ACS/ASE Medical Student Simulation-Based Skills Curriculum Study: Implementation Phase

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OBJECTIVE: Patient safety initiatives have revealed a need for standardized medical student skills curricula. In 2014 the America College of Surgeons/Association for Surgical Education Medical Student Simulation-based Skills Research Collaborative initiated a multisite study to implement and study the effect of a skills curriculum during the surgical clerkship.

DESIGN: Students underwent knot-tying and suturing sessions. They performed a self-evaluation survey before and after the modules to assess their comfort level with the skills. Faculty members also evaluated the students at the completion of the skills sessions. The comfort level choices were: needs further review; proficient in simulated setting with assistance; proficient in simulated setting without assistance; and proficient in clinical setting under supervision.

RESULTS: At the completion of the modules greater than 99.3% and 98.5% of students reported that they were proficient in knot-tying and suturing, respectively, in either a simulated or clinical environment. Similarly, when faculty evaluated student performance after a session, simulated or clinically proficiency reached over 97% for both two-handed and instrument knot-tying. The faculty rated the students 86.6% proficient for suturing.

CONCLUSIONS: After completing the modules, a large percentage of students obtained proficiency in knot-tying and suturing, representing technical skills improvements noted by both the participants and the evaluating faculty. The America College of Surgeons/Association for Surgical Education medical student surgical skills modules represent expert developed, low cost, easy to access resources that should continue to be evaluated and disseminated to medical student learners. (J Surg Ed 76:962–969. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

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COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

In the United States, medical students acquire basic physical exam skills in their preclinical years and begin learning procedural skills during their clinical clerkships or later. Many medical students are introduced to these clerkships with a short course featuring mostly didactic lessons and occasionally loosely structured sessions for knot tying, basic suturing, and BLS/ACLS certification.[1] Once on the wards, medical students have limited time to spend obtaining the vital hands-on experiences that will prepare them for residency due to work hour restrictions.

In order to address this issue, the America College of Surgeons (ACS) and the Association of Program Director in Surgery (APDS) created a National Skills Curriculum.[2] The curriculum has not yet been implemented on a large scale; the sites that use it, however, report that it is a useful template for the training of residents.[3] Many

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institutions have begun to see the value in this resident simulation curriculum and have added a variety of skills labs modules into their resident curriculum.[4,5] Some institutions have started boot camps to help their interns catch up on any skills that they did not obtain in medical school and are using the ACS/APDS modules or their own unique curricula.[6,7]

In addition to the ACS/APDS curricula, surgical educators from the Association for Surgical Education (ASE) and the ACS who were seeking a way to better meet the need for structured practice of specific skills while students were still in medical school, created a simulation-based medical student curriculum. These modules focus on basic procedural and exam skills relevant to preclinical and clinical medical students. Surgical education experts developed the curriculum with modules geared toward second−, third−, and fourth−year medical students. The modules were designed to be completely self-contained and require very few additional resources to implement, allowing educators in various settings to access the modules for free and immediately run a session at their site.

Following curriculum development and dissemination, the ACS/ASE Medical Student Simulation-Based Skills Research Collaborative initiated a multisite study to implement 2 of these modules. The suturing and knot-tying modules were targeted for study, in part due to the low cost of necessary materials and the widespread recognition of these skills as "core" to surgical clerkship experience. The primary aim of this study was to evaluate student comfort with the tasks before and after participation in these modules and to compare student evaluations to the postsessions faculty assessments. The secondary aim of the study was to identify major barriers to module implementation.

MATERIALS AND METHODS

Participating institutions were recruited via email and at the annual ASE meeting. Each site's lead investigator identified faculty members, residents, and skills lab personnel capable of assisting with module implementation. Each site obtained IRB approval or exemption, followed by implementation of the suturing and knot-tying modules within the third-year medical student curriculum within the core surgery clerkship. Each site determined the timing of the modules during their clerkships based on site-specific scheduling logistics. All sessions were scheduled to last 1 to 2 hours, allowing adequate time for completion of the module, pre/post self-survey, and the postsession faculty assessment.

Modules were available to participating sites at no cost via the ACS website. Sites were responsible for supplying any necessary materials (i.e., suture, knot tying boards, etc.).

The online content included an equipment list, videos of the skill being completed properly that can be looped on a monitor during the session, and a detailed session outline for the faculty to follow. The instructions that were provided to the faculty describe the actions that the proctors should take during the session to provide feedback for improvement prior to the final evaluations. These instructions vary for each module and are available at: https://learning.facs.org/content/year-3-modules. There was also a postmodule faculty assessment rater sheet with several methods of quantifying the overall score. At the completion of each session, faculty evaluations were completed using the rater tool included in the online module. This rater tool includes separate ratings for 2-hand tying and instrument tying.

Standardized pre− and postmodule surveys were created by the lead investigators and used at most participating sites (Figs. 1-3).

Specifically, the students were asked:

If you were asked to perform this skill right now, would you: (circle one)

Need further review/ instruction before starting.
Be proficient in simulated setting with assistance.
Be proficient in the simulated setting without assistance.
Be Proficient in clinical setting under direct supervision.

During the data collection period, some sites only used 3 answer categories. As a result, the investigators agreed to consolidate the 2 answer choices with "simulated setting" into 1 for all of the submitted data for the data analysis. Therefore, the data were analyzed with 3 options: needs further review (NR); proficient in simulated setting with or without assistance (PS); and proficient in clinical setting under supervision (CP). In addition, at the start of the study some sites used an older draft of the student survey, which included the answer choices: minimally comfortable, moderately comfortable, and completely comfortable. For the data analysis, these were converted into NR, Proficient in a simulated stetting, and Clinically proficient, respectively.

In order to be able to easily collect and compare the data, the sites were provided with an additional standard data collection sheet that is not included with the online modules. An example of this is provided in Figure 4.

For the data analysis, a statistician used a nominal (multinomial) logistic regression to compare the student survey responses from the premodule and postmodules and calculated the p values.

RESULTS

Ten sites were approved by the investigators to participate in the study and completed an IRB

Knot-tying Skills Pre-test Survey

Please answer the following questions honestly. Your answers will be used only as background demographic data and will be kept anonymous.

Please circle your answers.

1. Please indicate your year in medical school (circle):

1st 2nd 3rd 4th Other_____

2. Have you had any experience with knot-tying before this exercise (on models, animals, or human patients)?
Yes No

3. Were you formally taught these skills (in a workshop, study, class, skills course)?
Yes No

4. If you have had prior knot-tying experience, have you learned the technique of one-handed tying?
Yes No

5. How much experience have you had tying knots on a patient in the ED or OR?

No exposure (0 patients) Minimal exposure (0 – 10 patients)
Moderate exposure (11- 50 patients) Considerable exposure (51 or more)

6. If you were asked to perform this skill right now, would you: (circle one)

Need further review / instruction before starting

Be proficient in simulated setting with assistance

Be proficient in simulated setting without assistance

Be Proficient in clinical setting under direct supervision

FIGURE 1. Knot-tying skills premodule survey.

application. Of those sites, 7 ultimately implemented the curriculum, collected data and sent it to the investigators.

Data were collected for each completed skills session. All students reported that they were third-year students. Some students participated in just knot-tying, some just did suturing, and some completed both modules, depending on their schedules. Further, there are missing data points as some sites only did the faculty evaluations for knot-tying, while others submitted data for more students for premodule evaluations than for postmodule assessments.

The data collected from the 7 sites is reported in Tables 1 and 2, respectively and below.

Knot-Tying

A total of 195 students completed the knot-tying module. Two sites did not hand out the self-assessments at every session, resulting in 167 students completing the premodule self-assessment. Of the 167, 148 students also completed the postmodule assessment. Prior to the skills session, 44 students (29.7%) rated themselves as "NR," which decreased to only 1 student (0.7%) self-rating as NR on the postsession evaluation. The number of students identifying themselves as "PS" increased from 68 students (46%) in the presession evaluation to 90 students (60.8%) in the postsession evaluation. Students who reported they felt "CP" similarly increased from 36

Suturing Skills Pre-Test Survey

Please answer the following questions honestly. Your answers will be used only as background demographic data and will be kept anonymous.

Please circle your answers.

1. Please indicate your year in medical school (circle):

1st 2nd 3rd 4th Other_____

2. Have you had any experience with suturing before this exercise (on models, animals, or human patients)?

Yes No

3. Were you formally taught these skills (in a workshop, study, class, skills course)?

Yes No

4. If you have had prior suturing experience, have you learned the technique of subcuticular suturing?

Yes No

5. How much experience have you had suturing a patient in the ED or OR?

No exposure (0 pts) Minimal exposure (0 – 10 pts)
Moderate exposure (11- 50 pts) Considerable exposure (51 or more)

6. If you were asked to perform this skill right now, would you: (circle one)

Need further review / instruction before starting

Be proficient in simulated setting with assistance

Be proficient in simulated setting without assistance

Be Proficient in clinical setting under direct supervision

FIGURE 2. Suturing skills premodule survey.

(24.3%) to 57 (38.5%) in the pre vs. post session evaluation (Table 1). The knot-tying results were significantly different with a p value <0.0001.

The faculty evaluation sheets were different than the self-assessment in that they were broken down into two-hand tying and instrument tying. There was no premodule faculty assessment. Of the 195 students who completed the knot-tying modules, 156 underwent faculty evaluation of 2 handed knot-tying. Of those 156, 4 (2.6%) were rated as NR, 107 (68.6%) as PS, and 45 (28.8%) as CP following the knot-tying skills session. Faculty evaluation of instrument knot tying was completed on 123 students. Of those, 4 (3%) were rated as NR, 102 (83%) as PS, and 17 (14%) as CP following the session.

Of the 156 students who underwent faculty evaluation of the two-handed knot tying, 113 were the same students who had submitted a postmodule knot tying self-assessment. On those student assessments, 1 (0.9%) were rated as NR, 65 (57.5%) as PS, and 47 (41.6%) as CP. The faculty evaluations of those same students were reports as 2 (1.8%) NR,

Post-test Survey

Please answer the following questions honestly. Your answers will be used only as background demographic data and will be kept anonymous.

Please circle your answer.

This survey is for: Knot-Tying Suturing

1. Now that you have completed the training module, please describe your comfort with this skill/procedure:

Minimally comfortable (No comfort performing skill)	Moderate (Could perform skill with some assistance)	Very Comfortable (Could perform skill without supervision)

2. Please rate your satisfaction with this skills training experience:

Minimal satisfaction (I would rather have learned something else with my time)	Moderate (Reasonable training, I would do this again)	Considerable satisfaction (Excellent way to learn, a valuable use of my time)

3. If you were asked to perform this skill right now, would you: (circle one)

Need further review / instruction before starting

Be proficient in simulated setting with assistance

Be proficient in simulated setting without assistance

Be Proficient in clinical setting under direct supervision

FIGURE 3. Postmodule student self-survey.

71 (62.8%) PS, and 40 (35.4%) as CP. These results are different than the student postsession self-assessments ($p = 0.0082$) although the trend is similar.

Of the 123 students who underwent faculty evaluation of the instrument tying, 80 were the same students who had submitted a postmodule knot tying self-assessment. On those student assessments, 1 (0.9%) were rated as NR, 57 (71%) as PS, and 22 (28%) as CP. The faculty evaluations of those same students were reports as 2 (2.5%) NR, 67 (83.75%) PS, and 11 (13.75%) as CP. These results are not statistically different than the student postsession self-assessments ($p = 0.2378$).

Suturing

A total of 189 students completed the suturing module. Two sites did not hand out the self-assessments at every session, resulting in 163 students completing the premodule self-assessment. Of those, 134 students also completed the postmodule self-assessment and were included in the data analysis. Prior to the session, 48 students (35.8%) rated themselves as "NR," while only 2 students (1.5%) rated themselves as NR on the post evaluation. The number of students identifying themselves as "PS" increased from 53 students (39.6%) on the presession evaluation to 76 students (56.7%) on the postsession evaluation. The number of students identifying themselves as "CP" group similarly increased from 33 (24.6%) to 56 (41.8%) on the pre vs. postsession evaluation (Table 2). The differences between the premodule and postmodule self-evaluation for suturing were significant with a p value <0.0001.

Of the 189 students who completed the suturing modules, 97 underwent postmodule faculty evaluation of their overall suturing skills. Of those, 13 (13.4%) were evaluated by faculty as NR, 75 (77.3%) as PS, and 9 (9.3%) as CP following the skills module.

Of the 97 students with a faculty evaluation of suturing, 61 were the same students who did a postmodule self-assessment. In that group, 1 student (1.6%) rated themselves as NR, 45 (73.8%) as PS, and 15 (24.6%) as CP after the module. The faculty evaluations of these students were reported as 8 (13%) NR, 44 (72%) PS, and 9 (15%) as CP. There was no difference between the student and faculty evaluations with $p = 0.138$).

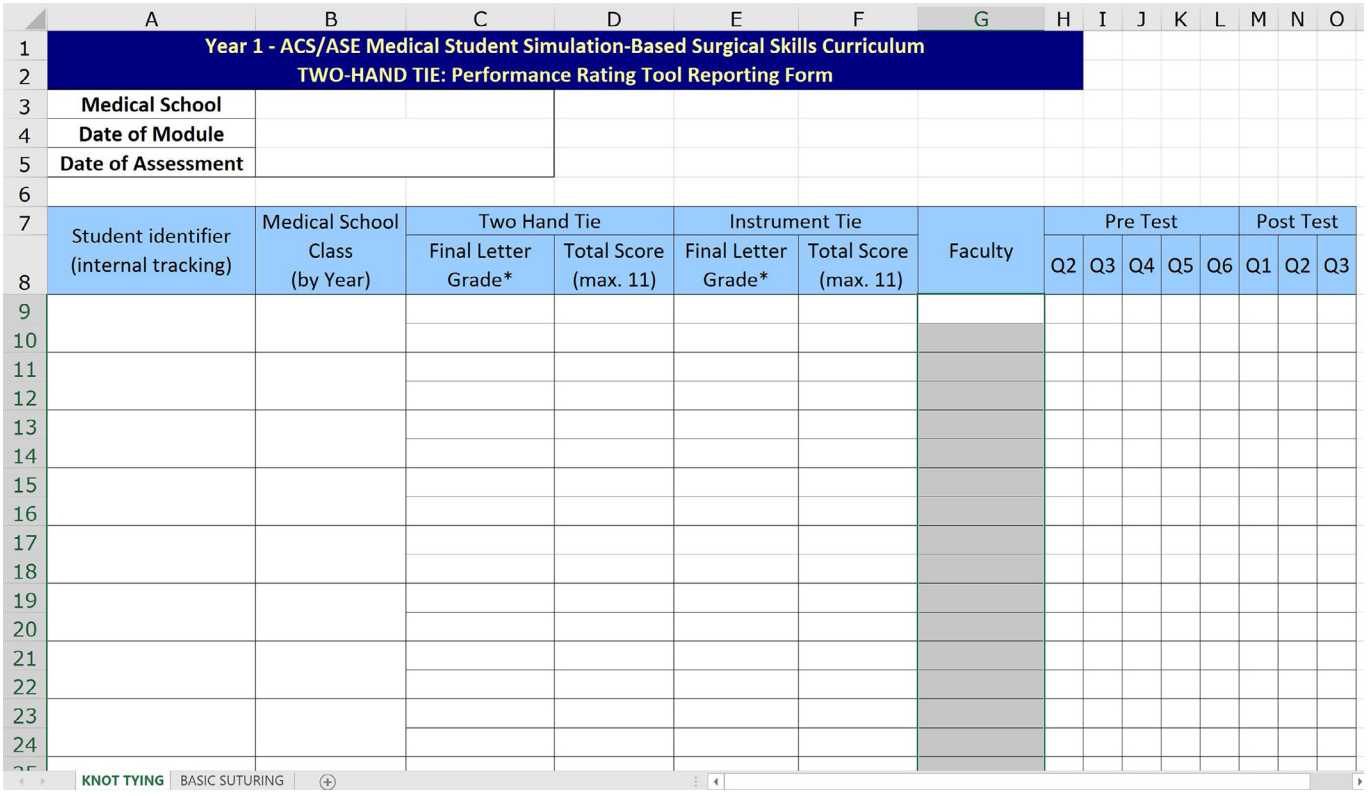

FIGURE 4. Example of data collection sheet used by sites.

TABLE 1. Knot-Tying Student Self-Evaluation Data

Comfort Level	Self-Assessments			
	Premodule		Postmodule	
NR	44	29.70%	1	0.70%
PS	68	46.00%	90	60.80%
CP	36	24.30%	57	38.50%
TOTAL	148	100.00%	148	100.00%

TABLE 2. Suturing Student Self-Evaluation Data

Comfort Level	Self-Assessments			
	Premodule		Postmodule	
NR	48	35.80%	2	1.50%
PS	53	39.60%	76	56.70%
CP	33	24.60%	56	41.80%
TOTAL	134	100.00%	134	100.00%

DISCUSSION

Surgical skills training has taken many forms over the past 50 years and gradually shifted away from on-the-job training toward simulation-based training.[12] Some medical schools have invested considerable resources toward developing the infrastructure needed for simulation-based education, while others have not. And even within vibrant, well-funded skills labs, a clear curriculum for medical student surgical skills is not necessarily present. The absence of a standardized, evidence-based curriculum can lead to disorganized, ineffective, or even incorrect skill training.[1]

Simulation has proven utility in providing students with experience in procedure-based fields.[8] Studies that evaluate medical students' assessments of simulation training have shown that it was more enjoyable than just didactics.[9,10] In addition, students who participated had higher scores on a knowledge test than those in the discussion format. In 1 study investigators performed a national survey of clerkship directors and medical students and asked what topics should be covered in a medical students' simulation curriculum and when these topics should be taught.[11] Both groups were mostly in agreement about the content, however on average, fourth-year medical students also wanted some topics to be taught earlier in medical school than the clerkship directors felt necessary. In other studies students whose skills were evaluated in a simulated environment rated the experience highly.[12-15]

The ACS/ASE Simulation Based Medical Student Skills Curriculum was developed to help solve this dilemma. Data from 240 students who underwent the basic airway module of the curriculum showed improvement in self-perceived proficiency by 99% of learners, as previously published.[16] This study presents data from the first multiinstitution implementation of the knot-tying and suturing modules from this curriculum. While 7 sites have completed the modules and relevant evaluations as of March 2017, additional sites continue to run the modules.

This study demonstrated that a low cost, standardized curriculum for knot-tying and suturing can successfully be implemented into the surgical clerkship rotation. Students' self-evaluations clearly improved following completion of the modules and this improvement reaches statistical significance. In fact, over 99.3% and 98.5% of students reported that they were proficient in knot-tying and suturing, respectively, in either a simulated or clinical environment at the completion of the modules. Similarly, when faculty evaluated student performance after a session, simulated or clinically proficiency reached over 97% for both types of tying. The faculty rated 86.6% proficient for suturing.

Overall the suturing activity had the highest rate of "NR" by faculty (15.3%) compared to 2.9% and 3.8% for two-handed tying and instrument tying, respectively. This could be related to the increased complexity of suturing, in comparison with various forms of knot tying, and the subsequent need for more student practice prior to faculty assessment of student proficiency.

While self and peer assessments have a tendency to be inflated relative to faculty evaluations,[17] this tendency may not hold true for self and faculty evaluations of pure technical skills. A related study, examining suturing skills specifically, found a positive correlation between student self-evaluations and objective scoring of performance.[18]

There are several limitations to this study that are relevant to the discussion as they are also potential limitations to widespread implementation of the modules. The categories of assessment listed on the surveys were based on the evaluations that had been created when the modules were written. The investigators of this study aligned the language in the surveys with the existing language of the module evaluations in order to align the student self-assessments with the faculty evaluations. Thus, "proficient in a clinical setting" was included as the highest evaluation category. However, future versions of the module assessment forms are being edited to no longer include this language. In practice, students in this study who are "proficient in a clinical setting" are considered to be the highest degree of "proficient in a simulated setting" that is possible and may be proficient in a clinical setting.

At the 2015 and 2016 ASE meetings, the research collaborative group held forums to review the modules and discuss perceived or experienced barriers to implementation, which may have affected compliance rate with the sites. Several of the sites involved in this project were in attendance and contributed to the discussion. The sites defined time limitations as a barrier to implementation and to compliance with the study methods. The modules themselves are designed to fit in a 1-hour block, however, if the students have not reviewed any material ahead of time, the videos, practice time, and assessments may take 2 to 3 hours. The faculty evaluation form is also quite lengthy. Some sites with limited faculty resources or limited time opted either not to do the assessments or to instead have peer to peer evaluations instead of faculty evaluations.

The suturing module is lengthy because it includes simple interrupted, simple running, subcuticular suturing, and both vertical and horizontal mattress sutures. Some sites opted to break this up into graduated sessions due to time limitations and some educators thought that implementing the modules as a longitudinal program would be more effective than in just 1 session. Those sites chose to establish the basic suturing skills in earlier sessions and then reinforced those lessons and introduced more advanced suturing, such as the mattress stitches, in later sessions.

Many participants in the feedback group felt that it would be adopted more readily if there was a way to track the students' progress nationally. Along a similar line, others felt that it would be best incorporated as part of a more comprehensive medical student program and not through the surgery clerkship alone.

Another limitation is that the study lacks of a control group. Future steps might include randomization of student cohorts to traditional skills session or to the ACS/ASE modules, to better define the impact of their use. Finally, this study lacks long term follow-up of skills retention, an outcome which should be pursued as these modules are increasingly adopted into medical student curricula.

CONCLUSIONS

After completing the modules, a large percentage of students obtained proficiency in knot-tying and suturing, representing technical skills improvements noted by both the participants and the evaluating faculty. The ACS/ASE medical student surgical skills modules represent expert developed, low cost, easy to access resources that should continue to be evaluated and disseminated to medical student learners.

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