Surgical Resident Performance on a Virtual Reality Simulator Correlates with Operating Room Performance

Eyad M. Wohaibi, M.D., Ronald W. Bush, B.S., David B. Earle, M.D., FACS, and Neal E. Seymour, M.D., FACS[1]

Department of Surgery, Baystate Medical Center/Tufts University School of Medicine, Springfield, Massachusetts

Background. To define the ability of a virtual reality (VR) simulator to reflect clinical skill in surgical residents, we compared clinical laparoscopic performance and contemporary lab performance during curricular VR skills training.

Methods. Nine postgraduate year (PGY) 1 and 2 surgical residents were assessed during laparoscopic cholecystectomies and appendectomies using a web-based interactive database (OpRate)over a 6-mo period. Operative performance data were collected at the conclusion of procedures (mean responses of attending surgeons in nine areas pertaining to resident preparedness and technical skill). During this period, all residents undertook iterative laparoscopic training using a new VR trainer (SEP: SimSurgery AS, Oslo, Norway; METI, Sarasota FL). OpRate performance over 4-wk blocks and closest VR performance data (mean time, path length, and errors for three iterations of six basic skills tasks) were tested for correlation by linear (Pearson) correlation method.

Results. Residents performed 1 to 6 operative cases each (median = 3) during time blocks used for comparisons (median separation operative and SEP performance data 18 d). Significant correlation of operative and VR scores was found for time to task completion in 5 of 6 VR tasks. Results were most significant for a gallbladder dissection task ($P = 0.0066$, correlation coefficient $= -0.6671$). No significant correlation of path length or error data and operative performance was observed for any VR task.

Conclusions. These data indicate that time to task completion on a VR training device correlates with resident performance in the clinical operating room. Serial evaluations will determine if concurrent performance improvement over time can be demonstrated. © 2010 Elsevier Inc. All rights reserved.

Key Words: virtual reality; objective assessment; operative performance; simulation.

[1] To whom correspondence and reprint requests should be addressed at Baystate Medical Center, Department of Surgery, 759 Chestnut Street, Springfield, MA. E-mail: neal.Seymour@bhs.org.

INTRODUCTION

Quantitative methodologies to evaluate surgeon performance have progressed beyond the status of investigative tools. Within surgical residency training systems, the need exists to constantly clarify resident performance issues for the purposes of (1) continuous educational needs determination, (2) modeling of training activities, and (3) determining the effectiveness of educational interventions. In the absence of performance monitoring, there is a tendency for educational processes to lag behind residents' needs, or potentially to focus efforts such as remediation in an imprecise fashion. The use of laboratory-based educational tools such as high-tech virtual reality surgical training devices has been undertaken in many institutions. It is assumed that practice on these platforms improves clinical performance, based on the results of small-scale investigative efforts [1, 2]. In large-scale, routine use during the course of efforts to train skills in the laboratory and in the clinical operating room, there are no data to define concurrent relationships between skills evidenced in the two venues.

The aim of this study was to test whether a concurrent relationship exists between skills evidenced by individual residents in computer-simulated laparoscopic surgery and skills evidenced in the clinical operating room, as an initial step towards showing that these related skills sets advance with practice in an interrelated fashion.

METHODS

This work was conducted within the framework of the surgical residency curriculum at Baystate Medical Center in Springfield, Massachusetts, an Accreditation Council for Graduate Medical Education (ACGME)-accredited training program in surgery. Operating room (OR) laparoscopic surgical performance and virtual reality (VR) laparoscopic training performance were examined for 12 postgraduate year (PGY) 1 and 2 surgical residents from July 2006 to January 2007.

Operative Skills Assessment

The Department of Surgery has used a network-based tool, OpRate, to assess resident performance in the operating room on a wide basis since 2005. OpRate is a data entry application (Microsoft Visual Basic 6, Microsoft Corp., Redmond, WA) that was developed in partnership with Baystate Information Services with specific design features to ease data entry and facilitate compliance with use. It interfaces seamlessly with the hospital's Enterprise Database (Oracle Corporation, Redwood Shores, CA), which is the server-based destination of all inputted data. Data fields include (1) resident case log information (procedure date, patient information and case description); (2) evaluation of specific areas of resident performance; and (3) summative information including global evaluation of resident performance, attending surgeon narrative comments, and both resident and attending estimates of percentage of the case performed by the resident, with single-window access to all survey questions (Fig.1). Case description data are drawn from an extensive series of drop-down menus listing specific Current Procedural Terminology (CPT)-linked procedures. Evaluation of resident performance consists of three preoperative preparedness questions on resident knowledge of patient information, technical aspects of procedure, as well as the disease being treated. Rater responses consisted of "well informed," "somewhat informed," "knows a few facts," and "knows nothing." Evaluation of open and laparoscopic technical skills consisted of six identical questions for each approach. These queried skill in tissue handling, knot tying security and dexterity, general dexterity with instruments, operative planning, and the ability to function independently. Rater responses consisted of four frequency-based levels of performance selected from a drop-down menu linked to each question ("always," "usually," "occasionally," and "never"). Responses for preparedness and skills questions were assigned numerical values of 1 to 4, the higher number reflecting better performance.

Access to the OpRate application is available on computers throughout the operating rooms and postanesthesia care unit. Proper use of OpRate is identified to all attending surgeons participating in resident training and reviewed during the course of the academic year at Teaching Faculty meetings. Requirements for optimal use include data entry by the supervising attending surgeon in the operating room at the end of the clinical operation.

The OpRate database was queried for assessments for the designated residents and time period, for laparoscopic cholecystectomy and laparoscopic appendectomy. These two cases were chosen for review because they were felt to represent a uniform construct as the basic laparoscopic teaching cases for residents during the PGY 1 and 2 years. A mean OpRate performance score for the preparedness and laparoscopic skills items was generated for each case. In view of the case types examined, open surgical skills were not considered.

Virtual Reality Simulation Training

Laparoscopic VR training was conducted on the Surgical SIM/Surgical Education Platform (SEP) system (Medical Education Technologies, Inc., Sarasota, FL; SimSurgery AB, Oslo, Norway). Iterative practice occurred in both scheduled, mentored sessions and in self-directed practice sessions. Recorded performance metrics consisted of time to task completion (seconds), instrument tip path length (centimeters), and number of errors for four basic manipulative tasks (retract, retract and dissect, traverse tube, place arrow) and two procedural tasks (apply clips, dissect gallbladder) configured at default intermediate to difficult, and customized difficult settings.

Data from OpRate encounters were matched to SEP performance data based on temporal proximity. Because both resident performance of the operative procedures (and hence OpRate evaluation
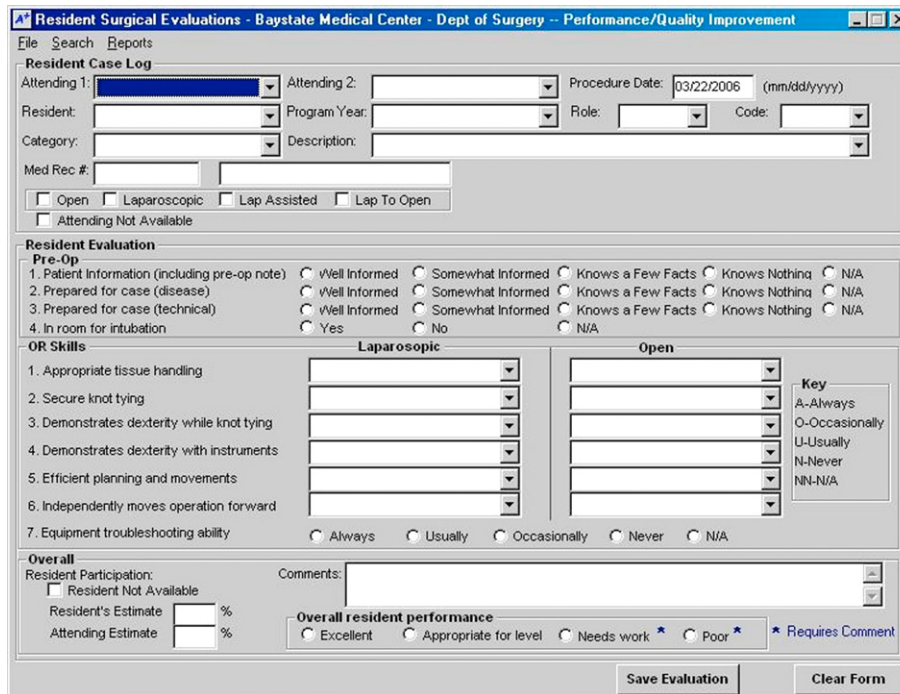

FIG. 1. OpRate user screen as it would be viewed by an attending surgeon rater and surgical resident at the end of an operative case. (Color version of figure is available online.)