on technical and decision-making skills. (J Surg Ed ■:■■■-■■■. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: error management, laparoscopy, surgical education, simulation, error recovery

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Patient Care

INTRODUCTION

The Accreditation Council of Graduate Medical Education expects general surgery trainees to develop skills in identifying and reducing error during residency.[1] Historically, residents received limited training to manage potential errors during procedures[2] and instead were trained to perform them correctly.[3] In surgical cases and patient outcome conferences, residents typically receive guidance

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in error *avoidance*.[4] However, recent studies suggest *incorporating* errors and error management into surgical training may be more effective than error avoidance training.[5]

Error management involves committing an error, identifying it, and attempting to recover from it.[6-8] Allowing trainees to explore while learning permits them to make errors and develop strategies to reduce and mitigate them. Nonsurgical fields discovered encouraging errors in appropriate training environments could provide beneficial learning opportunities. Those trained in error management performed better, showed increased skill retention and transfer over those taught through error avoidance.[9,10] Incorporating such methods into surgical residency training could equip residents with skills critical to error management and help to promote operative independence.[11]

Our work in surgical simulation with chief residents produced findings similar to those discussed earlier. During 2 simulated laparoscopic ventral hernia (LVH) repair procedures, residents successfully completed their second repair after failing to complete the first.[12] We previously identified error occurrence in each procedure and characterized how the errors changed between the first and second LVH repair procedure.[13] In this study, we aim to use the same data to identify how error management strategies changed across the 2 simulated procedures after receiving feedback from the simulator and verbal feedback on their initial performance. We hypothesize that error detection and recovery abilities would improve during the second procedure without hands-on practice.

METHODS

Participants and Setting

In total, 7 senior residents (postgraduate year 4-5; 86% male) from various institutions performed 2 simulated LVH repair procedures during a course on advanced laparoscopic surgery (Fig. 1). Each participant had 30 minutes to complete the first repair, a midline hernia. During each simulated procedure, participants had access to all necessary equipment and staff, including a faculty member who acted as a first assistant. The faculty member did not coach or provide instructions. Once the allotted time of 30 minutes had passed, participants ended the procedure regardless of how many steps they had completed. Faculty then provided individualized, verbal feedback to participants on their repair. The participants then returned to the course for didactics and training on other advanced laparoscopic procedures. The following day, participants returned to complete a more difficult LVH repair procedure located in the right, upper quadrant within 30 minutes. A scene camera and an endoscope recorded audio and video of the repairs for later analysis.

Derivation of Study Data and Prior Analysis

Data for this analysis came from a preexisting video databank of the simulated LVH repairs. Three investigators (K. L., A.D., and E.C.) reviewed the videos and used a human error framework[14,15] to categorize and tally the types of errors committed during the LVH repairs.[13] Errors were identified by error type (omission versus commission) and type (cognitive versus technical; Fig. 2).

Results from this study indicated the quantity of errors increased during the second repair, but the types of the errors changed significantly.[13] Participants committed 121 errors during the first LVH repair procedure and 146 errors during the second procedure. Participants committed fewer omission errors ($n = 20/146$, 14%) and cognitive errors ($n = 35/146$, 24%) in the second procedure than in the first procedure (omission, $n = 40/121$, 33%; cognitive, $n = 45/121$, 37%). Additionally, 85% of errors occurred during steps of the second procedure that participants failed to reach in the first.

Recognizing the role error detection and recovery can play in surgical knowledge and patient outcomes,[16] further examination of the errors was necessary. The errors committed during the first ($n = 121$) and second ($n = 146$) procedure constitute the sample used for this current study and additional analysis.

Key Variable Definitions

Error was defined according to the Bellagio Conference on Human Error: "something that has been done which was: (1) not intended by the actor, (2) not desired by a set of rules or an observed, and (3) that led the task or system outside acceptable limits."[17]

Error management was defined as "… the adaptive process [one] engages in to minimize disturbances within the system."[7(p11)] The error management process consisted of an error occurrence, its detection, and recovery. Stages of error management for each error were identified, if applicable.[8]

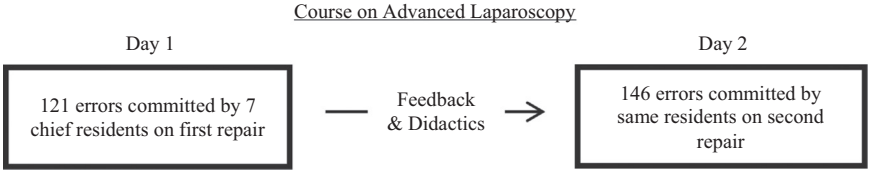

FIGURE 1. Data selected for this study.