Criterion-based Training with Surgical Simulators: Proficiency of Experienced Surgeons

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Abstract

OBJECTIVE: The new paradigm in surgical education for basic skills training is using computer-based (manikin, augmented or virtual reality) simulators with embedded criteria to be achieved by students before performing surgery on patients. To establish training criteria, we have assessed the performance of 18 experienced laparoscopic surgeons' basic technical surgical skills of recorded electronically in 26 basic skills modules selected in five commercially available, computer-based simulators.

METHODS/PROCEDURES: Quantitative data produced by the surgeons practicing repetitively during three one-half day sessions on each of five different simulators were collected in a Stanford IRB-approved study. Laparoscopic surgeons (8 generalists, six gynecologists, and four urologists) were recruited; eleven were academic surgeons, and fifteen perform ≥ ten laparoscopic surgeries per month. Surgeons were randomly assigned to simulator stations (a total of 15 were provided by vendors) during each session. Each surgeon received a demonstration of the functioning of each module by a trained assistant who also logged the surgeon into and out of modules, using assigned participant numbers to assure anonymity. Demographic and opinion data were obtained to facilitate analysis. We developed proficiency score formulas for each module of the form $b_0 + b_1X_1 + b_2X_2 + \ldots + b_kX_k$, where b_0, b_1, b_2, . . ., b_k are constants (called coefficients) and X_1, X_2, . . ., X_k are the measures (variables) recorded in the module. Assumptions in the analysis are that the proficiency levels of subjects are ≥ 50%, best performances do not exceed 100%, and proficiency increases with practice.

RESULTS: As expected, early practice attempts demonstrated a sharp learning curve and reduced variability among surgeons' performance. In the third and subsequent practice attempts, performance scores improved little. Median scores and the 10, 25, 50, 75, and 90 percent levels (percentiles) are provided for each module. Construct validity was examined with these data by comparing data for two of the modules from a convenience sample of less-experienced laparoscopic surgeons.

CONCLUSIONS: The mathematical method is simple, easily adjustable, and is applicable to the following simulators for which data are available: Lap Mentor (Simbionix), LapSim (Surgical-Science), LTS2000 ISM60 (RealSim), ProMIS (Haptica), and Surgical Sim (METI). Based upon this study, proficiency levels for training courses can now be specified objectively (and tentatively) by residency directors and by professional organizations for different levels of training or post-training assessment of technical performance.