The American Journal of Surgery*

Association of Women Surgeons

Predicting surgical skill acquisition in preclinical medical students



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Surgical simulation; Invasive skills; Medical education; Medical students; Preclinical; Skill acquisition

Abstract

BACKGROUND: The purpose of this study was to identify factors that predict medical student success in acquiring invasive procedural skills. We hypothesized that students with interest in surgery and with prior procedural experience would have higher rates of success.

METHODS: Preclinical students were enrolled in a simulation course comprised of suturing, intubation, and central venous catheterization. Students completed surveys to describe demographics, specialty interest area, prior experience, and confidence. Using linear regression, variables predictive of proficiency were identified.

RESULTS: Forty-five participants completed the course. Under univariate analysis, composite pretest score was inversely associated with confidence (P = .039). Under multivariable analysis, female gender was associated with higher pretest suturing score (P = .016). Male gender (P = .029) and high confidence (P = .021) were associated with greater improvement in suturing.

CONCLUSIONS: Among novices, higher confidence can predict lower baseline technical proficiency. Although females had higher pretest suturing scores, high confidence and male gender were associated with the greatest degree of improvement.

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According to a recent report released by the American Association of Medical Colleges, despite an increase in the number of women applying to medical school in the past several decades, the proportion of female students still

Manuscript received February 16, 2016; revised manuscript April 19, 2016

0002-9610/\$ - see front matter © 2016 Elsevier Inc. All rights reserved. http://dx.doi.org/10.1016/j.amjsurg.2016.06.024 remains at less than 50%.¹ Over the last 10 years, the number of female residents has increased from 41% to 46%. Despite this encouraging trend, a gender disparity remains in certain specialty areas, including surgery, where just 38% of residents are female.¹ Furthermore, as women progress through a career in academic medicine, the higher the rank, the more the gender gap widens.^{1,2}

Although several studies have demonstrated that women perform worse than men in initial laparoscopic skill, the relationship between gender and performance of basic procedural skills has not been well established.³ Previous studies have examined factors influencing acquisition of laparoscopic skills in an attempt to develop simulation or training activities that promote the acquisition of complex minimally invasive surgical skills.^{3,4} Studies investigating

This study was supported in part by funding support provided by the University of Virginia Academy of Distinguished Educators Grant to Y.H. and S.K.R. All the other authors have no funding and conflicts to disclose.

Presented in part at the American College of Surgeons' Clinical Congress 2015, October 4–8, Chicago, IL.

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laparoscopic or endoscopic skills have been more likely to focus on visual-spatial manipulation rather than common bedside procedures, which are heavily used by surgeonsin-training. There remains a dearth of evidence related to acquisition of basic bedside technical proficiency.

The educational experience for preclinical medical students focuses primarily on lecture-based courses typically in the first 2 years of medical school, leaving minimal time for early exposure to procedural skills. In most medical schools, emphasis in the preclinical curriculum is didactic. However, many schools are seeking to provide students with early experiences with procedural skills through early clinical exposure or simulation exercises.^{5–8} Several studies have sought to examine innate ability versus ability to acquire new skills.⁹ However, few have examined basic procedures and the ability to acquire and improve on these skills in a population of naive learners. Furthermore, differences in skill acquisition related to gender have not been fully explored.^{3,10–12}

For the present study, we sought to examine participantlevel factors that influence both initial, untrained performance of basic procedural skills, as well as the rate of skill acquisition. We hypothesized that students with an interest in surgery and prior experience would have higher initial proficiency. We predicted that both baseline skill level and rate of improvement would be equal between genders.

Methods

Basic skills course design and implementation

Forty-five first- and second-year preclinical medical students were enrolled in a longitudinal simulation course comprised of 3 modules created to train and evaluate medical students in basic procedural skills. These modules included basic suturing, endotracheal intubation, and subclavian central venous catheterization (CVC). Students participated in an orientation session, which provided instruction on proper technique, and weekly practice sessions administered over a 3-month period. This involved a commitment of between 10 and 15 hours, and students were compensated with a stipend of \$100. Specific details related to skill methods and scoring criteria have been described in previous publications.¹³ Briefly, orientation provided for the suturing skills module offered instruction on instrument handling and technique for 1-handed, 2-handed, and instrument-tie knots. The intubation module orientation provided instruction on oneperson bag-valve-mask ventilation, direct laryngoscopy, and endotracheal intubation. The CVC module orientation provided instruction regarding placement of a subclavian CVC without ultrasound guidance.

Scoring criteria for each task were developed using the objective structured assessment of technical skills. Details regarding the scoring have been previously described.¹⁴ Pretest performance was calculated by combining the top 2 scores from the first 3 practice attempts for each

participant. Participants were scored on a weighted checklist for each task, which included penalties for violating time restrictions: 5 minutes for suturing, 2 minutes for intubation, and 10 minutes for CVC.

Before participation, students completed surveys pertaining to demographic data, specialty interest area (ie, procedural vs nonprocedural), experience with common technical skills, and confidence in acquiring new skills. Survey responses were used to create outcome measures to represent experience, confidence, and intended area of specialization. Three questions assessed experience with prior procedural skills or "experience". One question assessed "confidence" in acquiring new skills. Each of these questions had 3 potential responses, which were given point values ranging from 1 to 3 points based on a Likert scale. An average score was then generated. Experience level and self-confidence were defined as "high" if calculated score was greater than the median or "low" if calculated score was less than or equal to the median. One survey question assessed area of current specialty interest. Possible responses included the following specialty areas: internal medicine; surgery and surgical subspecialties; obstetrics and gynecology; pediatrics; neurology or psychiatry; radiology; emergency medicine; anesthesiology; undecided. Specialty areas were then categorized as "procedural" or "nonprocedural".

Statistical analysis

A retrospective analysis was undertaken on the prospectively collected data. Summary data for the participant cohort survey responses were aggregated to describe the baseline response variables including gender, specialty interest area, experience level, and self-confidence level. Pretest composite score represents averaged initial performance on each of the 3 procedure modules. Univariate and multivariable linear regression analyses were used to test the effect of clinical covariates on the following outcomes: composite pretest score, improvement in composite score, individual task pretest scores, and improvement in individual task scores. The threshold for statistical significance was set at an alpha level of .05. All data were analyzed using Stata statistical software (version 14.1; StataCorp LP). The Institutional Review Board of the University of Virginia approved this study (protocol # 2013-0246-00).

Results

All 45 students completed the study, including the orientation and all subsequent required sessions, and were included in the final analysis. Participants were predominantly second-year students (N = 37, 82.2%). Thirty-one were male (68.9%). As demonstrated in Table 1, the only significant difference between male and female participants in this study was in self-reported confidence in ability to acquire new skills—a vast majority of female participants (n = 13,

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