The American Journal of Surgery 220 (2020) 90–94

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

A technical skills elective program for pre-clerkship medical students reduces levels of high anxiety for performing technical skills

Tyson Savage [a, *], Justin Z. Wang [a], Thin Xuan Vo [a], Gary Ko [a, b], Riaz J. Karmali [a], Jennifer Siu [a], Stefania Spano [a], Daniel You [a], Mila Kolar [a, c], Andrea Winthrop [a, c], Stephen Mann [a, c]

[a] Undergraduate Medical Education Program, Queen's University, Kingston, ON, Canada
[b] Postgraduate Medical Education Program, Queen's University, Kingston, ON, Canada
[c] Department of Surgery, Queen's University, Kingston, ON, Canada

ARTICLE INFO

Article history:
Received 9 September 2019
Accepted 13 October 2019

ABSTRACT

Background: We investigated the effect of a simulation-based technical skills course on rates of high anxiety reported by pre-clerkship medical students for basic and advanced technical skills.
Methods: Twenty-two second year medical students reported levels of anxiety by electronic survey for 21 technical skills before and after the course. A peer group of 75 students were invited to complete the survey for comparison.
Results: We received 21 (95.5%) responses before and after the course, and 12 (57.1%) in a three-month follow-up. Rates of high anxiety ranged from 19 to 86% across skills before the course and 0–48% afterward. There was no statistically significant difference in high anxiety reported in a three-month follow-up survey. The rates of high anxiety reported were reduced across all skills for course participants compared to the responding peer group of 32 (42.7%), reaching a statistically significant difference for 15/21 skills ($P < 0.05$).
Conclusions: Participation in this technical skills course was associated with decreased reports of high anxiety by pre-clerkship medical students regarding the performance of basic and advanced technical skills.

Introduction

Undergraduate medical curricula increasingly use simulation-based technical skills courses to introduce medical students to surgical specialties and to provide training for the technical skills required in clinical clerkship and residency.[1–3] Simulation-based training allows pre-clinical learners to begin skill acquisition in a safe and structured learning environment through deliberate practice under the guidance of skilled instructors.

The Surgical Skills and Technology Elective Program (SSTEP) is an initiative at the Queen's University School of Medicine (Kingston, Ontario) started in 2014. The goal of SSTEP is to provide pre-clerkship medical students with practice in high-yield technical skills, such as basic suturing and knot tying through simulation. The program also provides students with early exposure to more advanced technical skills not traditionally taught in pre-clinical undergraduate medical education but often encountered in clinical clerkship rotations, such as incision and drainage, chest tube insertion, and episiotomy repair. SSTEP has previously been shown to improve technical skill performance and increase interest in surgery as a career choice.[4]

This study examines a new cohort of students who completed SSTEP, exploring the effects of simulation-based technical skills courses on learner anxiety. Medical students transitioning from the classroom into the clinical setting are known to report anxiety about performing basic technical skills on patients.[5,6] Previous research has shown that simulation-based technical skills courses have been successful in reducing anxiety or increasing confidence in basic suturing, knot tying, and intravenous and nasogastric tube placement.[1,2] This study aims to expand upon these prior findings with a broader selection of technical skills, including the more advanced skills introduced to students in SSTEP. Our interest was in

* Corresponding author. Foothills Medical Centre, Department of Emergency Medicine, Room C231,1403-29 Street NW, Calgary, AB T2N 2T9, Canada
E-mail address: tyson.savage@ucalgary.ca (T. Savage).

https://doi.org/10.1016/j.amjsurg.2019.10.028
0002-9610/

identifying rates of high or extreme levels of anxiety which have the potential to impair skill acquisition.[7]

The goal of this study is to investigate the effects of a one-week simulation-based technical skills program on self-reported levels of anxiety. The primary outcome is the frequency of high or extreme anxiety reported for each technical skill before and immediately after the course. Secondary outcomes include frequency of high or extreme anxiety reported in a three-month follow-up survey and comparison of anxiety reported by the course participants to that of a peer group of medical students who did not participate in the course.

Methods

Twenty-two second year, pre-clerkship, medical students from the Queen's University School of Medicine voluntarily participated in SSTEP, a five-day, 30-h, technical skills elective course. The course taught technical skills by facilitating deliberate practice on simulation trainers with instruction and immediate feedback from senior residents and attending physicians. Each session began with a short didactic lecture on the indications, contraindications, complications, and technical approaches to a specific procedure before students had the opportunity to practice on a simulation trainer under direct supervision. Some of the simulation models used included: synthetic suture pads (suturing and biopsy), porcine ribs (chest tube insertion), bovine tongue (episiotomy repair), and bovine scapulae (burr hole drilling).

The course capacity of twenty-two was determined based on available resources (lab space, simulation trainers, supervisors) in the simulation lab. We invited all medical students in their second year of study at Queen's University ($N = 100$), excluding those involved in SSTEP administration or research ($N = 3$), to apply for the course and selected twenty-two participants from a total applicant pool of thirty-eight using an electronic lottery system.

An electronic survey was used to have participants report their levels of anxiety in performing twenty-one technical skills of interest. We used a 5-point Likert scale for each technical skill, with the options: "No anxiety at all", "A little anxiety", "Moderate Anxiety", "High Anxiety", "Extremely high anxiety (unable to carry out task)". Respondents were prompted to consider their level of anxiety after being asked to perform each technical skill in a clinical setting; for example: "Your preceptor asks you to close a surgical incision with subcuticular suturing".

Gender was recorded for demographic purposes as well as asking participants to list their top three career interests at the time of the initial survey before course participation.

A peer group of medical students from the same class who did not participate in SSTEP were also invited to complete the survey ($N = 75$). An invitation to complete the survey in July 2015 was sent and then again in September 2015 to increase response rate. We discarded any survey responses in September which came from an individual who had already responded in July.

Outcomes

The primary outcome was the percentage of respondents who reported "High Anxiety" or "Extremely High Anxiety (unable to carry out task)" for each procedural task before and after the course.

Secondary outcomes included self-reported anxiety three months after the course and comparison of participants' post-course responses to that of the peer group.

Statistical analysis

The Wilcoxon Signed-Rank Test was used for the paired data of individual participants at the different time points, and the Mann-Whitney *U* Test was used to compare the SSTEP participants to the peer group, considering a p-value less than 0.05 statistically significant for both. We used IBM SPSS statistics software for data calculations and analysis.

Ethics

The Queen's University Health Sciences Research Ethics Board reviewed this study and granted ethics approval (SMED-171-15). We obtained informed consent electronically, and this was required before respondents could access the survey.

Results

Response rates

Twenty-one (95.5%) of the course participants completed surveys before and after the course, and twelve (57.1%) responded in the three-month follow-up survey. Thirty-two (42.7%) students from the peer group provided responses. Four of the respondents in the peer group had applied to SSTEP but did not receive a position in the lottery. Three responses in the September peer group survey were discarded as those individuals had already submitted responses in the July survey.

Participant demographics

Twelve (54.5%) of the course participants were female. When participants were asked to list the specialities in which they were considering a career, 59% listed a surgical speciality at least once within their top three choices (Table 1).

Primary outcome

We observed a decrease in high or extreme anxiety reported immediately after the course for every skill, all of which reached a statistically significant difference ($P < 0.05$) with the exception of Foley catheter insertions. Reported levels of high or extreme anxiety ranged from 19 to 86% before the course and 0–48% afterward (Fig. 1).

Secondary outcomes

The frequency of high or extreme anxiety reported remained 0% in three-month follow-up for the basic skills of simple interrupted suturing, mattress suturing, and knot ties. The remainder of basic skills (subcuticular suturing, selection of suture size, and Foley catheter insertions) all had 1 of 12 (8.33%) participants reporting high or extreme anxiety in the 3-month follow-up, which did not reach statistical significance from the post course responses. For the majority of the more advanced skills, the rates of high or extreme anxiety reported was increased at the three-month follow-up ($P > 0.05$).

SSTEP participants reported lower rates of high or extreme anxiety compared to the peer group for all skills with 15/21 skills showing a statistically significant difference (Fig. 2). For the common core skills expected of medical students during clinical clerkship at Queen's University, such as basic suturing and knot tying, none of the SSTEP participants reported high or extreme anxiety after the course compared to 6–21% of the peer group who did ($P < 0.05$). For more advanced clerkship skills, including tissue biopsies, incision and drainage, intrauterine device insertion, and laparoscopic camera navigation, rates of high or extreme anxiety ranged from 0 to 15% among SSTEP participants compared to

Table 1
Number of participants who reported each speciality within their "top 3" of career interest.

	Number of Participants who listed each Speciality within their "Top 3" of career interest before taking SSTEP (%)
Surgery or Surgical Subspecialty[a]	13 (59.09)
Internal Medicine or Medical Subspecialty	11 (50.00)
Family Medicine	11(50.00)
Emergency Medicine or Anesthesia	8 (36.36)
Other[b]	5 (22.73)

[a] Including General Surgery, Plastic Surgery, Urology, Obstetrics/Gynecology, Orthopedic Surgery, Neurosurgery and Ophthalmology.
[b] Including Psychiatry, Radiology, Physical Medicine and Rehabilitation, Public and Community Health, and Neurology.

22–46% in the peer group. For skills considered beyond the expectation of medical students, such as burr hole placement, episiotomy repair, and chest tube insertion, high or extreme anxiety was reported in 19–33% of SSTEP participants and 53–75% of the peer group.

Discussion

In keeping with prior literature, we observed a reduction in reported anxiety for performing basic skills.[1,2] Reports of high or extreme anxiety for performing one-hand knot ties and instrument knot ties decreased from 33.00% to 19.05%, respectively, before the course to 0% after the course ($p < 0.05$). We also observed a reduction in self-reported high or extreme anxiety for more advanced skills, such as chest tube insertion (66.67% before and 23.81% after, $P < 0.05$) and episiotomy repair (71.43% before and 19.05% after, $P < 0.05$) suggesting that dedicated simulation-based technical skills training can reduce anxiety in pre-clinical medical students even in relatively advanced procedures that they may not be expected to perform until residency.

We did not find any literature to compare to regarding the duration for which the anxiety reduction would be retained after the course. At the three month follow-up, some of the advance skills had increases in reported rates of high or extreme anxiety compared to immediately after the course, including incision and drainage of a skin abscess (4.76%–16.67%), burr hole placement (33.33%–50%), and chest tube insertion (23.81%–58.33%); however, none of these reached a statistically significant difference ($P > 0.05$). We interpret this to suggest that the effect of anxiety reduction is maintained to some extent at the three-month interval but is likely fading. For these reasons, medical students may still gain some anxiety reduction benefit from these skills courses if

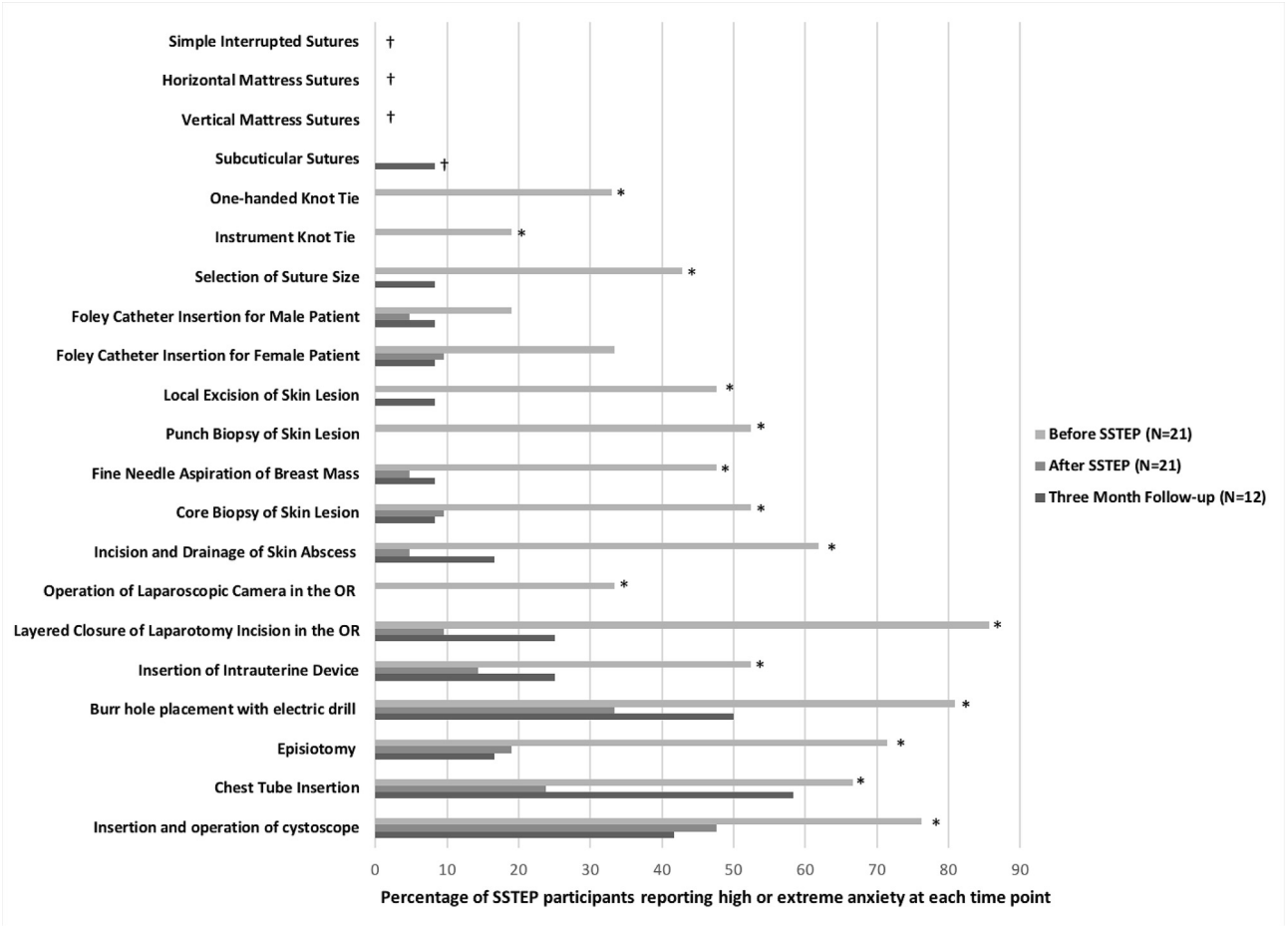

Fig. 1. Percentage of SSTEP participants reporting levels of high or extreme anxiety about performing various technical skills before, after, and three months following the course.
*p-value <0.05 for Before SSTEP versus After SSTEP
**p-value <0.05 for After SSTEP versus Three Month Follow-up
†only data for After SSTEP and Three-Month Follow-up was collected.

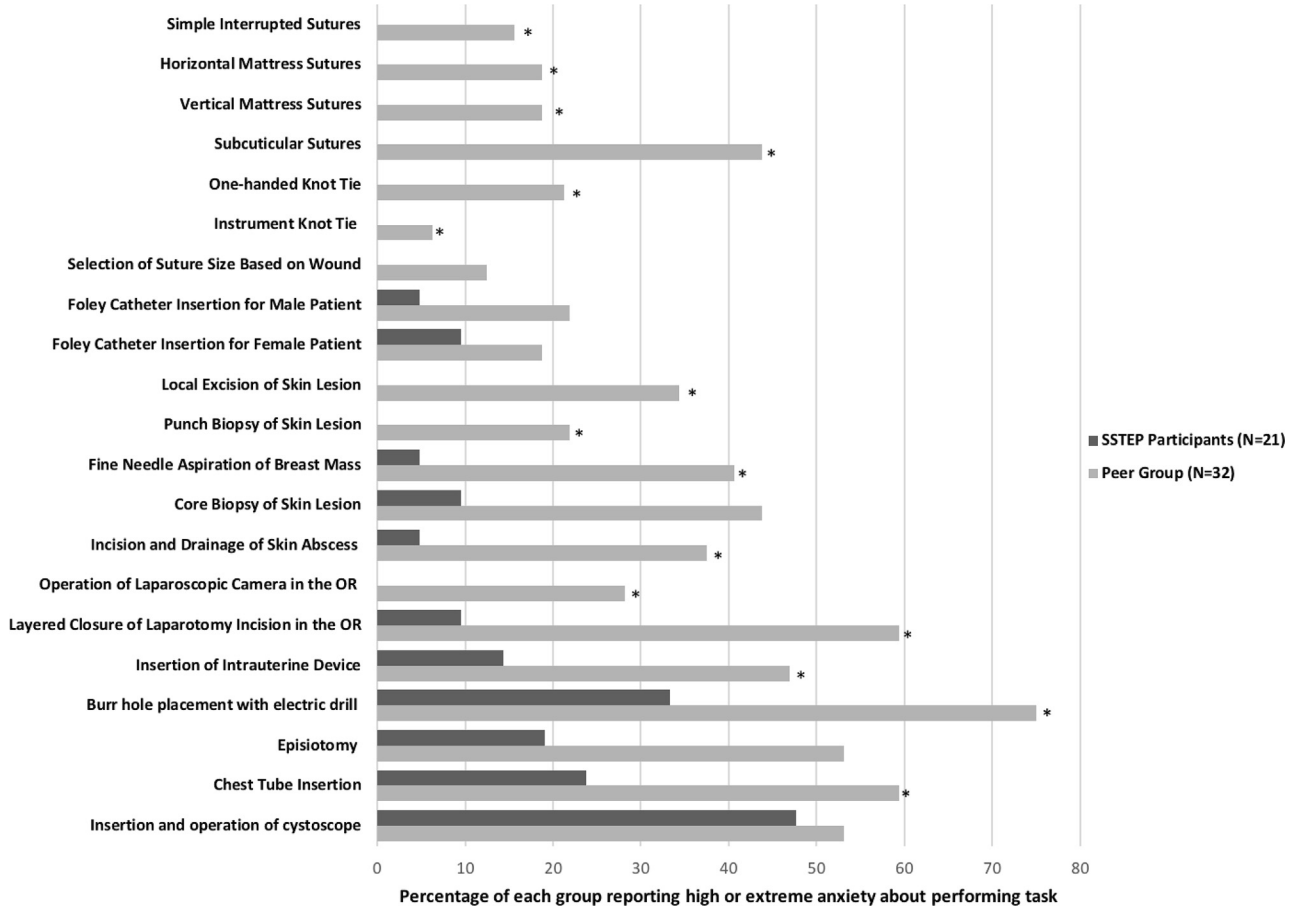

Fig. 2. Percentage of SSTEP participants and peer group reporting levels of high or extreme anxiety about performing various technical skills.
*p-value <0.05.

they take place within three months before they are on a clerkship rotation where they are exposed to the skill in a clinical setting.

Our interest in identifying high levels of anxiety is based on the proposition that higher levels of anxiety are detrimental to skill acquisition in junior learners. Pellegrini summaries works of Ericsson, Reznick, and others which suggests that, while low-tension environments can enhance learning, higher-tension environments, such as the operating room, may impair motor skill acquisition due to anxiety.[7] We suspect that reducing high anxiety levels through a technical skills course like SSTEP will contribute to improved skill acquisition during clinical clerkship where learners are performing tasks in higher-tension environments like the operating room and emergency department.

SSTEP occurs at the end of pre-clerkship at Queen's University in order to help prepare students for transition to clerkship, where there will be more regular opportunities to perform technical skills in a clinical setting. It is important to recognize that due to the one-time nature of some technical skills training courses, including SSTEP, there is no mechanism to ensure participants go on to have sustained deliberate practice, which is a key component of skill learning and development.[8] Ideally a mechanism to offer students on-going opportunities for simulated technical skills practise could be put in place in undergraduate curricula; however, if available resources limit sustained simulation-based practise, there may still be benefit from a one-time course if the reduction in anxiety encourages students to participate more often in clinical opportunities to perform technical skills, improving their proficiency. This is supported by Fincher and Lewis who showed a significant association between the number of procedures performed and self-assessed competence in clinical medical students in the year following a basic skills training session.[9]

Future directions

The next phase of this investigation is to examine clerkship technical procedure logs for SSTEP participants compared to their peers to determine whether course participation was associated with greater participation in technical skills throughout clerkship and improved skill performance at the end of medical school.

Limitations

We have collected self-reported levels of anxiety the participant believes they would feel if asked to perform the technical skill in a clinical environment. We make the assumption that this will serve as a surrogate marker of the anxiety the participant would feel in a true clinical setting; however, the survey is not validated to this regard and the accuracy of self-reported anxiety in this survey to true anxiety in a clinical setting is unknown.

In the first version of our survey, which was administered to the SSTEP cohort prior to taking the course, we did not divide suturing into the subcategories of simple interrupted, mattress, and subcuticular. The survey was modified for the post-course and three-month follow-up period to include these subcategories to increase the breadth of information obtained regarding suturing. Consequently, this study cannot quantify the degree of anxiety

reduction for suturing sub-categories for the time interval of the primary outcome.

We suspect that a degree of participation bias is present based on the high proportion (59%) of participants who reported interest in a surgical speciality before taking the course (Table 1). Although we did not obtain data on surgical interest in the peer group, we suspect it would be significantly lower than 59% as only 17.6% of Canadian medical students went into a surgical speciality according to 2017 Canadian residency match data.[10] The degree of anxiety reduction may be less in a cohort of students less inclined towards a surgical or technical-skill heavy career.

Conclusion

This simulation-based technical skills course for pre-clinical medical students was associated with reduced reports of high and extreme anxiety for both basic and relatively advanced technical skills. At least some anxiety reduction is suspected to have persisted at a three-month follow-up interval and reported levels of high or extreme anxiety were lower among course participants compared to a cohort of their peers. Our study is limited by an unknown ability of the survey-reported anxiety level to reflect what participants would truly feel in a clinical setting, as well as potential participation bias with more participants interested in surgical specialities than would be expected in an average cohort of medical students. We suspect that simulation-based technical skills courses for pre-clerkship students likely reduce levels of high or extreme anxiety, and therefore may potentially help mitigate the negative effects of high anxiety on skill acquisition. Future study of whether pre-clerkship technical skills courses affect participation in clinical opportunities to perform technical skills during clerkship and skill proficiency at the end of medical school would be beneficial.

Sources of funding

The technical skills course that this research study was based on was supported by the Queen's University Aesculapian Society Student Initiatives Grant; Queen's Vice Provost Office Student Initiatives Fund; in-kind contribution of staff, equipment, and laboratory space from the Queen's University Clinical Simulation Centre; and, in-kind contribution of staff and/or equipment from DePuy Synthes, Mizuho Co. Ltd., and Stryker.

Declaration of competing interest

The authors declare no conflicts of interest.

Acknowledgements

The authors wish to thank the Queen's University Clinical Simulation Centre and Departments of Surgery, Emergency Medicine, Obstetrics and Gynecology, Family Medicine, and the Division of Dermatology.

We would like to thank all faculty and resident facilitators of the 2015 SSTEP course: Drs. Reznick, Sanfillippo, Rudan, Belliveau, McGraw, Andrews, Bardana, Chamberlain, Cook, Engel, Ellsworth, Gauvin, Gemmill, He, Hogeboom, Hollins, Leveridge, Lett, Leslie, Levy, Marois, Moran, Nanji, Parslow, Petsikas, Pilkington, Reid, Richards, Russell, Sisson, Skinner, Tang, Thomas, Toprak, Waddington, Wade, Wadsworth, Wallace. We would like to give a special thanks to staff of the Queen's University Simulation Centre Ms. Kimberley Garrison and Ms. Lucy Rebelo. A thank-you to our corporate sponsors who supplied equipment, models, and/or staff for several of our simulations including DePuy Synthes, Mizuho Co. Ltd., and Stryker.

References

1. Stewart RA, Hauge LS, Stewart RD, Rosen RL, Charnot-Katsikas A, Prinz RA. A CRASH course in procedural skills improves medical students' self-assessment of proficiency, confidence, and anxiety. *Am J Surg*. 2007;193:771–773. https://doi.org/10.1016/j.amjsurg.2007.01.019.
2. Sammann A, Tendick F, Ward D, Zaid H, O'Sullivan P, Ascher N. A surgical skills elective to expose preclinical medical students to surgery. *J Surg*. 2007;142(2):287–294. https://doi.org/10.1016/j.jss.2007.03.034.
3. Gawad N, Moussa F, Christakis GT, Rutka JT. Planting the "SEAD": early comprehensive exposure to surgery for medical students. *J Surg Educ*. 2013;70(4):487–494. https://doi.org/10.1016/j.jsurg.2013.03.006.
4. Karmali RJ, Siu JM, You DZ, et al. The Surgical Skills and Technology Elective Program (SSTEP): a comprehensive simulation-based surgical skills initiative for preclerkship medical students. *Am J Surg*. 2018;216:375–381. https://doi.org/10.1016/j.amjsurg.2017.09.012.
5. Moss F, McManus IC. The anxieties of new clinical students. *Med Educ*. 1992;26(1):17–20. https://doi.org/10.1111/j.1365-2923.1992.tb00116.x.
6. Sarikaya O, Civaner M, Kalaca S. The anxieties of medical students related to clinical training. *Int J Clin Pract*. 2006;60(11):1414–1418. https://doi.org/10.1111/j.1742-1241.2006.00869.x.
7. Pellegrini CA. Surgical education in the United States: navigating the white waters. *Ann Surg*. 2006;244(3):335–342. https://dx.doi.org/10.1097/01.sla.0000234800.08200.6c.
8. Kneebone R. Evaluating clinical simulations for learning. *Acad Med*. 2005;80(6):549–553. https://doi.org/10.1097/00001888-200506000-00006.
9. Fincher R-ME, Lewis LA. Learning, experience, and self-assessment of competence of third-year medical students in performing bedside procedures. *Acad Med*. 1994;69(4):291–295. https://doi.org/10.1097/00001888-199404000-00012.
10. The Canadian Resident Matching Service. 2017 R-1 main residency match table 11: first choice discipline of CMG applicants. Published https://www.carms.ca/data-reports/r1-data-reports; 2017. Accessed September 4, 2019.