

Telemedicine and Medical Education in the Age of COVID-19

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Abstract

The COVID-19 pandemic has offered medical schools an opportunity to incorporate telemedicine training into the curricula in a timely and practical manner. Telemedicine has grown exponentially in the United States, and the shift toward remote care to align with social distancing guidelines is fueling this growth. Training medical students to deliver high-quality, secure, and personalized health care through telemedicine will prepare the next generation of physicians to conscientiously use these technologies

and meet a growing need for telehealth services. Telemedicine-specific educational goals can be incorporated into curricula and integrated with existing clinical experiences to provide students with core telemedicine and clinical skills to prepare them for current and future pandemics. Medical educators could explore 5 major telemedicine domains: (1) access to care, (2) cost, (3) cost-effectiveness, (4) patient experience, and (5) clinician experience. Schools could use the following learning vehicles to help

medical students explore these domains: (1) asynchronous lectures covering telehealth history; (2) discussions on applications, ethics, safety, etiquette, and patient considerations; (3) faculty-supervised standardized patient telehealth encounters; and (4) hands-on diagnostic or therapeutic procedures using telehealth equipment. Incorporating telemedicine into the medical school curriculum exposes students to the application of telemedicine across specialties as well as its limitations.

Medical education has been affected by the rapid outbreak of the coronavirus (COVID-19).¹ In line with social distancing guidelines and recommendations from the Association of American Medical Colleges, in March of this year, medical schools transitioned the preclerkship curriculum to online, and many paused clinical rotations.^{2,3} Lectures and small-group learning activities continued virtually. Clinical skills sessions either moved online or were deferred. Many examinations are now administered online. In other times of crisis, such as after the September 11, 2001, terrorist attacks, medical students were able to continue their education and help in the crisis response.⁴ However, given virus transmission risk and personal protective equipment (PPE) shortages, educators have been cautious in allowing students to be involved in patient care during the pandemic.

Fourth-year medical students were given the option to graduate early.

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Medical students also volunteered to support frontline workers remotely by triaging patients, assessing patients using telehealth platforms, transferring patient calls, conducting COVID-19 research, and providing both peer and patient mental health support. Additionally, they have assisted onsite with PPE donation and pharmacy logistics.⁵ Thus, lectures and exams are not the only aspects of the medical student experience that can be done remotely. These students also witnessed and took part in remote versions of vital medical tasks such as scribing, telemedicine encounters, medication reconciliation, and social work coordination.

With research models predicting that intermittent social distancing may be recommended through 2022, this pandemic has allowed medical schools the opportunity to incorporate telemedicine into their curricula.⁶ Here, we examine the state of telemedicine in the United States and propose a longitudinal telemedicine curriculum in undergraduate medical education so that future doctors may be prepared to smoothly transition to telemedicine during future pandemics.

Telemedicine in the United States

Telemedicine is defined as “the provision of health care services over

a spatial distance through the use of telecommunication technology with the aim of benefitting a patient or population.”⁷ Telemedicine can improve both the care experience and patients’ health, and reduce per capita costs of health care.⁸ In 2019, the telemedicine market was worth over \$41.4 billion.⁹ The World Health Organization also highlighted telemedicine as an essential service in response to the COVID-19 emergency.¹⁰ The health care landscape in the age of COVID-19 presents ideal conditions to accelerate this growth. A global physical workforce shortage, geographic maldistribution of primary and specialist care, and high national health care expenditure incentivize the deployment of telemedicine in rural, urban, military, and Veterans Affairs settings.^{11,12} In a 2019 survey, about 85% of consumers were interested in receiving virtual health care, but only 17% had access to it.¹³

In response to COVID-19, electronic health record providers such as Cerner and EPIC have evolved to support more telemedicine capabilities. For example, the mobile EPIC medical records system now includes infection tracing, communication with isolated patients, and remote monitoring. It also allows for the coordination of patient transfers between facilities, PPE tracking, handheld charting, and guidance for

nurses on remote patient support.¹⁴ These technologies have enabled continuity of care during the pandemic and can continue to bolster care beyond the immediate crisis.

Providers' concerns about telemedicine include compromised quality of care as compared with in-person visits, reduced privacy and security of patients' health information, and the potential lack of personal connection between providers and patients during telemedicine visits.^{15,16} In addition, there is evidence that direct-to-consumer telehealth may increase medical malpractice.^{17,18} Health care providers may also resist innovations in telemedicine because they perceive technology to be in competition with their services.¹⁹ However, training physicians during medical school to deliver high-quality, secure, and personable health care through telemedicine can alleviate concerns and promote population-wide adoption of the technology.

Through a curriculum that incorporates telemedicine training, medical students could learn how to maintain a strong patient–doctor relationship, protect patient privacy, promote equity in access and treatment, and seek the best possible outcomes while using telemedicine platforms. Store-and-forward telemedicine education—involving the acquisition of clinical information transferred to multiple clinical sites and appropriate specialists, such as radiology, dermatology, pathology, and ophthalmology—has also been shown to be effective.²⁰ Medical trainees who completed this curriculum reported that it helped them develop core competencies in patient care, medical knowledge, practice-based learning and improvement, and systems-based practices.

Concerns about telemedicine at a system-wide level include legal and liability uncertainties, licensure requirements, and nascent reimbursement mechanisms.²¹ A longitudinal telemedicine curriculum could equip future providers with a more comprehensive understanding of the legal and regulatory resources in the states in which they practice.²² The American Medical Association has encouraged telemedicine training for medical education, and the Liaison Committee on Medical Education's

survey shows that over a quarter of MD degree-granting medical schools have implemented telemedicine training components into the preclinical phase of their curriculum and nearly half have implemented it into the clerkship phase.^{7,23} Therefore, we hope to advocate for more institutions to rapidly incorporate telemedicine education into their curricula and recommend how the process could occur.

Telemedicine in Medical Education

The basic goals of using telemedicine platforms in medical education include: facilitating basic knowledge acquisition, improving decision making, enhancement of perceptual variation in anatomy lessons or 3-dimensional simulations, improving skill coordination, practicing for rare or critical events, learning team training, and improving psychomotor skills.²⁴ These goals can be incorporated into curricula and integrated with existing clinical experiences to provide students with core telemedicine and clinical skills to prepare them for current and future pandemics. Through meaningful and sustained remote patient care in a wide variety of clinical settings, supervised by a diverse, interprofessional faculty body, students will learn how to incorporate telemedicine in a patient-centered, compassionate way while practicing history taking, guiding patients through self-examination, and acquiring clinical reasoning skills remotely.

Historically, the clerkship curriculum is where most medical schools incorporated their telemedicine education.⁷ However, preclinical education is also an opportunity for telemedicine training and exposure during didactic lectures or small-group discussions. Videoconferencing technologies, such as Project ECHO (Extension for Community Healthcare Outcomes), can aid in the incorporation of case-based discussions, short didactic presentations, and real-time evaluations to educate future providers in underserved areas or global settings on remote care.²⁵ Although medical students may not directly be involved in patient care at such an early stage of their training, it is important to expose them to different technologies and teach them how to incorporate telemedicine into their own careers.

Medical educators could explore 5 major telemedicine domains: (1) access to care, (2) cost, (3) cost-effectiveness, (4) patient experience, and (5) clinician experience.²⁶ They could use the following learning vehicles to help medical students explore these domains: (1) asynchronous lectures covering telehealth history; (2) discussions on applications, ethics, safety, etiquette, and patient considerations; (3) faculty-supervised standardized patient telehealth encounters; and (4) hands-on diagnostic or therapeutic procedures using telehealth equipment such as live video, the store-and-forward method, remote patient monitoring (RPM), and mobile health.^{26,27} Telemedicine's applications are abundant and we will focus on how medical schools can consider formalizing the medical student exposure in 4 key areas: (1) telesurgery, (2) telerehabilitation, (3) tele-intensive care units (tele-ICUs), and (4) chronic disease management and RPM.

Telesurgery

During telesurgery, surgeons use wireless networking and robotic technologies to operate on patients who are distantly located.²⁸ It facilitates surgical education in medically underserved locations, especially in rural areas where health care capacity may be lower.²⁹ Virtual interactive presence allows for real-time, long-distance surgical collaboration during complex microsurgical procedures using shared 3-dimensional displays via high-definition binoculars.³⁰ This technology could enable remotely located experts to mentor medical students or residents at the surgical site with applications in surgical training programs, remote proctoring for proficiency, and expert support for rural and global health settings. Haptic sensation feedback technology also enables the transmission of tactile information to teleoperators, which allows the operators to feel tissue consistency and tension within the sutures, preventing damage to fragile tissues or tearing of sutures during the operation.^{31,32} Therefore, telesurgery can improve surgical patient care, eliminate the need for long-distance travel and costs, and increase surgical collaboration and education among academic medical centers around the world. With telesurgery, medical students on virtual surgical rotations and those interested in surgical specialties would gain observational experience of core

procedures and become familiar with technologies they may use in the future to instruct other trainees globally.

Telerehabilitation

Telerehabilitation allows for the transfer of inpatients to their homes after an acute phase of disease and reduces hospitalization costs for both patients and health care providers.³³ After recovering from COVID-19, patients are at high risk of developing post-intensive care unit syndrome—which could include cognitive, psychiatric, or physical disability after treatment.³⁴ Telerehabilitation may promote social distancing and more effective integration of exercise routines into daily life. Individualized exercise routines at home on a treadmill, telemonitoring by a physiotherapist via videoconferencing using a tablet computer, and self-management via a customized website have been shown to be effective.³⁵ Rehabilitation specialists and medical students can use technology to observe patients as they execute movements and monitor their improvement.

COVID-19 has also been reported to increase stroke incidence in younger patients.³⁶ Telerehabilitation has proven to be effective in helping poststroke patients recover motor and sensory function of affected limbs and may be adapted to help a surge of younger poststroke patients.³⁷ Individuals with underlying comorbidities, such as cardiovascular and pulmonary diseases, are at higher risk of developing severe COVID-19 disease.³⁸ Medical students may want to become skilled in cardiac telerehabilitation because it is as effective in decreasing morbidity and mortality as facility-based cardiac rehabilitation programs.³⁹ Medical students can employ motivational interviewing skills, a core competency of clinical skills curriculum, to promote step counts, measure walking activity, and increase adherence to a schedule of regular physical activity. Supervising members of the rehabilitation team could provide feedback on students' communication skills and efficacy of counseling after receiving quantitative data from step counters. Students can serve as active partners with rehabilitation teams and form longitudinal relationships with rehabilitation patients while acquiring core competencies at the same time.

Tele-intensive care units

A tele-ICU uses technology to assist in providing care for critically ill patients with offsite clinical resources.⁴⁰ Two types of tele-ICUs have been described in the literature.⁴¹ The decentralized tele-ICU is one or more medical facility that can be accessed from remote sites such as the office, home, or mobile clinic. In the centralized system, a single ICU provides intensive care via telemedicine and remote monitoring to several satellite ICUs. Physicians working in these systems might be able to more effectively treat ICU patients, providing better clinical outcomes for patients at lower costs compared with hospitals without an ICU. Patients and health care workers have reported that the streamlining of workflows for rapid diagnosis and isolation, clinical management, and infection prevention are important during the COVID-19 pandemic.⁴² There may also be a shortage in ICU resources such as dialysis machines and respiratory support equipment, so it is important that future providers learn how to adapt tele-ICU care to their hospital's resource status.⁴³

Research also indicates that a structured tele-education critical care program using case-based learning and ICU management principles can facilitate knowledge translation and quality improvement in the critical care setting.⁴⁴ Medical students rotating through a remote critical care elective would still be expected to learn the systems-based approach to the critically ill patient, report on patient statuses during daily rounds, and identify a plan for each systems-based issue. A shortcoming of such an elective, particularly for students interested in specializing in critical care, would be a lack of hands-on experience with standard ICU interventions such as central catheter and line placements, intubation, and extubation, among others. Such a deficiency could be countered by remote video monitoring capabilities that allow providers to be virtually present in patient rooms at all times, such that learners could continue to observe the procedures. Remote monitoring of arterial lines, mechanical ventilators, dialysis machines, and infusion pumps would also allow for more accurate reporting of clinical status and assessment for next steps in management.

Chronic disease management and RPM

Emerging technologies such as inpatient telemedicine and online file sharing applications can enable clinical programs to continue to function while protecting medical staff and patients from the spread of COVID-19.⁴⁵ RPM programs have been rapidly deployed to safely monitor the physical and mental well-being of patients who are at high risk of contracting or have contracted COVID-19.⁴⁶ RPM has previously been shown to vastly reduce the rates of visits to the emergency department and re-hospitalizations in individuals managing multiple complex conditions.⁴⁷ Emotional trauma instigated by large-scale human disasters, such as COVID-19, may require use of tele-psychiatry to mitigate costs and increase access to global psychological counseling.⁴⁸ RPM can also be used for continuous glucose monitoring, home monitoring of cardiovascular implantable devices, and remote consultations and diagnosis.⁴⁹ The Food and Drug Administration also authorized a COVID-19 test using saliva for home collection under the guidance of telehealth professionals.⁵⁰ Such technologies invite students to learn and actively contribute in troubleshooting and refining interventions to be user friendly through community-based participatory research.⁵¹

Forward triage—sorting patients before they arrive in the emergency department—has been a central strategy for health care surge control during COVID-19.⁵² Telemedicine allows efficient screening of patients while protecting patients, clinicians, and the community from exposure. It has also been deployed in the primary care setting and is valuable for patients in need of chronic or preventative care who are reluctant to visit the clinic because they're afraid of viral transmission. Medical students could be directly involved in testing, screening, and triage using history taking and clinical reasoning skills to report findings to their preceptors.

Implications

The current pandemic has rapidly accelerated the move toward telemedicine and has provided an opportunity for medical schools to prepare students to participate in and develop the competencies for this transition. Over

half of U.S. medical schools included telemedicine in required or elective courses during the 2016–2017 academic year.⁵³ We believe that a swifter transition toward telemedicine in medical education will help future doctors prepare for the present age of COVID-19 and future pandemics. With the recent relaxation of restrictions on video visits, more practitioners are able to perform virtual visits across state lines and on non-Health Insurance Portability and Accountability Act compliant platforms.⁵⁴ COVID-19 has challenged providers to deliver health care remotely and has demonstrated which kinds of care are more readily offered virtually. Incorporating telemedicine into medical school curricula will not only expose medical students to relevant telemedicine technologies but also increase their understanding of the complex ethical, regulatory, and legal issues related to such cases.

Importantly, patients should give their consent to student involvement in their telemedicine care. Threats to patient privacy in a telemedicine education program, where information is shared on different devices and accessed by multiple students and providers, may make patients reluctant to participate. It is essential that a robust privacy and security plan is well implemented and disclosed to patients. Medical students should also be exposed to telehealth visit disclosures in which providers discuss the risks and benefits of phone or video visits. As informed consent is a core competency for providers-in-training, these disclosures must be conveyed to learners, and in turn, to their patients. In addition, research indicates an inequity in geographical distributions of telemedicine training, especially in rural areas where hospitals may benefit most from telemedicine.⁵⁵ The COVID-19 pandemic has also exposed inequities in access to educational technologies.⁵⁶ Thus, hospitals and/or state governments should consider supporting these initiatives to establish the technological infrastructure needed for providers and patients. To address the potential lack of educator training in teaching telemedicine, communities of collaboration, professional credentialing standards, and automated guidance systems based on learner feedback are warranted.⁵⁷

Telemedicine curricula should include the limitations of telemedicine platforms, especially in emergency or urgent care. Patients using on-demand telemedicine may encounter reduced care continuity since the same provider may not be available at different unscheduled visits. Insufficient or disjointed efforts in establishing high-quality telehealth training may lead to inconsistent quality of care and risks to patient safety.⁵⁸ It could also place additional burdens on medical students who are already overwhelmed with existing coursework.

Rapid implementation of telemedicine based on profit-driven motives may lead future providers to ignore critical research on quality and cost of care and focus on efficient, rather than evidence-based, technology implementation. In addition, the lack of implicit cues, such as body language, during telehealth consultations increases the risk of misunderstandings between patients and providers.⁵⁹ New sensitivities are also required when discussing new diagnoses and end-of-life care across lines of technology. Some clinicians have stepped in to provide guidelines for video and telephone visits.⁶⁰ Learners should be briefed on these limitations and be provided with tools, such as the teach-back method, to ensure mutual understanding between clinicians and patients. In the teach-back method, providers invite patients to explain their understanding of the information or action plans discussed.⁶¹ Teach-back may be useful not only for patient communication but also among telehealth providers to prevent medical documentation errors.

By integrating telemedicine training into existing curricular structures such as clinical rotations, lectures, ethics programming, rural care exposures, electives, and research opportunities, medical schools can expose students to telemedicine without significant additional burden. Existing online resources for students and providers include the American Telemedicine Association, Center for Telemedicine and eHealth Law, Health Resource and Services website, and the American Academy of Pediatrics' Section on Telehealth Care and Council on Clinical Information Technologies.^{22,62–65} As telemedicine training is incorporated into more medical schools, systemic evaluation of these training methods

may also allow for more effective implementation of programs. More research on the efficacy of existing telemedicine curricula and practice implementation should be explored.

Conclusion

COVID-19 has highlighted possibilities for technological advancement within medicine and medical education. With greater knowledge about which aspects of medicine work best with telehealth, it is important to train future providers to use these technologies and provide these modes of care. Telemedicine curricula should train future providers to deal with the ethical, legal, and regulatory implications of telemedicine. This training is especially important in light of the imminent care needs during the COVID-19 pandemic. Physicians must not only be trained to use telemedicine but also learn how to do so professionally, safely, and in an evidence-based manner.

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