Status of Simulation-Based Training in Departments of Surgery in the United States

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ABSTRACT

Background: Surgical simulation is particularly attractive because it allows training in a safe, controlled, and standardized environment. However, the status of surgical simulation among Departments of Surgery (DoS) in the United States is unknown. The objective of this study was to characterize the status of simulation-based training in DoS in the United States.

Materials and methods: A Qualtrics online survey was sent to 177 chairs of DoS in the United States in March 2018 regarding the utilization of surgical simulation in their department. Questions in the survey were focused on simulation capacities and activities as well as chairs' perception of the value and purpose of simulation.

Results: A total of 87 of 177 chairs responded to the survey (49% response rate). Most programs had either 20-50 trainees (42 of 87; 48%) or more than 50 trainees (37 of 87; 43%). Most chairs reported having a simulation center in their institution (85 of 87; 98%) or department (60 of 86; 70%) with a formal simulation curriculum for their trainees (83 of 87; 95%). Ninety percent (78 of 87) of DoS had protected time for simulation education for their residents, with most residents engaging in activities weekly or monthly (65 of 85; 76%). Although most chairs felt simulation improves patient safety (72 of 84; 86%) and is useful for practicing surgeons (68 of 84; 81%), only 40% reported that faculty use simulation to maintain technical skills and only 17% reported that faculty use simulation to address high complication rates.

Conclusions: The vast majority of the DoS in the United States have established simulation activities for their trainees. However, engagement of faculty in simulation to maintain or improve their skills remains low.

Both M.R.K. and M.G.P. share senior authorship.

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Introduction

Simulation can be defined as a model of a real activity created for training purposes or to solve a problem.[1] Surgical simulation has been implemented during the past few decades and is particularly attractive because it allows training in a safe, controlled, and standardized environment. Reduced working hours, concerns over patient safety, increased medical malpractice litigation, and emphasis on surgical efficiency have further motivated embracement of simulation by surgical specialties.[2-4]

Surgical simulation has proven to reduce learning curves in the operating room, decrease intraoperative and postoperative complications, and improve patient outcomes.[5,6] In addition, simulation seems to be a cost-effective method of improving surgeon confidence and performance of technical and nontechnical skills.[7] In the United States, the Accreditation Council for Graduate Medical Education established that general surgery programs must ensure the availability of simulation and skills laboratories, which must address acquisition and maintenance of skills with a competency-based method of evaluation.[8] However, little is known regarding how surgical simulation is used and integrated among Departments of Surgery (DoS) across the United States. Thus, the goal of this study was to characterize the status of simulation-based training in DoS in the United States. We hypothesize that variability exists among DoS in the United States with respect to utilization of simulation-based activities.

Materials and methods

An electronic mail (e-mail) containing a link for an anonymous online survey named *Status of Simulation-based Training in the US* was sent by the chair of surgery of our institution (M.R.K.) to 177 chairs of DoS in the United States in March 2018. E-mails of the chairs were obtained through the Society of Surgical Chairs Membership Directory available at the American College of Surgeons Web site.[9] Two reminders were sent to them within 1 mo of sending the link, and the survey was closed 2 mo after the initial e-mail.

The survey was designed using Qualtrics, a web-based platform, which provides a link to the survey that can be accessed through a computer, tablet, and/or mobile device. The questionnaire sought responses to different blocks of questions regarding simulation capacities, simulation center activities, resident participation, faculty participation, financial support, and chair perception of the value and purposes of simulation. Different response types were used depending on the type of information requested (e.g., closed-ended questions or multiple-choice questions).

Survey responses were only retained for those who fully completed the questionnaire. Data were downloaded and analyzed using descriptive statistics to calculate the frequency of responses according to categories. The study was approved as exempt by the University of North Carolina Institutional Review Board.

Results

A total of 87 of 177 chairs responded to the survey (49% response rate). The total number of trainees in the DoS was as follows: <20 trainees (8 of 87; 9%), 20-50 trainees (42 of 87; 48%), or >50 trainees (37 of 87; 43%).

Most of the chairs reported having a simulation center in their institution (85 of 87; 98%) or department (60 of 86; 70%), with a formal simulation curriculum for their trainees (83 of 87; 95%). Specifically, 81 of 87 (93%) and 64 of 87 (74%) chairs stated having a minimally invasive or a robotic simulation curriculum, respectively. Although 78 of 87 (90%) of the DoS had protected time for simulation for their residents, only 51 of 87 (59%) had protected time for faculty to teach simulation. Resident participation in simulation was mostly during weekdays from 8 AM to 5 PM (75 of 85; 88%), at least once a week or once a month (65 of 85; 76%), and engaged both junior and senior residents (73 of 85; 86%) (Fig. 1). Simulation included multidisciplinary (surgery, anesthesia, and/or nursing) activities in most of the cases (77 of 87; 89%), with the use of virtual simulators (77 of 87; 89%), cadavers (62 of 87; 71%), tissue blocks (53 of 87; 61%), and live animals (36 of 87; 41%) (Fig. 2).

Most of the chairs considered that simulation improves patient safety (72 of 84; 86%), reduces operative times (50 of 84; 60%), and is useful for practicing surgeons and not just trainees (68 of 84; 81%) (Fig. 3A). However, only 35 (40%) chairs reported that simulation was used to maintain technical skills by faculty, and only 15 (17%) chairs reported that simulation was part of a process for helping surgeons with high complication rates (Fig. 3B). On further examination of these responses, more chairs reported faculty using simulation activities if the department had its own simulation center. For example, 47% of chairs (28 of 60) with a simulation center within their department reported faculty using simulation activities to maintain their technical skills, whereas only 27% (7 of 26) of chairs who did not have a simulation center in their department reported the same (Fig. 3C). Similarly, 22% (13 of 60) of chairs reported that faculty used simulation activities to address high complication rates if they had a simulation center within the department, whereas only 8% (2 of 26) of chairs who did not have a simulation center in their department reported the same (Fig. 3D).

Finally, simulation activities received financial support from either the institution or DoS or both in most cases, with only 8% of programs reporting no financial assistance from either the DoS or the institution (Fig. 4).

Discussion

We aimed to characterize the status of simulation-based training in the United States through an online survey delivered to chairs of DoS. Contrary to our hypothesis, we found that almost all DoS have simulation activities with a formal simulation curriculum; most surgical residents in the United States have protected time for simulation; but that few faculty members are using simulation activities to maintain their

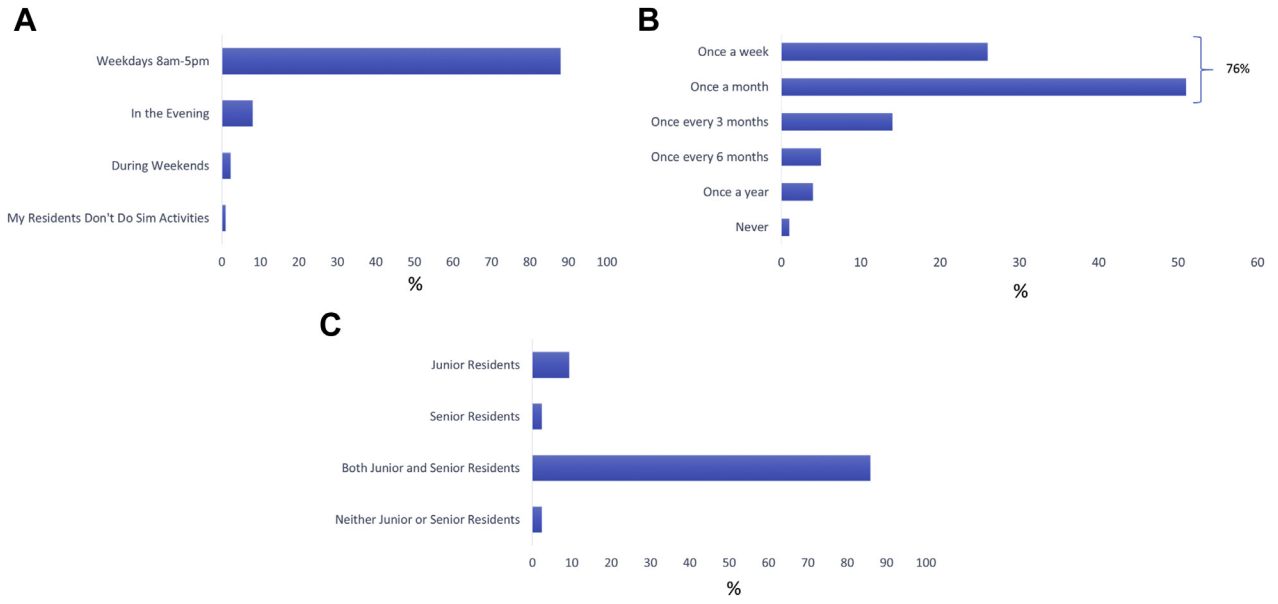

Fig. 1 – Characterization of resident use of simulation activities. Most chairs report that (A) residents use the simulation center during the workweek and not during nights or evenings, (B) at least once a week or once a month, and (C) that simulation activities are focused on both junior and senior residents. (Color version of figure is available online.)

technical skills or address high complication rates, despite chairs believing that simulation activities improve patient safety and should be used by practicing surgeons.

Considering the proven benefits of surgical simulation, it is reassuring that almost all chairs affirmed to have a simulation center at their institution. Although a wide variety of surgical simulators can be used for teaching or training purposes, virtual simulators seem to be the most frequently used. Current virtual reality simulators consist of high-fidelity platforms with haptics (or force feedback) that allow for learning basic skills and simulate full procedural surgical tasks.[10] For instance, residents have shown higher economy of movements and fewer errors during a laparoscopic cholecystectomy after training with these platforms, as compared with those without virtual reality simulation.[11,12] High initial cost of system acquisition, greater maintenance expenses compared with lower fidelity platforms, and challenges with training in the full complexity of procedures are their main drawbacks.[13]

Cadaveric simulation also seems to be frequently used, probably because of its capability of practicing entire operations with the highest possible anatomic, environmental, and technical fidelity.[14] Unfortunately, costs and availability may limit their use in some DoS. The lesser use of live animals (41%), which also provide high-fidelity training with the opportunity of simulating the full spectrum of the operation as well as surgical complications (e.g., bleeding), might be related to costs, logistical and infrastructure challenges, and even ethical or legal restrictions.[15,16] Realistic models based on perfused tissue blocks are also available and may represent a valid and less expensive training tool.[17,18] Efforts should be directed toward a standardized nationwide simulation curriculum, determining the appropriateness of each simulator in relation to the skills offered and ability to assess the competencies required of a surgeon.

Simulation must be integrated into the surgical residency curriculum to be effective as an educational process for our

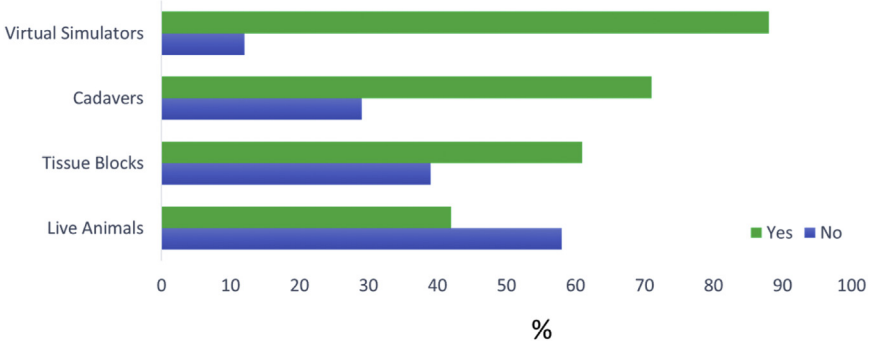

Fig. 2 – Types of simulation activities used in simulation centers. Most chairs report using virtual simulators followed by cadavers in their simulation centers. (Color version of figure is available online.)

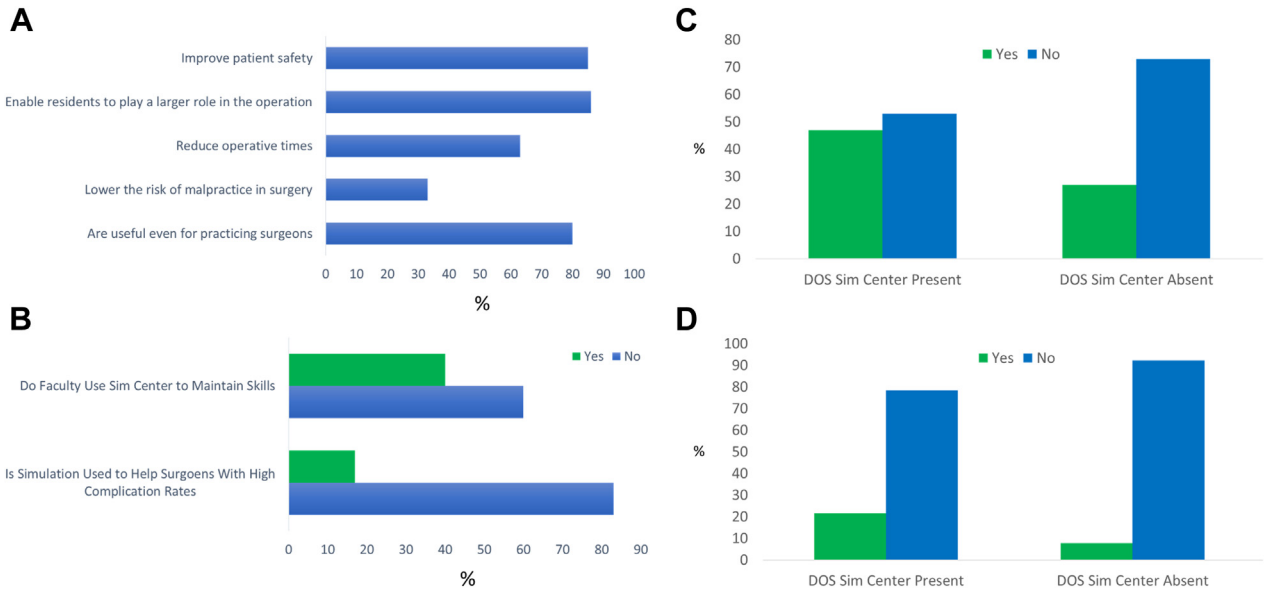

Fig. 3 – Characterization of faculty use of simulation activities. (A) Most chairs believe that simulation activities improve patient safety and are useful for practicing surgeons. (B) However, few faculty were reported to use simulation activities to maintain their technical skills or address high complication rates. On further exploration, (C) more faculty were reported to use simulation activities to maintain their technical skills if they had a simulation center present in their department, and (D) more faculty were reported to use simulation activities to address high complication rates if they had a simulation center present in their department. (Color version of figure is available online.)

trainees.[19,20] Episodic and opportunistic simulation activities by residents should be discouraged, and there should be dedicated protected time for these activities. A positive finding of our study is that almost 90% of the chairs reported having protected time for simulation for both junior and senior residents. On the other hand, less than 60% reported that faculty had protected time to teach using simulation. Understanding what type of simulation is beneficial at different stages of training is vital for the rational use of capital and manpower resources. For example, junior trainees can reliably learn basic technical skills with low-fidelity models, and even nonphysician personnel can be used as instructors for this purpose.[21] On the other end of the spectrum, senior trainees may need higher fidelity models and the assistance of faculty surgeons to adequately learn more complex procedures. Multidisciplinary activities also should be offered to the trainees as they are key for the development of nontechnical skills, such as teamwork, situation awareness, and decision making.[22]

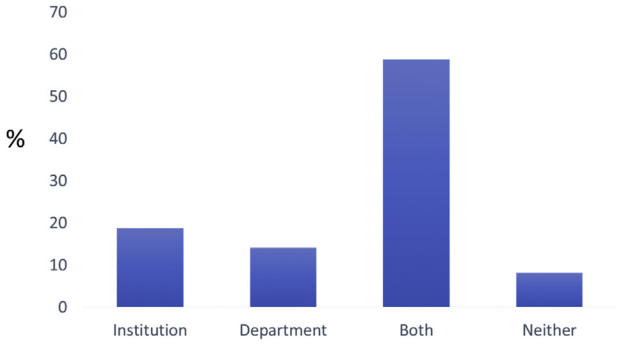

Fig. 4 – Funding for simulation centers. Most chairs reported receiving funds from both the institution and department to support simulation activities. (Color version of figure is available online.)

The role of simulation for practicing surgeons is still a matter of debate. In fact, a recent study including considerations from experts in simulation-based training determined that one of the research priorities in surgical simulation should be the use of simulation for surgeon certification/recertification and/or credentialing/recredentialing.[23] Interestingly, a study showed that around 30% of practicing surgeons may not initially pass the fundamentals of laparoscopic surgery, which is required by the American Board of Surgery for graduating residents.[24] In addition, simulation can be useful for established experts who want to embrace new technologies in their practice or address high complication rates. In our study, although most chairs considered that simulation was useful for practicing surgeons, a relatively low proportion reported that faculty used simulation to maintain skills, and even less stated that simulation was used for helping surgeons with high complication rates. However, it was encouraging that a higher percentage of faculty were reported to use simulation activities if the department had its own simulation center. This suggests that either the enhanced privacy, ease of access, and/or inclusion of simulation equipment more relevant for their practice may help to stimulate established surgeons to use a simulation center. Overall, further research is needed to elucidate how simulation should be used with practicing surgeons.

Costs are often a significant limitation for the widespread adoption of simulation in surgery.[25] The cost of establishing a simulation laboratory can be as high as $1 million and maintaining personnel, materials, and equipment can cost up to $55,000/y.[26] Potential cost savings from shorter operative times, decreased intraoperative and postoperative complications, and better usage of equipment may outweigh those expenses. Therefore, returns on investment analyses are needed by surgeons, hospital administrators, and policymakers to make informed decisions regarding simulation expenditures. We strongly believe that investing in surgical simulation ultimately will benefit our patients by improving the delivery of health care.

Several limitations inherent to the use of a survey should be considered when interpreting the results of this study. Although we had an acceptable response rate, the study is not exempt from selection bias. In addition, most of the participant chairs were part of large training programs, which may limit generalizability to other smaller programs in the United States. The survey did not collect demographic information on the individual chairs who answered the survey. This is important as the background, specialty, and beliefs of a chair may influence the way simulation is implemented in a department. We did not have a definition of simulation center—whereby a room with some shoe boxes and a center with many simulators and a real curriculum might both have been considered centers. Finally, although the confidentiality of the study was made clear to participants, it is possible that some chairs were hesitant to disclose low levels of engagement with simulation.

Conclusions

The vast majority of the DoS in the United States have established simulation activities with a formal simulation curriculum for their trainees. However, engagement of faculty in simulation to teach residents and maintain or improve their skills appears to be low. Research should focus on determining how standardized simulation activities should be implemented for both trainees and practicing surgeons.

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Authors' contributions: F.S., M.R.K., and M.G.P. contributed to the conception and design of the study. F.S., S.T.-R., M.G.P., and M.R.K. contributed to data collection and data analysis. F.S. and S.T.-R. contributed to statistical analysis of the data. F.S., M.G.P., and M.R.K. prepared a draft of the manuscript. All authors critically revised, reviewed, and gave approval for the final version of the manuscript.

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Disclosure

The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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