Boot Camp in a Box: Initial Experience with Pretraining Skills Preparation for New Interns

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PURPOSE: In order to increase selected skills at onset of training, we provided newly matched PGY-1 trainees with materials and instructions to practice these skills, as well as the opportunity to share video-recorded performance and receive feedback based on these videos.

METHODS: Knot tying and suturing kits, instruments and supplies, and video instructions for task performance were sent to newly matched trainees to our program ($n = 10$), with instructions to practice 4 tasks (1- and 2-handed knot tying, interrupted and running suturing) until self-assessed comfort with each task was achieved or the 8-week time point before start of training was reached. Each trainee returned a video of each task, which was graded by blinded reviewers for time and errors using an itemized evaluation instrument (12 items for suturing and five items for knot-tying). Feedback (annotations of submitted videos) was provided after grading was completed. Task performance was repeated and reassessed at the time of new intern "Boot Camp" and again 8 weeks after start of training. Performance scores were compared for the 3 time points and with scores of PGY 2-4 residents using ANOVA with posthoc tests.

RESULTS: Compliance with instruction for practice and return of video recorded tasks in the months before start of PGY-1 training was high, with only 1 of 10 failing to return knot-tying videos. A significant pattern of performance change ($p < 0.05$) was observed for all tasks with an initial decrease between the pre-employment practice period and the Boot Camp test followed by an increase to the highest level of performance 2 months after start of training. At that point, scores were not significantly different than those of more senior residents.

CONCLUSIONS: A high level of compliance was achieved with requested skills practice and video documentation of performance. We attribute the consistently lower scores on the tasks during Boot Camp tests to higher stress test environment which was apt to be less favorable than having the trainee choose to submit their best possible preresidency video recording of performance in a low-stress situation. Subsequent achievement of significantly higher performance even compared to more senior residents may have been helped by incentivized pretraining practice. (J Surg Ed 76:e225–e231. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Surgical education, Boot camp, Skills assessment, Performance feedback

COMPETENCIES: Patient Care, Professionalism, Practice-Based Learning and Improvement

INTRODUCTION

The transition period between medical school and residency is brief and opportunities for systematic preparation are nonstandardized or nonexistent. For medical students entering the surgical specialities, preresidency preparation can be particularly important, as it involves the acquisition of both a broad knowledge base and a variety of technical skills. Some of the basic skills can be acquired during medical school, but well-defined levels of competency in these skills are not generally required pregraduation achievements. Furthermore, societal demands to avoid medical errors impose practical limitations on the role of medical students in many aspects of patient care. As a result, new surgical interns may very well be unable to perform certain basic surgical skills which, if mastered prior to the start of residency, would position them for greater success.

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The potentially steep learning curve that new trainees must confront at the start of residency can be addressed using a variety of tools. Some of these have been successfully implemented during the fourth year of medical school, focusing on specific areas of knowledge and skill that are deemed appropriate for new surgical interns to acquire as early as possible.[1-4] In the absence of these efforts, pretraining preparation for this challenging transition has essentially been self-directed, at least until such time as the new trainee arrives for the start of the PGY-1 year. At that point, there are numerous examples of early development of skills and knowledge in the course of "Boot Camp" experiences during the first weeks of residency.[5] Pandian et al recently reported successful implementation of an at-home pretraining curriculum consisting of 5 cognitive and technical skills practice areas sent to new interns 1-month prior to start of training.[5] Trainees appeared to benefit from this novel approach and it has raised the possibility of either expanding or focusing this type of program's scope in order to achieve more ambitious educational goals. In a follow-up study of pretraining skills assessment, Naik et al reported the performance benefit of feedback in the form of a commentary added to video recording of learner-performed suturing tasks.[6]

Many types of basic skills can be practiced outside of patient care settings with a few simple instruments and supplies that might be adapted to a pretraining skills acquisition model. Based on these reports, we implemented a preinternship curriculum for the practice and grading of performance of a small number of essential basic surgical skills, with provision of remotely-delivered feedback, and report how these skills progressed over the 2 months following start of residency, concurrent with an established intern "Boot Camp."

METHODS

New trainees ($n = 10$) in the surgical residency program at Baystate Medical Center, a 716-bed independent academic medical center and the regional campus of the University of Massachusetts Medical School (UMMS-Baystate), were enrolled in a preinternship surgical skills curriculum following the National Resident Matching Program Match in March 2017. Since these preemployment trainees would not become employees of UMMS-Baystate until July 2017 this was not a mandated program and they were given the choice to either not participate in the training or to opt out at any time. After agreeing to do the training, each prospective PGY-1 was mailed a knot-tying and suturing kit, basic knot-tying and suturing supplies (Fig. 1), written curricular instructions, and links to online curricular instructional videos. The instructional videos, created by Baystate surgical educators utilizing the same supplies that were mailed to trainees, described 4 different tasks: 1-handed and 2-handed knot tying, simple interrupted suturing, and running subcuticular suturing. These were standard tasks practiced and assessed during the 9-week PGY-1 Surgical Boot Camp[7] in prior years. The instructional videos comprehensively described each task and emphasized critical learning points that were expected to be demonstrated when each was performed competently. The education team overseeing this curriculum project included 2 senior faculty members, 1 nonclinical faculty member, 2 residents, and 2 ancillary staff members.

Pre-employment trainees were asked to familiarize themselves with each task and to practice regularly until self-assessed competency was achieved based on the described learning points in the introductory tutorials.

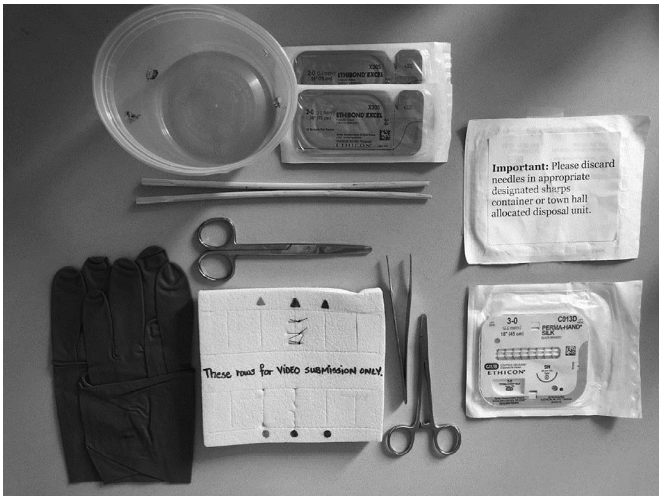

FIGURE 1. Items included in training package sent to new trainees after matching to the UMMS-Baystate surgery residency 3 months prior to start of employment. Materials include basic instrumentation to perform suturing, suture material (with and without needle), knot-tying apparatus, tissue suturing pad, and nitrile gloves. The total cost of materials and shipping was $62 per trainee.

Baystate Medical Center
SIMULATION CENTER AND GOLDBERG SURGICAL SKILLS LABORATORY

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Surgical Resident PGY-1 BOOT CAMP Wound Closure Assessment

Resident Name: ____________________ **Date:**______________ **Examiner:** ____________________

	ITEM	NOT DONE or DONE INCORRECTLY (0)	DONE CORRECTLY (1)	COMMENTS
*	**SIMPLE INTERRUPTED SUTURING**			
1A	**Holds needle driver appropriately >80% of the time** *(with fingers in place)*			
2A	**Needle loaded appropriately (1/2-2/3 from tip) > 80% of the time**			
3A	**Needle enters skin at right angles** *(i.e. 90 degrees perpendicular)* **> 80% of bites**			
4A	**Single attempt at needle passage through skin >80% of the time**			
5A	**Follow through on curve of needle on entrance/exit > 80% of the time**			
6A	**Equidistant bites on each side > 80% of the time**			
7A	**Uses needle holder or forceps to handle needle**			
8A	**Minimal damage to tissue with forceps** *(avoids multi-grasping or pulling forcefully)*			
9A	**No misalignment of wound closure**			
10A	**No over-tightened sutures**			
11A	**Square knots with a minimum of 3 throws on knots**			
12A	**Instrument tied square knots done appropriately**			
			Total: _____	**Total % Correct : __/12 = ____%**
*	**RUNNING SUBCUTICULAR SUTURING**			
1B	**Holds needle driver appropriately >80% of the time** *(with fingers in place)*			
2B	**Needle loaded appropriately (1/2-2/3 from tip) > 80% of the time**			
3B	**Needle enters dermal layer appropriately** *(parallel to the cut edge)* **> 80% of bites**			
4B	**Single attempt at needle passage through skin >80% of the time**			
5B	**Follow through on curve of needle on entrance/exit > 80% of the time**			
6B	**Equidistant bites on each side > 80% of the time**			
7B	**Uses needle holder or forceps to handle needle**			
8B	**Minimal damage to tissue with forceps** *(avoids multi-grasping or pulling forcefully)*			
9B	**No misalignment of wound closure**			
10B	**No over-tightened sutures**			
11B	**Square knots with a minimum of 3 throws on knots**			
12B	**Instrument tied square knots done appropriately**			
			Total: _____	**Total % Correct : __/12 =____%**

FIGURE 2. Scoring sheet for suture task performed by trainees. Each task element is graded as having been done correctly or incorrectly and the final score reflects percentage correct.

No minimum or maximum amount of practice was defined and trainees were not instructed to count the number of times each task was practiced. They were further instructed to record cell phone videos of what they felt was 1 competently-performed example of each task 8-weeks prior to start of internship. Although this request clarified that competence be defined according to the technical criteria and ability to avoid pitfalls and errors laid out in the relevant tutorial videos, they were asked to submit a video whether or not they felt that these criteria had been reached.

To facilitate pre-employment practice and to provide reassurance that early participation in Boot Camp would not be associated with a bias based on pre-employment performance, trainees were told that videos would be deidentified prior to assessment by the surgical education team. Task videos were uploaded to a shared Google Drive folder for review by a faculty member blinded to student identity. Tasks were graded for successful completion using checklist-type evaluation instruments (Fig. 2). The suturing task assessments consisted of 12 elements that were either graded as "done correctly" or "done incorrectly." Knot-tying task assessments consisted of 5 similarly graded elements. A group of 7 current Baystate residents in the PGY 2, 3, and 4 years performed all 4 tasks using the same assessment methods. These tasks were video-recorded to determine inter-rater agreement when assessed by 2 trained raters blinded to resident identity for the purpose of establishing the effectiveness of rater training. These performance results were used for comparison with new trainee pretraining and post-Boot Camp performance.

Based on each task evaluation, feedback annotations were made to each video (text in video sidebar at appropriate points in the video), which were then uploaded to individual Google Drive folders for each trainee to review and use to aid continued practice. They were also encouraged to submit additional task videos if they felt that their performance had improved or if additional feedback was needed. Once trainees started their PGY-1 year, the same 4 tasks were repeated and assessed during live sessions during the first week of Boot Camp and again 8-weeks afterward. During that 8-week period, varied competency-based training was conducted, which included iterative practice of the same tasks that were assessed.

Statistical Analysis

Data are presented as mean ± standard deviation. Average new trainee performance scores for each task for the pretraining assessments were compared to those of more senior current residents in the Baystate program using 1-way ANOVA with Tukey-Kramer posthoc multiple comparisons tests. Task scores for all new trainees were compared for the 3 time points for each task type, using a repeated measures ANOVA with Tukey-Kramer posthoc multiple comparisons tests.

RESULTS

All 10 new trainees accepted the offer of pre-employment skills training. Materials costs associated with assembling and shipping the training packages totaled $62 per trainee (Table 1). Education team members' time and effort expended in assembling the training packages, reviewing the videos, and providing feedback was not specifically recorded but represents nonquantified project cost.

Compliance with instructions for pre-employment trainee practice of the tasks and submission of videos 8-weeks prior to the start of internship was high: all trainees submitted videos of both suturing tasks as instructed, while only 1 of 10 did not return the knot-tying videos. Good inter-rater agreement was achieved for current resident-performed task assessments prior to the assessment of new trainee videos based on blinded 2-rater review (simple frequency of agreement was 0.82 and Cronbach's alpha was 0.8).

The pretraining performance on the 2-handed knot tying and continuous subcuticular suturing tasks were not significantly different than performance for current residents (Table 2), but resident performance for 1-handed knot tying and interrupted suturing was significantly better. These differences diminished to nonsignificant levels for all of the tasks by the end of Boot Camp 2 months into training, and new intern performance on the continuous suture task was numerically better than that observed for the more senior residents. Overall scored performance changed significantly across the 3 assessed time points (Fig. 3) with a decrement in scores at the start of training relative to the pretraining assessments, and a subsequent increase in performance to a level comparable to or higher than was achieved on the pretraining assessment. This pattern of change was statistically significant and occurred for all task types (Table 3). Posthoc testing demonstrated that the strongest pattern of change occurred between the assessment at start of employment and 8-weeks later at the time of wrap-up of the Surgery Resident Boot Camp. Following feedback, 5 of the trainees submitted 1 additional task video for assessment, but these were not included for analysis.

TABLE 1. Content and Costs of Pretraining Package Sent to New Trainees

Baystate Surgical Preparatory Packet Budget	
Preinternship Boot Camp Packet	**Item Cost Per Packet**
Suture instrument packets (1 each)	7.99
3-0 Suturing packets (2 each)	13.33
2-0 Suture tie packets (2 each)	6.58
Large suture pads (2 each)	16.67
Plastic drilled cups for tying (1 each)	0.11
Chopsticks (1 each)	0.02
Postage & Handling (UPS)	16.82
Total cost pertrainee packet	$61.52

DISCUSSION

The results of this experience of facilitating practice and assessment of specialty-specific skills prior to start of residency suggests that new trainees will use these tools when they are provided. At least half of the new trainees took advantage of the feedback video annotations to do further practice and to send at least 1 additional task video. This is an encouraging indicator that the feedback experience may have provided a motivation to practice further.

We did not compare Boot Camp performance for 2017 with that of earlier years seeking evidence for effectiveness of the curricular change as others have done.[5,6] The small and sometimes variable size of the intern group at UMMS-Baystate has historically been associated with significant interyear performance variability for virtually all of the Boot Camp cognitive and technical skills performance measures. We did, however, show that meaningful learning was achieved by both evaluating the trend of each trainee's scores over time to see if

TABLE 2. Scores (%) of New Trainees on Tasks Performed Before Start of Training and at the Conclusion of PGY-1 Boot Camp (8 Weeks After Start of Training) Compared to Current Residents (PGY 2,3,4; n = 7)

	New Trainees (Pretraining)	New Trainees (Postboot Camp)	Current Residents	ANOVA p value
1-Handed knot tying	60 ± 28%*	74 ± 34%	96 ± 4%	0.034
2-Handed knot tying	80 ± 20%	84 ± 26%	88 ± 12%	0.36
Simple suture	64 ± 17%*	73 ± 17%	87 ± 16%	0.048
Running suture	57 ± 22%	76 ± 18%	69 ± 21%	0.172

One Way ANOVA with Tukey-Kramer multiple comparisons tests.
*p < 0.01 compared to current residents.

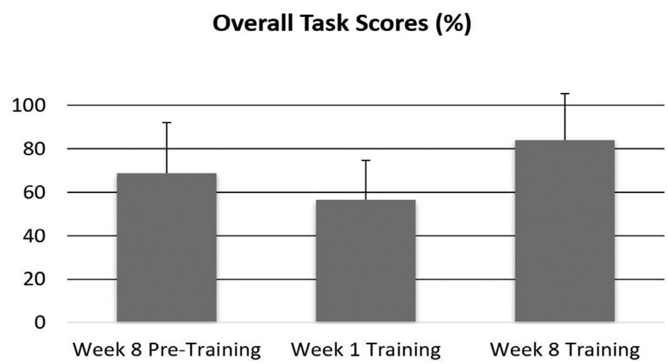

FIGURE 3. Overall scoring result for all tasks at each of the 3 assessment time points. The first (8 weeks pretraining) is for the video recorded task iteration that the trainee has self-assessed to be a satisfactory performance based on the objectives described in the preparatory videos. The second and third assessments occur during the PGY-1 Boot Camp at the start of residency and 8 weeks afterward. These were based on direct observations of a scheduled task by a faculty rater. We suspect that the decrement in performance at start of residency is related to the this circumstance, but performance rapidly improved to the high level observed for the 8 week assessment.

TABLE 3. Scores (%) for Each of the Tasks at Each of the Assessment Time points

Task Type	Week 8 Pretraining	Week 1 of Training	Week 8 of Training	ANOVA p value
1-Handed Knot Tying	60 ± 28 %	38 ± 18 %	74 ± 34 %†	0.01
2-Handed Knot Tying	80 ± 20 %	50 ± 17 %*	84 ± 26 %†	0.007
Simple Suture	65 ± 17 %	53 ± 20 %	73 ± 17 %†	0.008
Running Suture	58 ± 22 %	49 ± 24 %	78 ± 18 %*,†	<0.0001

Repeated measures ANOVA with Tukey-Kramer multiple comparisons tests.
*p < 0.05 vs pre-training.
†p < 0.05 vs Week 1 of Training.

there was a durable improvement in performance and by comparing their pretraining performance to that of current residents in the program. This work was undertaken in the context of a formative curriculum expansion rather than a formal study and we did not make provisions to survey ease of use or effectiveness of the feedback. However, there is good reason to believe that the use of video tools to provide personalized feedback can be effective in surgical skills acquisition[6,8] and may be the best and most practical method to ensure learner engagement and ongoing practice.

We found that targeting specific performance characteristics with our current visual (and in the future, possibly audio voice-over) form, was the most time-intensive educator activity associated with this project. Some of the work required of our educators was facilitated by allowing the trainees to choose when to submit a video based on their own determination of when a defined level of competency was achieved, thus potentially avoiding premature examination of performance. Although resident self-assessment of surgical task performance has been extensively compared to expert assessment with which is generally shown to be in agreement,[9] it was not used for the purpose of creating a competency standard. Our tutorial example of "expert performance" (provided in the initial instruction set) was intended to represent targeted performance or proficiency. Given limitations in monitoring performance remotely prior to the onset of employment, self-assessment was the only practical method for triggering video submission other than the end time point. Effective use of video recorded tasks relies on high quality implementation to achieve positive effects. Based on current experience, we should be able to continue this curriculum element; however, expansion of the number of trained tasks may require a more substantial commitment of time and effort.

We did not track practice sessions or collect baseline performance and demographic data for each participant, including previous suturing- and knot tying-training in medical school or medical school boot camps. Such information would be useful in understanding results and creating a richer picture of each trainee's skills characteristics. Despite this limitation, we believe that the general pattern of performance change observed over 16-weeks for the 3 assessment time points and their early performance compared to current residents ultimately suggested that these trainees learned the skills that they were asked to practice. In addition, the submission of videos by 5 participants suggested that trainees continued to practice their skills after receiving feedback on the initial videos. Despite this evidence of ongoing practice, it was felt that the performance decrement observed for the second assessment required explanation. At this point, we have speculated that the drop in scored performance between the initial pre-employment assessment and the assessment in the first week of residency was likely due to the specific circumstances of the assessments. In the pre-employment setting, when given the choice of what to submit and when to submit it, we believe that new trainees were apt to provide the very best example of their work produced in a low-stress, unobserved environment. Arguably, this might be a motivating factor in trying to understand the task objectives. Trainee choice in this matter was not possible at the time of the first Boot Camp assessment in July, however. That assessment is done each year as a scheduled event in an educator-observed setting. Skills decay[10] could also have been a factor, although the degree to which this may have also contributed to this performance decrement is not known, as we do not have a clear picture of how much practice continued following the initial assessment.

This report continues to press the question of whether pretraining skills acquisition between medical school and start of residency makes interns more competent, knowledgeable, confident, or safer on July 1 than they would have been without such training. Even studies suggesting that intensive preparatory training during Boot Camp experiences early in residency can improve performance generally do so on the basis of comparisons to historical controls during different academic years.[11] Although such comparisons may provide impetus for broadening such efforts, it also speaks of the need for further study before pretraining preparation can be claimed to be a best practice. That would require comparison to a more appropriate contemporaneous control group without such training. We were able to show that for 2 of the 4 tasks, pretraining practice, coupled with self-determination of a competent level of performance (as defined in the tutorial materials), resulted in performance patterns that were not substantially different than those of PGY-2 to -4 residents whose performance was examined contemporaneously using the same methods. By the conclusion of Boot Camp, these performance differences were no longer significant for any of the tasks due to further gains in new intern performance compared to the much more clinically experienced residents.

There is precedent for this: Supervised preparatory experience during the fourth year of medical school has been shown to be highly effective in imparting skill, even compared to those expected of PGY-1 residents. Boehler et al reported use of an extensive training 1-month long elective course with faculty- and resident-run case discussions, cadaver lab, ICU rounds, as well as simulation experiences for senior medical students to prepare for surgical residency.[2] Students' knowledge was evaluated both before and after the course and compared to that of current surgical interns. Post-test knowledge scores were significantly higher than pretest and surgical intern scores, suggesting that junior surgical learner characteristics are not an impediment to achievement of high levels of performance.

In summary, based on the performance observations made, we feel that preinternship training with an element of feedback was a valuable adjunct to our established training regimen for new residents. Furthermore, we felt that it was sustainable despite the time-intensive nature of video recorded task assessments. Our team developed the strong sense that as rater experience builds, the assessment piece became easier and that readily available tools such as Google Drive greatly eased our ability to facilitate transfer of information to and from trainees. It is very appropriate to ask whether, following an intensive Boot Camp experience during the first weeks of residency, a pretraining benefit will continue to be in evidence. Residency program Boot Camp curricula specifically directed at new surgical residents at the start of training,[7,11-13] have been increasing in number over the past 10-years, but are not at the point where they are considered de rigueur in all training programs. Some evidence does strongly suggest that there is an opportunity to use this education intervention to better prepare new surgical residents for the rigors of their training experiences. Among other measures, correlation has been demonstrated between Boot Camp cognitive scores and American Board of Surgery In-Training Examination scores, as well as Boot Camp technical scores and operative evaluations,[7] suggesting an opportunity for early directed interventions to improve educational outcomes. Accelerated acquisition of skill and high levels of performance in lab-based skills training has similarly been demonstrated, especially when competency-based training methods are used.[11,12] The degree of supervision and access to feedback that is possible in these settings is greater than that of the pretraining curriculum we have described; however, we are also encouraged by the advancement of technologies for distance learning that might make personalized feedback a real-time experience for the learner. Arguably, the best use of pretraining skills acquisition may be to not only push new trainees to higher points on their skills learning curves, as forwarded for fourth year medical student Boot Camp experiences, but to make practice of other, more advanced skills at the start of residency possible.

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