



# Distance Learning in Surgical Education

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## Abstract

**Background** Medical education has traditionally relied on in-person-based curriculums in medical school and residency. However, due to the COVID19 pandemic, medical schools and residency programs have been forced to rapidly transition to virtual platforms for learning. Surgical education poses a particular challenge, as virtual platforms cannot adequately replace hands-on learning of surgical skills. In this review, we will discuss the various ways in which virtual learning has been employed in surgical education and how it may be used to enhance learning of medical students and residents in the future.

**Methods** We conducted a comprehensive literature search to identify articles published regarding medical school and surgical residency curriculum changes after COVID19.

**Results** Over the past year, several surgery departments have piloted programs using virtual learning modules, live online lectures and training workshops, and remote streaming into the OR to supplement more traditional in-person learning. Overall, these programs have received positive feedback from participating medical students and residents, suggesting that virtual and online tools may be helpful in supplementing surgical education. However,

several programs also noted the possibility for significant disparities in learning due to variable access to internet and availability of newer technologies.

**Conclusion** Going forward, distance learning will play an important role in surgical education to further enhance learning of medical students and residents in a field with rapid technological advancements.

**Keywords** Surgical education · Medical education · Telehealth · Virtual learning · Distance learning

## Introduction

Traditionally, medical training has heavily relied on in-person education, emphasizing the importance of learning through clinical experiences, patient encounters, and hands-on surgical training. Over the past year, trainees at all levels have adapted to new ways of learning that accommodate for social distancing practices and minimize the spread of COVID-19. As the world prepares for future pandemics given worsening climate change and declining vaccination rates, it is crucial that the medical community is prepared with effective means to continue training future medical professionals during these times [1, 2].

Surgical education poses a particular challenge when considering distance learning, given that there has not been an adequate substitute for mastery of surgical techniques with hands-on experience [3]. However, even prior to the COVID19 pandemic, surgical trainees have utilized some distance learning techniques with success to supplement more traditional ways of learning. As technology has evolved, online modules and simulations have increasingly provided ways for medical students and residents to learn surgical techniques and prepare for surgeries outside of the

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clinical setting. In this review, we will provide an overview of how medical schools employed distance learning during the COVID19 pandemic, as well as how these methods may be incorporated into surgical education going forward.

### **Knowledge Acquisition—Preclinical Curriculum**

The preclinical curriculum of medical education requires less direct clinical exposure, and thus may arguably have been the easiest to convert to distance learning. Medical schools often offer students the choice of listening to pre-recorded lectures online, rather than attending in-person sessions. During the COVID19 pandemic, web-based meeting platforms allowed medical schools to conduct socially distanced, live lectures that could be recorded for asynchronous viewing. In addition, some schools created online formative assessments in order to supplement online lectures, which allowed students to assess their understanding of certain lectures prior to official exams [4, 5]. Preclinical students must also learn physical examination skills in preparation for clerkship years, and many schools used pre-recorded videos and virtual interviewing workshops with success to develop these skills [6–8].

The student response to virtual learning has been varied. In one study including 104 students, 64.1% appreciated the increased flexibility of distance learning, yet 56.7% felt that they were underprepared for the USMLE Step 1 exam [9]. In another large meta-analysis including 7 randomized-control trials and 594 students from a variety of health science professions, students reported significantly higher satisfaction levels with distance learning curriculums due to increased flexibility in their schedules. In addition, the study found no significant difference in knowledge acquisition and test scores between students in distance learning versus traditional in-person curriculums [10]. In general, medical schools found that students were more likely to send live questions through private message during virtual learning sessions compared to asking questions in public during in-person sessions [11]. When used effectively, web-based learning platforms may allow students to be more active learners, interacting more with their peers and lecturers.

Preclinical students also highlighted several drawbacks to distance learning techniques. In one school conducting physical exam workshops via virtual workshops, students reported being less comfortable detecting physical exam signs that required palpation, auscultation, and percussion after web-based learning workshops. Despite this, over 98% of students found that virtual learning was “better than expected” or “acceptable” for learning majority of clinical skills, suggesting that students may be able to adapt to new ways of learning [12]. In schools that offered online

formative assessments, majority of students completed these assessments with the help of cellphones or other technology, suggesting that these may not have been very helpful to students in testing their knowledge [4, 5]. Another major drawback of distance learning was higher rates of anxiety and stress among medical students, with many students reporting that distance learning made them feel isolated from the medical school and their classmates [9, 13]. If distance learning becomes more common, medical schools will also need to come up with creative ways to engage students socially and enable more peer interaction.

### **Skills Acquisition—Simulation Learning**

For several years, simulation learning has been used successfully for surgical education, including the use of virtual cadavers in anatomy labs, 3-D body parts for suturing and venous puncture practice, mannequin-computer systems that allow physiological responses in practice case scenarios, and virtual reality surgery simulations [14]. When used effectively, these tools have overall shown to enhance learning, while minimizing the need for standardized patients or exposure to the clinical setting. In one meta-analysis including 22 studies, simulation learning was associated with significantly improved breast and pelvic examination skills when compared with no learning intervention. In addition, feedback after the simulation appeared to further enhance the learning experience [15]. Other medical schools have had success teaching surgical skills, such as suturing and knot-tying, using models mailed to students beforehand, online simulations, and real-time feedback on virtual platforms [16, 17].

Surgical residencies have also employed simulation technologies to enhance training. Kryklywy et al. successfully used a tablet-based training to assist residents with instrument identification and found that, although this method did not achieve equivalent results as real-world practice, repetitive review using the simulations helped to prevent performance decline over time [18]. In addition, other studies found that simulation-based learning curriculums used in conjunction with hands-on training increased overall confidence of surgical residents in performing various skills [19, 20]. A recent review looking at the utility of simulation-based teaching in learning revascularization techniques showed that residents using both hands-on learning and simulations had reduced procedural times, use of fluoroscopy, incidence of mistakes, and improved utilization of surgical instruments [20]. A similar study evaluating an Endoscopy Training System curriculum of less than 10 h of training found that, after completion of these modules, residents had significantly higher

scores on the Fundamentals of Endoscopic Surgery exam [21]. While simulation-based teaching may not replace traditional hands-on learning, it does offer a promising alternative when in-person teaching is limited.

Aside from aiding in distance learning, simulation-based teaching is actually increasingly important in a technologically advancing medical community. It is important for surgical trainees to become familiar and comfortable with evolving technology, as it will likely play a large role in their future careers. For example, many surgeries can now be performed using robotic technologies, and training programs are incorporating simulation-based teaching for robotic skills training. One study including 123 surgical trainees showed that simulation-based robotic skills training significantly improved performance with higher speeds and fewer errors compared to control groups, highlighting the importance of simulations in surgical training [22]. As technology evolves to compensate for a rapidly growing physician shortage, medical education will need to adjust the traditional training model to incorporate more technologically based training [6]. Over the past year, the COVID19 pandemic has further highlighted the importance of simulation-based teaching, both in the need for distance learning and in the need for technology in medicine going forward.

### **Clinical Application—Telehealth**

Telemedicine is not new to health care and actually has its origins during the early stages of NASA's manned space program, where telehealth was employed to monitor vital signs of astronauts during space flight. Over time, this technology has evolved to allow for diagnostic evaluations of various medical conditions [23]. During the COVID19 pandemic, telehealth has been used globally as a substitute to traditional in-person patient care, allowing patients to see doctors from the safety of their homes. Going forward, telehealth has wide implications to increase health care access in rural communities lacking local physicians. As a result, medical schools have started integrating telehealth into curriculums, and medical students increasingly appreciate the important role that telehealth will play in their careers (Abraham et al.).

Medical education has always emphasized the importance of learning through direct patient care and exposure to the clinical setting, especially after completion of the undergraduate medical education curriculum. However, during the past year, many medical students were removed from the clinical setting, and telehealth offered a way for students to stay involved in patient care. In one survey of twenty medical students on a telehealth-based Internal Medicine rotation, students reported being exposed to a

variety of patient cases over telehealth and felt confident effectively completing an outpatient telemedicine visit. These students particularly were appreciative of prompt feedback from attendings and residents after patient encounters on telehealth [24]. Telehealth has also been used for teaching medical students in the inpatient setting. Some medical schools have employed a virtual bedside rounding method, in which on-site physicians use iPads or computers on wheels to run videoconference applications during rounds. Students are able to connect remotely to the videoconference and are able to see and hear the physician–patient encounter. In one study, 14 students completed a survey about their experience virtual rounding on patients with COVID19, and an overwhelming majority reported that they felt engaged and that they had gained a better understanding of COVID19 through virtual rounds [25].

Sub-internship and away rotations are important in the match process for residency, especially to allow medical students to visit specific programs that they may be interested in. Due to the COVID19 pandemic, medical schools suspended their away rotation programs, and many created virtual rotation curriculums. Surgical rotations have employed secure video conferencing software in order to stream live surgical encounters, allowing students to participate in and gain exposure to the operating room. One urology program created a virtual rotation curriculum, which included a virtual didactic curriculum, interactive online modules, and virtual live stream into clinical and surgical encounters. Students were given individual feedback virtually, and several virtual social events were scheduled for residents and students. At the end of the rotation, 100% of students and 63% of physicians rated the program as “excellent” or “very good,” and an overwhelming majority indicated that virtual learning should be incorporated into urology rotations going forward [26].

### **Disparities in Distance Learning**

Although distance learning in surgical education has significant benefits that will continue to be utilized in the future, it is important to address the potential disparities that distance learning may create. Over the past year, students reported network connectivity as a major drawback to distance learning [4]. In a virtual pathology curriculum that employed whole slide viewing software to share pathology slides with medical students, 80% of students reported that learning was impaired by technological challenges in accessing the slides [27]. As medical schools increasingly employ telehealth and other technologies as a learning tool, medical students who may have poorer internet access or limited access to computers with updated

software will inevitably be at a disadvantage. Another study found that indigenous students in higher education reported significant difficulty in forming social connections with other learners through online platforms, suggesting that differences in cultural upbringing may place racial and ethnic minority students at a further disadvantage in distance learning curriculums [28]. Going forward, medical schools will need to consider how incorporating distance learning may worsen educational disparities in surgical education.

### Remaining Gaps in Distance Learning

Most of the research surrounding distance learning has focused on its efficacy in teaching medical knowledge and concrete skills. Some physicians and educators argue that there are many other equally important factors to consider in medical education, such as communication, decision-making skills, and development of professional identity [29]. These endpoints are much more difficult to assess via surveys and objective test scores that many studies have used to evaluate success of distance learning curriculums. As more distance learning is incorporated into surgical education, medical schools will need to consider how they can evaluate more subtle and subjective components of learning medicine. Hopefully, we will soon see reports from those surgeons administering or taking the American Board of Surgery Qualifying Exam which was given virtually this year and will serve as an important early marker of efficacy in this setting.

### Conclusion

Over the past year, the COVID19 pandemic forced medical schools into virtual learning curriculums rapidly, and many schools have used this opportunity to expand and enhance resources for distance learning. As technology continues to advance in medicine, new virtual learning technologies are likely to form a large component of medical education going forward. In undergraduate medical education, pre-recorded lectures, virtual physical examination workshops, and virtual feedback sessions have been used with success. In clinical years, medical students have participated in virtual rounding and clerkships, gained more exposure to telehealth, and refined basic surgical skills through virtual workshops. Even surgical residents have benefited from increasingly available online simulations, which have been shown to improve overall confidence, test scores, and procedural efficacy. Unfortunately, we have not yet been able to quantify the efficacy of distance learning platforms on the “soft skills” of medicine. Further, distance learning

curriculums have the potential to cause significant disparities in learning among ethnic and racial minority students and students from lower socio-economic backgrounds. In a rapidly evolving field, technology is bound to play an increasingly important role in medicine, and therefore, it is equally important that technology is incorporated into medical education. The rapid transition to virtual learning during the COVID19 pandemic has highlighted significant drawbacks to distance learning, and further research should focus on preparing medical educators with ways to overcome these problems.

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#### Declarations

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