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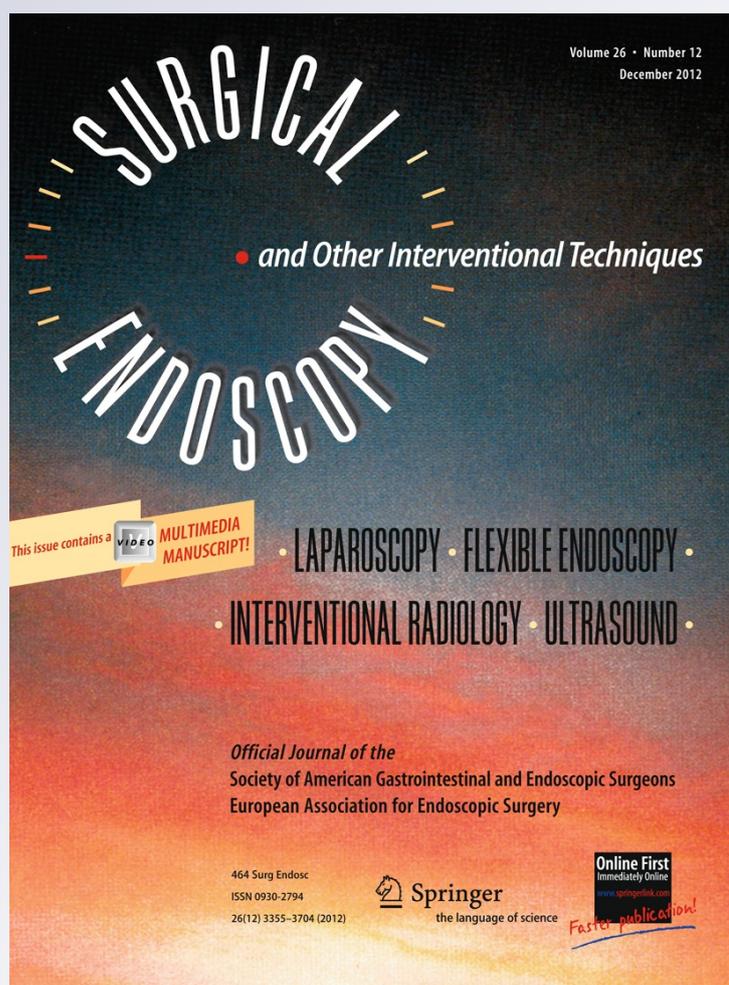
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## Data-based self-study guidelines for the fundamentals of laparoscopic surgery examination

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### Abstract

**Background** In preparing for the fundamentals of laparoscopic surgery (FLS) exam, residents usually adopt a self-learning strategy where practice time can be managed with more flexibility. However, with this self-learning strategy, there is a lack of direct supervision from experts and residents risk understudying for this high-stakes exam. Our objective is to determine study goals for effective self-guided practice for the FLS manual skills tasks that will result in passing the examination.

**Methods** FLS manual skills data for all PGY-5 residents during 2009–2010 was supplied by the FLS administrative office. Descriptive statistics were performed, and data were regrouped by the pass/fail results of the exam. The minimum practice time requirement for passing each manual skills task is reported in order to guide practice.

**Results** 1,047 proctored FLS exams were completed by 2009–2010 residents. Mean task time achieved by all residents was  $84 \pm 31$  s for peg transfer,  $139 \pm 54$  s for pattern cut,  $78 \pm 29$  s for endoloop,  $158 \pm 66$  s for extracorporeal suturing, and  $168 \pm 77$  s for intracorporeal

suturing. In the pass group ( $n = 988$ ), mean time to complete each task was 80 s for peg transfer, 134 s for pattern cut, 75 s for endoloop, 148 s for extracorporeal suturing, and 160 s for intracorporeal suturing. Calculations suggest a self-study goal for each task of 53 s for peg transfer, 50 s for pattern cut, 87 s for endoloop, 99 s for extracorporeal suturing, and 96 s for intracorporeal suturing. If a resident can reliably achieve these results during self-study, they have an 84 % chance of passing the exam.

**Conclusions** Residents preparing to take the FLS exam can refer to data presented in this study to set practice goals. Referring to these data-based practice goals will help residents to improve their chances of passing this high-stakes exam.

**Keywords** Fundamentals of laparoscopic surgery program · Surgical education · Simulation · Skills training · Residency training

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The fundamentals of laparoscopic surgery (FLS) program is an educational program which was launched by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) in 2004, with an aim of ensuring surgeons' competency in performing laparoscopic surgery [1]. Since its introduction, FLS has undergone a rigorous series of validations, both from a metrics standpoint and by beta field-testing with general surgeons from multiple institutions [2–4]. Currently, the proctored high-stakes FLS exam is taken at designated testing locations, and it is currently available at more than 70 testing centers throughout North America as well as 6 testing centers in Australia/New Zealand. Surgeons can also sit for the exam at the SAGES annual meeting, the American College of Surgeons National Congress, or through appointments with on-site

traveling proctors. To date, over 3,000 FLS exams have been administered. In 2010, the American Board of Surgery (ABS) mandated that all general surgery residents pass the FLS examination in order to qualify for the American Board of Surgery certifying examination [5, 6].

The FLS program curriculum covers topics including preoperative, intraoperative, and postoperative considerations regarding basic laparoscopic procedures, as well as the knowledge, judgment, and technical skills considered necessary to be competent in basic laparoscopic surgery. Laparoscopic competence is assessed through a two-part high-stakes examination: a cognitive examination and a manual skills examination. The cognitive examination is a computer-based multiple-choice exam, which tests knowledge and judgment relating to clinical scenarios. The manual skills tasks include bimanual transfer of objects, precise pattern cutting, use of ligating loops, and intracorporeal and extracorporeal suturing through five simulated laparoscopic tasks. These tasks are then scored based on the examinee's time, accuracy, and errors according to the standardized FLS protocol supervised by an experienced FLS proctor.

Study material for FLS is typically presented through a self-paced curriculum. Using this method, residents can study laparoscopic knowledge and acquire basic laparoscopic skills on their own time during their clinical service. This study focuses on the manual skills practice, which is an important component of the FLS program. There are five basic skills a resident must practice. In the bimanual transfer of objects task, the examinee is asked to lift six objects with a laparoscopic grasper and place them in a designated location. This exercise tests hand–eye coordination, ambidexterity, and depth perception. In the second task, the examinee is asked to cut out a predefined circle from a square piece of gauze. This exercise tests the examinee's ability to use both hands in a complementary manner and evaluates accuracy and precision. In the third task, the examinee is asked to place a pretied ligating loop around a tubular foam appendage as close as possible to a mark, and then secure the knot by sliding down the handle. This task tests familiarity with the basic tool of a ligating loop, and bimanual skills. In the fourth task, the examinee is asked to complete a simple suture and tie an extracorporeal knot. In the fifth task, the examinee is asked to perform a simple suture with intracorporeal knot. The suturing tasks test the accuracy of placement of the suture, knot-tying skills, ambidexterity, and depth perception.

In preparing for the manual skills portion of the FLS test, residents usually adopt a self-learning strategy where they practice the tasks when they have available practice time. The FLS program includes guidelines on basic task requirements, including detailed measurement and scoring criteria, but does not give any time-to-completion goals to allow the trainee to set practice goals for their self-practice.

The goal of this study is to analyze residents' performance on the FLS manual skills tasks since the American Board of Surgery mandate in 2010, and provide a set of data-based self-study reference guidelines for residents to optimize their chances of passing the manual skills test.

## Methods

The raw FLS exam data for the manual skills exam was obtained in cooperation with the FLS program administrative office, for all Accreditation Council for Graduate Medical Education (ACGME)-accredited general surgery residents who were in their fifth postgraduate year (PGY-5) during 2009–2010. This was the first year that passage of the FLS exam was required for graduating surgery residents in order to be certified by the ABS and therefore represented a full cohort of residents, 98 % of whom had passed the FLS exam. Residents may have taken the FLS exam at any time during their general surgery residency training (PGY-1 through PGY-5).

FLS score sheets list the time and accuracy of each of the five components of the exam, and descriptive statistics were conducted on the results of these test elements as well as the overall test. Data were then grouped by the pass/fail results of the exam to display means scored for passing each skill test. This allowed the definition of the minimal time requirement (calculated as the mean minus one standard deviation) to pass each skill test. Results are reported as mean  $\pm$  standard deviation. A *p*-value of  $<0.05$  was considered to be statistically significant. All statistical analysis was performed using SPSS 11.0 (IBM, Chicago, IL, USA).

## Results

A total of 1,047 residents who were in their fifth postgraduate year during 2009–2010 completed a proctored FLS exam during their residency training. This was the first year that graduating residents were required to take and pass the FLS exam according to the American Board of Surgery mandate, which gave a complete cohort of motivated test-takers. One resident had taken the exam as a PGY-2, 34 residents as a PGY-3, 353 residents as a PGY-4, and 659 residents as a PGY-5.

Results of the manual skills exams are listed in Table 1. The mean task time achieved by all residents was  $84 \pm 31$  s for peg transfer,  $139 \pm 54$  s for pattern cut,  $78 \pm 29$  s for endoloop,  $158 \pm 66$  s for extracorporeal suturing, and  $168 \pm 77$  s for intracorporeal suturing. Of those who passed the manual skills exam ( $n = 988$ ), the mean time to complete each task was 80 s for peg transfer,

**Table 1** Mean FLS task time for all PGY-5 residents in 2009–2010 ( $n = 1,047$ )

	Peg transfer time (s)	Pattern cut time (s)	Endoloop time (s)	Extracorporeal suture time (s)	Intracorporeal suture time (s)
Mean	83.8	139.2	77.9	158.3	167.9
Median	78	131	74	144	148
Standard deviation	31.1	53.6	29.4	65.6	76.5
Range	193	467	232	613	541
Minimum	32	45	22	62	59
Maximum	225	512	254	675	600

**Table 2** Mean FLS task time for all PGY-5 residents in 2009–2010 grouped by pass/fail exam results, and minimum task time recommendations ( $n = 1,047$ )

	Fail group ( $n = 59$ ), mean $\pm$ SD task time, in seconds	Pass group ( $n = 988$ ), mean $\pm$ SD task time, in seconds	Time recommendation (calculated as mean task time of the pass group minus one SD), in seconds
Peg transfer	139 $\pm$ 35.7	80 $\pm$ 27.5	53
Pattern cut	130 $\pm$ 43.2	75 $\pm$ 25.3	50
Endoloop	229 $\pm$ 69.3	134 $\pm$ 47.4	87
Extracorporeal suture	308 $\pm$ 100.2	149 $\pm$ 50.6	99
Intracorporeal suture	307.6 $\pm$ 117.2	160 $\pm$ 64.5	96

SD standard deviation

134 s for pattern cut, 75 s for endoloop, 148 s for extracorporeal suturing, and 160 s for intracorporeal suturing.

The raw data for the manual skills exam were then divided into two groups (pass and fail) in order to show the minimal requirement for each skill set (Table 2).

The suggested self-study goal for each test, calculated as the mean minus one standard deviation, is 53 s for peg transfer, 50 s for pattern cut, 87 s for endoloop, 99 s for extracorporeal suturing, and 96 s for intracorporeal suturing. If a resident can reliably achieve these results during self-study, they will have an 84 % chance of passing the exam.

## Discussion

In 2004, the SAGES introduced the FLS program, with the aim of documenting and improving surgeons' competency in the performance of laparoscopic surgery. Since its introduction, FLS has been shown to be an efficient, cost-effective, and comprehensive training program [4, 7, 8], which aims to have a positive impact on patient safety by establishing and certifying a minimal baseline of surgical competency in laparoscopy, therefore increasing clinical

skills in the operation room [9] and decreasing the incidence of medical errors [10].

Through the SAGES initiative and a generous grant from the Covidien Educational Fund, the FLS program has been made available to all general surgery training programs in the USA with the intention of having all residents complete their training with the opportunity to take the exam at some point in their training. Each program received free or subsidized exam vouchers, as well as one trainer box and supplies [11]. In 2010, the American Board of Surgery mandated that all graduating general surgery residents pass the FLS exam before qualifying to take the American Board of Surgery certifying examination, and since this time the pass rates of trainees have improved [1].

Residency training programs have traditionally used the operating room and wards to teach basic surgical skills to residents; however, with the current reduction in work hours, limited case volumes, and care responsibilities due to patient safety concerns, bench-top training is increasingly being incorporated into technical skills education in order to augment learning outside of the clinical environment [12, 13]. Residents often elect, or are required to, practice manual skills tasks on their own outside of their clinical duties. A recent study showed that portable bench-top simulators, such as those used in FLS, are often taken home by residents so that they can practice laparoscopic skills on their own time outside of clinical hours. This practice of using a portable home simulation box for surgical training has been encouraged by many [14, 15]. When residents adopt a self-training strategy on their own time, it is important to provide specific training goals during such independent practice to help them to achieve the best educational outcome.

Although the results of our study showed that the pass rates for general surgery residents during the first year of the ABS mandate was high, it was not 100 %. Trainees undergoing the FLS training program today are highly motivated to succeed. FLS manual skills assessment is based on a complex scoring system combining task time and accuracy [16]. While all of the components that factor into the overall manual skills score are important, task time serves as an important factor as to whether a trainee passes or fails the examination. Therefore, task time can serve as a

marker for direct feedback to trainees during their practice of the manual skills component, since it is easily recorded and followed.

Our study reviews FLS test results of PGY-5 general surgery residents graduating during the first year of the ABS mandate who had taken the exam at some point in their training. The data in this study provide a clear description of the time requirement for passing each separate task, and should provide self-study goals that can aid surgery residents who are practicing for the manual skills section of the FLS examination. Residents can refer to Table 1 to set their practice goals according to the “average” or “above-average” performance levels. Table 2 provides a reference for minimal requirements for passing the manual skills tasks. Residents who are preparing to take the FLS test can therefore refer to data presented in this study to set their practice goals. Having data-based practice goals will help residents improve their chances of passing this high-stakes exam.

This study is not without limitations. We found that, if a resident can reliably achieve these suggested results during self-study, they will have an 84 % chance of passing the exam. The recommended self-study guidelines given are based on completing each task in an achievable amount of time. However, there are other variables that factor into the scoring method (i.e., deviation on the pattern cut, security of knot during the simple suture). While residents can use this guideline to improve their task time, they may also need instruction to adjust their movement accuracy.

## Conclusions

This study attempts to define easily measurable study goals for each of the manual skills components of the FLS exam for general surgery residents, based on pass/fail data from the actual resident test results during the first year of the ABS mandate. While the pass rate was high as might be expected, it was not 100 %. It is hoped that our calculated goals will aid program directors to give residents advice on how to study for the FLS exam.

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