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Simulation-Based Laparoscopic Surgery Crisis Resource Management Training—Predicting Technical and Nontechnical Skills

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OBJECTIVES: To develop a unique simulation-based assessment using a laparoscopic inferior vena cava (IVC) injury scenario that allows for the safe assessment of urology resident's technical and nontechnical skills, and investigate the effect of personality traits performance in a surgical crisis.

METHODS: Urology residents from our institution were recruited to participate in a simulation-based training laparoscopic nephrectomy exercise. Residents completed demographic and multidimensional personality questionnaires and were instructed to play the role of staff urologist. A vasovagal response to pneumoperitoneum and an IVC injury event were scripted into the scenario. Technical and nontechnical skills were assessed by expert laparoscopic surgeons using validated tools (task checklist, GOALS, and NOTSS).

RESULTS: Ten junior and five senior urology residents participated. Five residents were unable to complete the exercise safely. Senior residents outperformed juniors on technical (checklist score 15.1 vs 9.9, $p < 0.01$, GOALS score 18.0 vs 13.3, $p < 0.01$) and nontechnical performance (NOTSS score 13.8 vs 10.1, $p = 0.03$). Technical performance scores correlated with NOTSS scores ($p < 0.01$) and pass/fail rating correlated with technical performance ($p < 0.01$ for both checklist and GOALS), NOTSS score ($p = 0.02$), and blood loss ($p < 0.01$). Only the conscientiousness dimension of the big five inventory correlated with technical score ($p = 0.03$) and pass/fail rating ($p = 0.04$).

CONCLUSIONS: Resident level of training and laparoscopic experience correlated with technical performance during a simulation-based laparoscopic IVC injury crisis management scenario, as well as multiple domains of nontechnical performance. Personality traits of our surgical residents are similar and did not predict technical skill. (J Surg Ed ■:■■■-■■■. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: laparoscopy, simulation-based assessment, crisis management, technical skills, nontechnical skills

COMPETENCIES: Patient Care, Practice-based Learning & Improvement

INTRODUCTION

A variety of factors in the modern surgical training landscape have provided an impetus to increase the role of simulation-based training (SBT).[1] Pressures to increase the efficiency of health care delivery and mandates to decrease resident work hours have shifted surgical training away from an apprenticeship model toward a competency-based one.[2] Increasing ethical demands in patient care and increased case complexity have driven interest in SBT to augment training programs.[3] Several decades of development have made SBT an accepted training method with supporting validity evidence, and experience gained from SBT has been shown to translate into the clinical environment.[4] For example, learners who trained with SBT methods demonstrated decreasing operative times, errors, intraoperative and postoperative complications during laparoscopic surgery when compared to those trained without SBT.[5,6]

Modern SBT is moving toward high-fidelity training scenarios that incorporate the teaching and assessment of

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both technical and nontechnical skills. Simulation platforms had traditionally focused on the development of surgical technique, however, nontechnical skills such as communication, teamwork, and decision making have been increasingly emphasized and incorporated into simulation.[7] Motivation of these efforts comes from clinical data with evidence suggesting that almost half of surgical errors involved failures in effective communication among medical personnel.[8] Incorporation of these essential principles into simulation has yielded specific and targeted ways of educating physicians and trainees in how to be effective communicators.[9-11]

Beyond developing technical and nontechnical skills required for competency, the nature of high fidelity SBT offers several key advantages over traditional training methods. SBT provides a safe and standardized method of practice—learners can refresh or gain confidence in rare, emergency situations or risky procedures and can explore outside the "zone of clinical safety."[12] This advantage of simulation has been recognized in the aviation industry where simulation of crisis scenarios is routinely part of training.[13] Despite this, crisis or intraoperative emergency simulation training have received little attention in surgery to date.

This paper follows our work in 2012 describing a low-cost surgical model for use in a simulation-based team training laparoscopic crisis scenario.[14,15] Building on this work, we present an observational study further validating this high-fidelity laparoscopic crisis scenario designed to better understand predictors of surgeon technical skill with emphasis on nontechnical performance.

METHODS

This prospective single cohort simulation-based study was conducted at a single institution, after receiving Research and Ethics Board approval. Urology residents at the University of Toronto were recruited to participate in the study, giving written and verbal consent. Participants were blinded to the details of the simulation, only told that they were consenting to partake in a SBT laparoscopic nephrectomy exercise. Consenting residents completed a brief prestudy questionnaire that included participant demographics, previous SBT and laparoscopic nephrectomy experience, and self-assessment of laparoscopic skill. Participants additionally completed a multidimensional personality questionnaire, the big five inventory (BFI).[16] This validated, Likert-scale questionnaire covers 5 types of personality trait: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism.

The simulation scenario was held at our institutional simulation centre, in an immersive simulated operating room (OR), complete with full laparoscopic suite, surgical equipment, and an anesthesia machine (Fig. 1). Participants were recorded during the scenario through combined endoscopic video and in-room audio and video capture via wall-mounted cameras. The simulated patient consisted of a laparoscopic box-trainer, fully draped and positioned on the table as a patient would be during a laparoscopic right nephrectomy. The intra-abdominal organs were simulated using part-task trainers (Fig. 2). Participants were instructed to act as a staff urologist during the simulation, and direct the surgical team accordingly. Confederates included in the simulation included a scrub nurse, surgical assistant, and an anesthesiologist. The standardized scenario was coordinated by a trained simulation technician observing the entire scenario through one-way mirrored glass (Fig. 3).

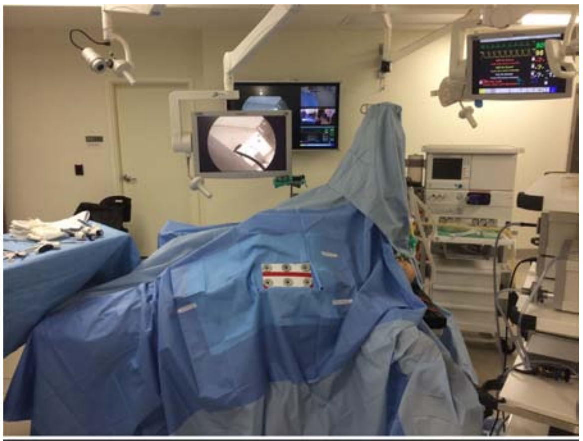

FIGURE 1. immersive simulated operating room (OR), complete with full laparoscopic suite, surgical equipment, and an anesthesia machine.

The simulated scenario began with the participant entering the OR after scrubbing, the patient already prepped and draped, the surgical team waiting for the final preoperative time-out before beginning the laparoscopic right radical nephrectomy. The participants were oriented to the specific surgical case, including patient details, and were instructed that they were to act as the staff urologist. They were oriented to the rules of the simulated scenario but were not told that any adverse events were included in the scenario.

The scripted scenario consisted of 2 crisis events. First, a vasovagal response occurred following the insertion of a Veress needle and the start of pneumoperitoneum. The simulation technician could cause alarms to ring at the anesthesiologist's machine, as would occur in a real OR environment, indicating acute and severe bradycardia and hypotension. If the participant did not recognize the event as a vasovagal response, the anesthesiologist was scripted to prompt the participant of the diagnosis. Second, an inferior vena cava (IVC) injury was simulated during mobilization of the kidney using the model shown in Figure 2. This injury occurred at a standardized step of the procedure—after clipping and cutting the renal artery. The patient condition was linked to the management of the IVC injury scenario and controlled by the simulation technician. All participants could proceed to the second part of the simulation