

Building a Laparoscopic Surgical Skills Training Laboratory: Resources and Support

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ABSTRACT

Background: Technical skills have historically been developed and assessed in the operating room. Multiple pressures including resident work hour limitations, increasing costs of operating room time, and patient safety concerns have led to an increased interest in conducting these activities in a safe, reproducible environment. To address some of these issues, many residency programs have developed laparoscopic surgical skills training laboratories. We sought to determine the current status of laparoscopic skills laboratories across residency programs.

Methods: In December 2004, surveys were mailed to all 251 United States general surgery residency program directors. This brief 2-page survey consists of 9 questions regarding laparoscopic skills training laboratories.

Results: Of the 251 mailed surveys, 111 completed surveys were returned (44%). Of the respondents, 81 have laparoscopic skills training laboratories in place (80%). Skills laboratories that used a defined curriculum, and general surgery programs that shared their laboratories with other training programs were determined to have significantly more resources. A wide variety of funding sources have been used to develop and support these skills laboratories.

Conclusions: Significant variability in training practices and equipment currently used exists between laboratories. A more efficient, standardized approach to skills training across residency programs is a desirable goal for the immediate future.

Key Words: Laparoscopy, Surgical skills training, Education.

INTRODUCTION

Generations of surgeons have trained according to Halsted's concept of, "See one, do one, teach one." Although ultimately effective, this manner of training is costly in terms of time, resources, and patient morbidity. New technologies and advanced minimally invasive surgical techniques are disseminating throughout residency training programs. Recent pressures, such as the 80-hour work week and the American College of Graduate Medical Education (ACGME) directive regarding the general competencies, challenge the traditional model of surgical training. To address some of these issues, many residency programs have developed laparoscopic surgical skills training laboratories.

To date, no standard curriculum or training method exists. Minimally invasive skills laboratories are costly, take up valuable space, and require a significant amount of time to staff and monitor. A brief survey was mailed to surgical residency program directors with the objective of defining the skills training resources currently in use in residency programs and to identify the obstacles encountered in developing these skills laboratories. This information may prove valuable for residency programs seeking to develop a laparoscopic skills laboratory and curriculum.

METHODS

In December 2004, surveys were mailed to all 251 United States general surgery residency program directors. This study consisted of a single mailing without follow-up attempts. This brief 2-page survey consists of 9 questions regarding laparoscopic skills training laboratories. Questions were designed with the intention of determining common skills laboratory resources, curricula, and obstacles. Specific additional questions that we sought to answer through this survey included whether factors like a defined curriculum, shared resources, or industry financial support fostered the development of a successful laboratory. As a surrogate of success, we examined the number of video trainers and virtual reality trainers used in each laboratory. Statistical analysis of results was performed using Mstat v4.01 software (University of Wisconsin Medical School, Madison, Wisconsin).

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RESULTS

Of the 251 mailed surveys, 111 completed surveys were returned (44%). Of the 111 respondents, 81 have laparoscopic skills training laboratories in place (80%). Laboratories have been established for an average of 4 years (range, 0 to 12). Respondents without a laboratory cited (in sequence, most cited to least cited obstacle) money, space, and time as the most significant perceived obstacles to building a laboratory.

Of the respondents with laboratories, 41 (51%) do not use a defined manual skills curriculum. Unique manual skills curricula developed in-house are used in 15 (19%) training laboratories. The McGill Inanimate System for the Training and Evaluation of Laparoscopic Skills (MISTELS) tasks¹ are used in 11 (14%), the Rosser tasks² in 10 (12%), and Southwestern tasks³ in 4 (5%) minimally invasive skills laboratories. Programs using a manual skills curriculum have more video trainers per laboratory (3.2 vs 1.1, $P<0.01$) and more computer-based simulators per laboratory (1.3 vs 0.4, $P<0.01$).

A didactic curriculum devoted to the development of cognitive skills is used in 58 laboratories (72%). Lap 101 (Ethicon Endosurgery Inc, Cincinnati, OH) is the didactic curriculum for 31 (38%) programs, while 20 (25%) use a curriculum developed in-house and 7 (9%) use the Fundamentals of Laparoscopic Surgery (FLS Program, SAGES, Los Angeles, CA) didactic curriculum.

Video trainers are available in 90% of skills laboratories with an average of 2.9 trainers/laboratory (range, 1 to 10). The size of a residency program (number of categorical residents per year) has no relation to the number of video trainers present in each laboratory (Pearson correlation coefficient (r) = 0.037, $P=0.78$). Computer-based or virtual reality (VR) simulators are currently present in 48% of training laboratories. The most prevalent VR simulators include the Minimally Invasive Surgical Trainer (MIST, Mentice Corporation, Gothenburg, Sweden) in 22 laboratories, LapSim (Surgical Science, Goteborg, Sweden) in 18, and ProMis (Haptica, Inc., Boston, MA) in 8 laboratories. Multiple VR simulators are present in 21 skills laboratories. The size of a residency program has no relation to the likelihood of that program having a VR simulator. Programs with VR simulators had an average of 5.5 categorical residents per year compared with 6.5 categorical residents per year in programs without these simulators ($P=0.38$).

Thirty-seven (46%) skills laboratories are shared with other training programs (urology and gynecology for ex-

ample). Programs that share their laboratories have more video trainers per laboratory (3.2 vs 2.0, $P=0.01$) and more virtual reality trainers per laboratory (1.1 vs 0.6, $P=0.03$) than programs that do not share their laboratory. Residents are required to spend a specified amount of time in the laboratory in 24 programs (31%). The required resident time commitment in the laboratory varied widely from 1 hour per year to 6 hours per month.

Funding for these skills laboratories was attained from a variety of sources. The major source of funding was derived from industry in 34 laboratories (42%). The hospital provided the majority of the financial support for 16 laboratories (20%), 15 laboratories (19%) received primary financial support from the surgical department, and 8 laboratories (10%) received the majority of their funding from other sources. These other sources include alumni, the university or medical school affiliated with each program, and research grants. The remaining 8 laboratories received funding in equal amounts from a variety of the sources listed above. Skills laboratories that received the majority of funding from industry tended to have been established for a longer period of time than other laboratories (4.6 vs 3.2 years, $P=0.005$). No significant difference existed in the number of video trainers per laboratory, nor were these 'industry funded' laboratories more likely to have a VR trainer (2.9 trainers vs 2.8, $P=0.95$; 19/34 industry funded laboratories with VR vs 19/45 other laboratories with VR, $P=0.23$; 0.88 VR per laboratory industry funded vs 0.76 VR per laboratory other funding, $P=0.27$).

When asked to indicate the major obstacles encountered when developing their laboratories, 49 respondents indicated that faculty time constraints presented a major obstacle, 47 respondents felt that financial obstacles existed, 42 indicated resident time obstacles, and 29 indicated that finding appropriate space for the laboratory was difficult.

DISCUSSION

Technical skills have historically been developed and assessed in the operating room. In most training programs, a resident's surgical skills are assessed by the attending surgery staff at the end of each rotation using in-training evaluation reports. This method of technical skill evaluation has many shortcomings and has been widely criticized.⁴ Multiple pressures including resident work hour limitations, increasing costs of operating room time, and patient safety concerns have led to an increased interest in developing and objectively assessing surgical skill outside of the operating room.

The skills required to safely perform laparoscopic surgery are unique and not necessarily derived from those used during open surgical procedures. The laparoscopist must learn to overcome obstacles, such as the fixed position of the trocars, 2-dimensional visualization, decreased haptic feedback, and the fulcrum effect of long instruments. Several groups have demonstrated that many of these laparoscopic skills can be attained in a dry laboratory setting using simulators.^{5,6}

There are 2 general categories of simulators: physical simulators (video trainers) and computer-based simulators ('virtual reality'). Video trainers consist of a trainer box and a video imaging system. Tasks are performed within the confines of the box using actual laparoscopic surgical instruments. The metrics used to assess performance in a video trainer are relatively simple (time to complete a task, predefined errors). Computer-based simulators vary in their sophistication but generally involve the performance of a task in a 'virtual' environment. The metrics in a computer-based simulator are typically more complex (motion analysis). Computer-based simulators are significantly more expensive than video trainers are. This appears to be a major factor preventing many training programs from integrating virtual reality trainers into their curricula.

Several significant obstacles have prevented the widespread implementation of laparoscopic skills training laboratories throughout residency programs. Eighty percent of respondents to this survey have a laboratory at their institution (n=81). It is likely that the actual prevalence of laboratories in surgical residency programs is lower than this. In a similar survey, Korndorffer and Scott⁷ determined that 89 programs of the 162 to respond to their survey have skills laboratories (55%). It is interesting that programs without laboratories cite money, space, and time in sequence as perceived obstacles to building a laboratory, but programs that have successfully developed laboratories most often cited time and manpower requirements as the biggest obstacles encountered. Clearly, the time required to design, implement, monitor, and maintain a training laboratory is significant.

One surrogate measure for a successful laboratory may be the resources available (number of video trainers or VR simulators). In this study, factors associated with more training resources at a program included a defined manual skills curriculum and a laboratory shared with other programs. Our experience at the University of Wisconsin before the introduction of a skills curriculum was that our solitary video trainer was unused. The introduction of a

mandatory curriculum has led to increased utilization, additional funding from several resources, and more trainers. An invitation to trainees in other surgical disciplines to participate has led to further support from the hospital in the form of funding and space. An informal survey of surgical faculty in our department indicates that junior residents are subjectively better prepared to actively participate in laparoscopic cases early in their training than in previous years. This sense may be partly responsible for increased faculty support for this laboratory in the form of department funding and faculty time commitment.

Evident from this mailed survey is the fact that there is a wide variety of ways in which residency programs use their laparoscopic skills training resources. It is likely that basic skills sets are developed more completely and efficiently in certain laboratories and less so in others. With the pressures facing residents and programs today, it is becoming increasingly important that trainees develop an identifiable laparoscopic skill set in a safe, cost-effective, time efficient, reproducible environment, such as the training laboratory. Ideally, residents would perform to a preset competency based standard before participating in laparoscopic cases in the operating room. A validated and standardized curriculum that could be uniformly implemented across residency training programs would be ideal as well. The skills developed in the laboratory would be real skills transferable to a live laparoscopic case in the operating room. These skills would be measurable in a highly reliable way using relatively simple metrics. Further research on a gold-standard, high-stakes skills assessment and training curriculum is necessary and ongoing at many centers throughout the world.

CONCLUSION

In summary, building and maintaining a laparoscopic skills laboratory required a variety of resources. Making the laboratory valuable to as many people as possible can help foster support. Significant variability currently exists in training practices and equipment used between laboratories. A more efficient, standardized approach to skills training across residency programs is a desirable goal for the immediate future.

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