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ORIGINAL SCIENTIFIC REPORT

Trends in Retention and Decay of Basic Surgical Skills: Evidence from Addis Ababa University, Ethiopia: A Prospective Case–Control Cohort Study

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Abstract

Introduction While prior studies have evaluated surgical skills simulation and retention in highly resourced environments, there is paucity of data on the retention of surgical skills taught in simulation laboratory to undergraduate students, and virtually none from low-resource settings. We aimed to evaluate the trends in retention/decay of surgical skills among medical students in Ethiopia and determine whether regular intervention in the form of intermittent skills testing can aid retention.

Methods Forty-four final year medical students were randomly divided into two cohorts of 22 students each. All 44 were trained in surgical instrument identification, simple interrupted suturing and one-handed knot tying. A previously validated, standardized assessment was performed before training, immediately after training, and then at 6 weeks, 3 months, 6 months and 1 year for cohort 1, and before training, immediately after training, and at 6 months and 1 year for cohort 2. All areas learned were tested for general decay.

Results The baseline mean scores of surgical skills were 3.8/30 for instrument identification, 3.3/15 for one-handed knot tying, and 1.35/15 for suturing. At the end of the training, mean scores improved to 26.6/30, 11.2/15 and 11.1/15 (instrument identification +599% and +772%, knot tying +447% and +417%, suturing +237% and +260%, respectively, for Cohort I and II). At 6 months and 1 year, there was a significant drop in all the three areas tested, especially in knot tying and suturing. There was no statistically significant difference between the two cohorts.

Conclusions While our surgical skills course is an effective means to teach surgical skills to medical students, there is significant decay in abilities after 6 months. Conducting regular assessments does not appear to have any effect in helping students retain these skills. We recommend such surgical skills training be conducted at appropriate intervals, such as just before internship, to prepare student for active surgical practice.

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Abbreviations

OSATS Objective structured assessment of technical skills
ANOVA Analysis of variance

Introduction

Surgical training programs have dealt with an increase in the number of trainees and an overall decrease in exposure to surgical practice by increasing simulation and skills laboratory teaching. Controlled, standardized surgical skills teaching is one instructional strategy used to teach technical skills, procedures, and operations [1, 2]. Its main objective is to present trainees with situations that resemble reality and provide unrestricted access to repetitive and controlled practice. However, it has been argued that it cannot be a replacement to the actual practical teaching at operation rooms. Simulation is also time and resource intensive and needs dedicated staff [1–3].

Like many low- and middle-income countries, Ethiopia has expanded the number of undergraduate students with little or no matching increase in operating room experience. It has further coupled this with the ambitious expansion of postgraduate programs throughout the country, but without a corresponding increase in consultants who can provide oversight or dedicated training [4, 5]. The Addis Ababa University School of Medicine established a skills laboratory in 2006 and has been teaching essential clinical skills to its undergraduates and basic surgical skills to its residents [5, 6].

Retention and appropriate demonstration of surgical skills is one of the most important aspects of surgical competency, particularity where simulation-based skills are concerned. It is assumed that most motor skills are lost over time, or at least the level of performance deteriorates after a period without practice [6, 7]. The studies done so far seem to agree that certain advanced surgical skills such as laparoscopic suturing and knot tying last for about 6 months. Better retention was seen when participants received ongoing training compared with participants with only one training period. Other studies have also shown that when not used, skill loss begins less than 1 day after training stops [8–10].

To our knowledge, there are few studies that looked into the retention and decay of surgical skills taught to senior medical students [6, 11], none from low-income countries. In addition, there is a gap in understanding the utility of periodic assessment in the retention of surgical skills over time.

The objective of this study was to determine whether, in the context of a low-resource environment, periodic skills assessment improves retention of basic surgical skills taught to final year medical students at the Addis Ababa University.

Materials and methods

This prospective comparative cohort study was undertaken by the Department of Surgery, School of Medicine of the Addis Ababa University from February 2015 to February 2016. The School of Medicine is the first medical school in Ethiopia and its surgical residency program accommodated more than 75% of the surgical trainees in the country during the study period. Its roster of surgical residents has increased from 10 in 2005 to 30 in 2014, while the total intake of undergraduate medical students also increased from 120 to 320 per year.

The study received ethical clearance and written permission from the Department of Surgery, research and publication committee. A group of 44 final year medical students were enrolled into the study after each of the participants gave informed verbal consent to participate.

For the purpose of this study, retention was defined as preservation of the effects of experience and learning that makes recall or recognition possible. If the performance on the retention test is unchanged from performance measured immediately after the end of the original learning, one would conclude that no loss has occurred and learning has been fully retained.

A panel of three expert surgeons (authors of the article) convened as a panel and systematically went through the list of procedures covered during the training and identified three skills as key indicator skills. The fourth author was responsible for handling the data and computation of the statistical figures. These three skills were recommended since they were considered to be universally important for medical students in their routine practice. These were instrument identification, one-handed knot tying and simple interrupted suturing. A standard curriculum was developed using the Fitts and Posner learning model of skill acquisition as a guiding principle [12], which states that performance is characterized by sequential cognitive, associative, and autonomous stages. First, task goals are established and used to determine the appropriate sequence of actions using explicit knowledge (cognitive). Next, attention is focused on specific details of the sequence to determine the appropriate subparts and transitions (associative). Finally, the action is practiced to hone performance into an automatized routine (autonomous). The curriculum utilized lectures, reading reference materials, videos, face-to-face hands-on training and independent practice as modes of skills transfer. During the training, the trainees had unrestricted access to the skills laboratory to practice the skills. The curriculum consisted of a lot of skills sets including the ones mentioned above, intestinal skills such as perforation repair and anastomosis, abdominal wall incision and closure, catheterization, chest tube insertion and basics of air way management. The curriculum is now an integral part of the general surgery curriculum and is publicly available.

At the beginning of the study, all 44 students that were doing their mandatory clerkship rotation at the department of surgery completed a pre-training assessment. After the 1-week hands-on skills training course, identical assessment was performed by the same assessors. For the comparative study, the students were randomly divided in half, with a specific attempt to keep the gender balance equal: Cohort A (22 students) underwent periodic assessment by the same assessors at weeks 6 and 12 weeks, 6 months, and 1 year following the original training; Cohort B (22 students) were assessed only at 6 months and 1 year following the training. Over this time, the students had progressed through their final year, sat for their qualifying exams, and started their first week of internship.

We used the objective structured assessment of technical skills (OSATS) evaluation format, an internationally accepted, validated tool, which we modified slightly to match the three key domains of assessment (Appendix). This tool was selected as a reliable and valid mechanism for assessing technical skills [13, 14]. Data were entered after checking for completeness, cleaning and coding using EPI-INFO software. Analysis was performed, and results were presented in the form of tables, graphs, percentage and mean. Statistical analysis was made for selected variables. Analysis of variance (ANOVA) was conducted to examine the difference between group means. Regression analysis was carried out to determine the relationship between variables. A p value of <0.05 was considered significant. EPI-INFO for Windows (version 16.0) was used for statistical analysis.

Results

The two groups of students were demographically similar regarding age, sex and year of training, as well as pre- or post-training surgical exposure. Results of the pre-training assessment using the OSATS were 3.82/30, 1.32/15 and 3.32/15 for cohort 1 and 3.86/30, 1.29/15 and 3.14/15 for cohort 2, with no difference significant difference between them (Fig. 1). Following the 5-day training, the same tests were administered to both cohorts by the same assessors with substantial improvements noted in both cohorts—26.64/30 versus 26.67/30 for instrument identification, 7.18/15 versus 6.67/15 for suturing, and 11.18/15 versus 11.29/15 for knot tying for Cohorts 1 versus 2, respectively (Fig. 1).

All students in cohort 1 underwent this same skill assessment at 6 and 12 weeks after the training, and all the cohorts underwent assessment at 6 and 12 months; these results are demonstrated in Fig. 1. The mean scores of cohort 1 at 6 and 12 weeks were relatively maintained at 26.82 and 25.91 for instrument identification, 9.18 and 8.86 for knot tying and 5.86 and 4.86 for suturing. The mean scores of the two cohorts at 6 months were 20.27 versus 20.91, 7.00 versus 8.68 and 2.27 versus 2.73 (Fig. 1). At 12 months (just following the start of internship), the mean scores for cohort 1 were 20.17/30, 6.91/15 and 4.09/15, while cohort 2 scored 18.82/30, 6.01/15 and 2.18/15 (Fig. 1). There was no statistically significant difference between the scores of the two Cohorts (p value = 1.1).

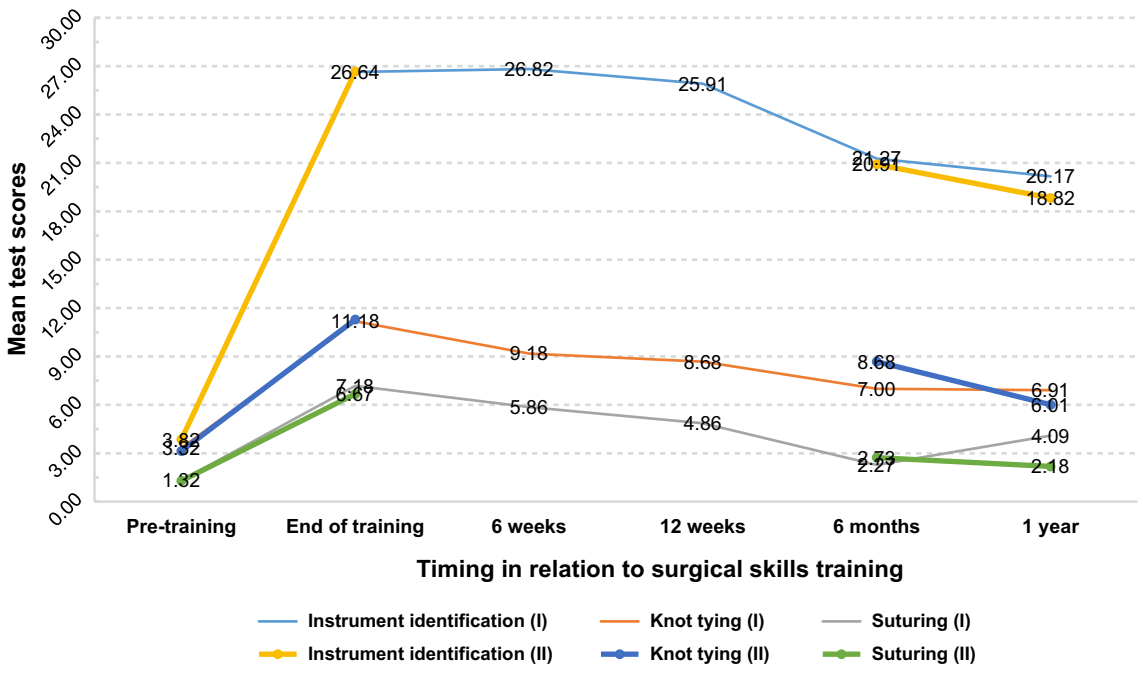

Fig. 1 Surgical skills pattern of medical students of Addis Ababa University, Ethiopia: 2015–2016 (cohort I and II)

Discussion

In Ethiopia, as in many settings, interns are expected to handle minor emergency surgical conditions like suturing and repair of traumatic lacerations. It is, therefore, necessary that they have the knowledge of relevant surgical instruments and simple suturing techniques among other competencies, and are taught these skills in medical school. In the curriculum for our undergraduate medical students, we incorporated a 1 week of intensive basic surgical skills training designed to achieve this during the final year of medical school. Depending on the time of their attachment to the department of surgery, the training will take place 6 months to a year before they start their internship rotation. Our skills training demonstrated significant improvement in surgical skills as measured by the increase in mean scores following standardized assessment. Students retained knowledge of instruments; technical skills declined over time, but also did not increase as dramatically following the training. Incorporating more frequent assessments of skills during the year did not improve retention of knowledge or technical skills compared to more infrequent assessments.

Following the training, the students proceeded with placement in other clinical departments hence did not have any opportunity to practice the skills they were taught. Discussion with the students and review of their rotation also revealed that almost all of them had no practice of these skills in any rotations. It is, however, important to note that despite the decay in basic surgical skills over time, the students still had a much higher skill levels when they started their internship compared to their pre-training skills; this highlights the advantage of the training.

The initial training session was a success regarding learning the names of instruments (instrument identification) and to a lesser extent one-handed knot tying. These lessons were fairly well maintained. Their skills with suturing degraded over time nearly back to baseline, likely from lack of practice, and intermediate assessments did not help them maintain it. Thus, memorization was fine, but complex technical skills such as suturing with instruments seem to be something that requires ongoing practice. That is a meaningful finding as it highlights the idea that technical skills require ongoing practice and cannot be easily taught in a single session. Simulation can thus help as long as there is a way to continually practice the skill. The role of simulation is to recreate a clinical scenario that is representative of a true life situation. Refresher courses and frequent, "low-dose" training sessions have been demonstrated to aid skills retention [15]. Multiple studies have shown that skills learned at the bench using simulators are translated into the operating room [16]. This allows trainees to focus more on operative strategy and managing operative complications rather than wasting valuable and expensive operating room time on the initial refinement of psychomotor skills.

The rationale for timing the "assessments" at 6 and 12 weeks was based on the completion of the trainees 6-week surgery rotation and completion of their major clinical rotations. The assessment schedule at 6 and 12 weeks is also supported by other studies [6, 7]. However, one might argue that a single assessment performed at intervals—just an assessment, not continuous practice—would not be beneficial. And hence such "assessments" need to be considered as "single episode of practice of the acquired skills". It is established that skills that are practiced are maintained and that those that are not practiced are lost over time.

One of the imitations of the study is the limited number of students in the two cohorts. Another may be the fact that students may be practicing the skills on their own time and this may not be known to the investigators. The random selection of the cohorts, and not randomizing the selection should also be taken as a limitation. Demographic information and the medical student's proposed career path that can potentially cause bias are not used during the cohort allocation.

Conclusions

Surgical skills training is very important for senior medical students to equip them with necessary skills required to handle surgical cases during their internship. However, given the fact that skills can be lost as time passes after the training, it is important to provide refresher training at the beginning of internship. Periodic skill assessments do not appear to add value or improve retention of certain skills sets.

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Author contributions AB designed the study as part of his FAIMER project. He participated in questioner preparation, data collection, write up and approval of the final manuscript. SW participated in questioner preparation, data collection, write up and approval of the final manuscript. NF was involved in the statistical analysis, interpretation of results and write up. AT participated in questioner preparation, data collection, write up and approval of the final manuscript.

Compliance with ethical standards

Conflict of interest The authors would like to disclose that they have no conflict of interest.

Availability of data and materials The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication Not Applicable.

Ethical approval Ethical approval was obtained from the Research committee of Department of Surgery, School of Medicine, Addis Ababa University.

Appendix

Skills Session Assessment Form

Facilitator: _____ **Date:** _____

Learner: _____

INSTRUMENT IDENTIFICATION AND HANDLING	Incorrect Identification (0)	Incorrect Handling (0)	Correct Identification (1)	Correct Handling (1)
1. #10 Scalpel				
2. Scalpel Holder				
3. Toothed forceps				
4. Non-toothed Forceps				
5. Tissue Scissors				
6. Needle Drivers				
7. Retractors				
8. Kocker clamps				
9. Artery forceps				
10. Allice Forceps				
11. Babkok Forceps				
12. Roux retractors				
13. Deaver retractor				
14. Currate				
15. Silk suture material				
TOTAL SCORE (30%)				

KNOT TYING	Cannot Complete	Completed with >2 Attempts or >1 Common Error	Completed with ≤ 2 Attempts or ≤ 1 Common Error	Completed on First Attempt without Common Error	Completed Quickly and Expertly Without Error and Flawless Final Knot
1. Two Handed Knot-Tie	1	2	3	4	5
2. One Handed Knot-Tie	1	2	3	4	5
3. Instrument Tie	1	2	3	4	5

TOTAL SCORE KNOT-TYING_____

SUTURING	Cannot Complete	Completed with >2 Attempts or >1 Common Error	Completed with ≤ 2 Attempts or ≤ 1 Common Error	Completed on First Attempt without Common Error	Completed Quickly and Expertly Without Error and Flawless Final Suture
1. Simple Interrupted With Instrument Tie	1	2	3	4	5
2. Simple Running With Instrument Tie	1	2	3	4	5
3. Horizontal Mattress	1	2	3	4	5
4. Tension	1	2	3	4	5

TOTAL SCORE SUTURING_____

References

1. Kneebone R, Fry H (2011) Surgical Education, 2 (August 1992), 268. http://doi.org/10.1007/978-94-007-1682-7
2. Miller BJ, Effeney DJ, Chan ST (1991) Pre- and post-testing of students in surgery: do medical rotations help? Aust N Z J Surg 61(12):949–952
3. Parent RJ, Plerhoples TA, Long EE, Zimmer DM, Teshome M, Mohr CJ et al (2010) Early, intermediate, and late effects of a surgical skills "boot camp" on an objective structured assessment of technical skills: a randomized controlled study. J Am Coll Surg 210(6):984–989. https://doi.org/10.1016/j.jamcollsurg.2010.03.006
4. Mengistu BS, Vins H, Kelly CM, McGee DR, Spicer JO, Derbew M, Bekele A, Mariam DH, del Rio C, Blumberg HM, Comeau DL (2017) Student and faculty perceptions on the rapid scale-up of medical students in Ethiopia. BMC Med Educ 17:11. https://doi.org/10.1186/s12909-016-0849-0
5. Gedlu E, Tadesse A, Cayea D, Doherty M, Bekele A, Mekasha A, Derbew M (2015) Jung J (2015) Introduction of simulation based medical education at the Addis Ababa University, College of Health Sciences: experience and challenges. Ethiop Med J 53:1–8
6. Routt E, Mansouri Y, de Moll EH, Bernstein DM, Bernardo SG, Levitt J (2015) Teaching the simple suture to medical students for long-term retention of skill. JAMA Dermatol 151(7):761–765. https://doi.org/10.1001/jamadermatol.2015.11
7. Sonnadara RR, Garbedian S, Safir O, Nousiainen M, Alman B, Ferguson P et al (2012) Orthopaedic boot camp II: examining the retention rates of an intensive surgical skills course. Surgery (US) 151(6):803–807. https://doi.org/10.1016/j.surg.2012.03.017
8. Zaid H, Ward D, Sammann A, Tendick F, Topp KS, Maa J (2010) Integrating surgical skills education into the anatomy laboratory. J Surg Res 158(1):36–42. https://doi.org/10.1016/j.jss.2008.08.012
9. Zeng W, Woodhouse J, Brunt LM (2010) Do preclinical background and clerkship experiences impact skills performance in an accelerated internship preparation course for senior medical students? Surgery 148(4):768–777. https://doi.org/10.1016/j.surg.2010.07.022
10. Martinez A, Cassling C, Keller J (2015) Objective structured assessment of technical skills to teach and study retention of fourth-degree laceration repair skills. J Grad Med Educ 7(1):32–35. https://doi.org/10.4300/JGME-D-14-00233.1
11. Gershuni V, Woodhouse J, Brunt LM (2013) Retention of suturing and knot-tying skills in senior medical students after proficiency-based training: results of a prospective, randomized trial. Surgery 154(4):1–13. https://doi.org/10.1016/j.surg.2013.07.016
12. Taylor JA, Ivry RB (2012) The role of strategies in motor learning. Ann N Y Acad Sci 1251:1–12. https://doi.org/10.1111/j.1749-6632.2011.06430.x

13. Shaharan S, Neary P (2014) Evaluation of surgical training in the era of simulation. World J Gastrointest Endosc 6(9):436–447. https://doi.org/10.4253/wjge.v6.i9.436
14. Acton RD, Chipman JG, Gilkeson J, Schmitz CC (2010) Synthesis versus imitation: evaluation of a medical student simulation curriculum via Objective Structured Assessment of Technical Skill. J Surg Educ 67:173–178
15. Sutton RM, Niles D, Meaney PA, Aplenc R, French B, Abella BS, Lengetti EL, Berg RA, Helfaer MA, Nadkarni V (2011) Low-dose, high-frequency CPR training improves skill retention of in-hospital pediatric providers. Pediatrics 128(1):e145–e151. https://doi.org/10.1542/peds.2010-2105 **Epub 2011 Jun 6**
16. Sturm LP, Windsor JA, Cosman PH, Cregan P, Hewett PJ, Maddern GJ (2008) A systematic review of skills transfer after surgical simulation training. Ann Surg 248(2):166–179