Texas Tech University Health Sciences Center Frontiers in Telemedicine Simulation Lab and Certificate Course: Facility and Curriculum Development

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ABSTRACT

The Texas Tech University Health Sciences Center (TTUHSC) F. Marie Hall Institute for Rural and Community Health (FMHIRCH), created the Frontiers in Telemedicine Simulation Lab (FIT Lab) and Certificate Course.

The FIT Lab is a one-of-a-kind training facility that educates healthcare professionals and students about telemedicine presenting procedures, technology, and business practices through a hands-on, competency-based approach. It features a simulated clinic environment with state-of-the-art exam rooms, faculty viewing areas, standardized patient preparation area, lecture rooms, conference room, and a wide-range of telemedicine equipment for demonstration and practice. It is a hybrid course, featuring online modules in addition to in-person lectures and hands-on training. Students use current telemedicine technology, presenting standardized patients to simulated providers at a remote location.

The curriculum features educational games, equipment demonstration, hands-on practice, billing/coding and legal information, and Objective Structured Clinical Examinations (OSCEs) in a simulated clinic setting. The OSCE cases cover a wide range of specialties from Primary Care to Mental Health. Practice cases and testing cases are used. Students gain confidence and a familiarity with the telemedicine setting and equipment through a "see one, do one, teach one" approach, a term commonly used in medical education.

Keywords: *Telemedicine, Telehealth, Simulation, Objective Structured Clinical Examination, OSCE, Standardized Patient, Interdisciplinary*

INTRODUCTION

Telehealth and telemedicine are rapidly evolving disruptive healthcare technologies nationwide. From the fanciful, imaginative beginnings in the 1920s to the very real technological advances taking place in healthcare today, telehealth and telemedicine have changed the way we care for patients in a tangible way. Telehealth encompasses patient care, education, consultation services, and even artificial intelligence. Telemedicine literally means "medicine at a distance" and it "has been defined as the electronically transmitted rapid exchange of medical information between sites of clinical practice" [1].

Healthcare leaders today think, "telemedicine will help them keep patients healthier" [2]. Telemedicine technology increases access to care, decreases time and costs associated with access issues, and improves health outcomes for vulnerable populations. It "dramatically increas[es] a specialist's geographic footprint" and "enabl[es] chronic care management outside the hospital" [3]. Even in critical care situations, studies have shown that "[telemedicine] program implementation has generally been associated with lower mortality and shorter length of stay" [4].

The field of telehealth and telemedicine "has become pervasive" [5] and has grown so rapidly that it has been hard to keep up with ever-changing applications, laws and ethical requirements, and payment models. In fact, "the use of telecommunications technology in health care is no longer considered an innovation. Telemedicine applications have become part of the routine care for several urban and rural areas across the country" [6].

- In the 1960s, the use of "two-way closed-circuit television systems… facilitate[d] both the transmission of medical images, such as radiographs, as well as consultations between healthcare practitioners and patients" [7].
- "In 1994… there were probably over 100 telemedicine projects in the US at the time" [8].
- "A year later, the executive director of the American Telemedicine Association estimated 200 projects" [8].
- "By 1996, market claims from each of the top three interactive video equipment manufacturers indicated that more than 2400 interactive video systems had been sold to telehealth customers, primarily in the US" [8].
- By 2003, "a survey by the US Healthcare Information Management Systems Society (HIMSS) found that 34% of the responding health care executives reported that their organizations [used] telemedicine, 10% [planned] to use telemedicine within the next year, and 28% [were] investigating its use in the future" [6].
- Of course, the figures have only gone up from there, spiking recently by the Affordable Care Act, which rewarded efficient healthcare delivery. In 2014, "the vast majority of leaders (90 percent) report that their organizations have already begun developing or implementing a telemedicine program" [2]. Half of the respondents in that study indicated that "the potential to improve quality of care" was the primary motivator in launching telemedicine projects" [9].

Texas Tech University Health Sciences Center (TTUHSC) recognized that technological advancements and legislative updates were changing the game for healthcare nationwide, and realized that it was quickly becoming "the wild, wild west" in the healthcare landscape. Unclear payment models, ambiguous rules, vague legalities, uncertain equipment needs, and little-to-no readily available information about telemedicine left many practitioners scratching their heads and in search of solutions and competent advice. Health professionals were largely left to figure it out on their own with a steady stream of industry vendors as the most ready supplier of information, albeit, marketing-driven. TTUHSC saw a need to implement a standard of care for the sake of patient safety and to establish best practices in telemedicine. Studies indicate, "The use of guidelines in telemedicine encourages standardization of work practices as well as providing evidence of quality assurance" [10].

EXPERTISE

Since the 1980s, TTUHSC has been the trusted advisor in west Texas. Interactive two-way videoconferencing equipment was used to deliver specialized medical care to a vast area of west Texas, in prison units, schools, clinics, and hospitals, from hubs located in Lubbock, Amarillo, El Paso, and Odessa, sites of the regional campus structure of TTUHSC. The system used medical peripheral equipment, TV monitors, and high-speed telephone communication lines to connect remote video exam units to the TTUHSC system as a means of facilitating physician-to-physician consultation, presenter-to-provider encounters, distance education, and other services. TTUHSC is recognized as being a pioneer in telehealth and telemedicine.

The F. Marie Hall Institute for Rural and Community Health (FMHIRCH, or the Institute,) was established at TTUHSC in 2007 as an endowed center of excellence. The Institute is overseen by one of four TTUHSC officers at the Executive Vice President level that reports directly to the TTUHSC President. FMHIRCH is made up of a multidisciplinary team of professionals that focus on three major areas: Innovative Healthcare Transformation (InHT), Transforming Communities through Outreach, Recruitment, and Education (T-CORE), and Research, Reporting, and Data Management (R^2DM). Together, these three programs have a focus to advance healthcare through innovation, research, the advanced use of technology, articulation of community health policy, and comprehensive education and outreach.

The Institute's Telemedicine program is consistently ranked in the Top 10 nationally, and TeleHealth Magazine placed it in the Telemedicine Hall of Fame. More than 8,500 patients are treated annually by TTUHSC physicians using telemedicine technology, and more than 90,000 telemedicine examinations have occurred since the program began. Services through the years have included rural health clinic-based specialty care, school-based clinic primary care, mental health services, correctional care, an innovative adolescent diabetes program, a burn clinic with regular follow up, an HIV clinic for underserved and uninsured patients, a dermatology consultant service using store and forward technology, and remote patient monitoring and follow-up in cardiology and oncology.

The TTUHSC Telemedicine program and the Louisiana Health Care Quality Forum partnered in 2012 to form the TexLa Telehealth Resource Center (TexLa TRC). The TexLa TRC is federally funded, and it was created to expand capacity and telemedicine use throughout the states of Louisiana and Texas to improve health care access, quality, and outcomes. The mission of the TexLa TRC is to be the trusted advisor and resource for the adoption, implementation, and effective use of telehealth resources. Through education and guidance, the TexLa TRC aids healthcare organizations in planning, implementation, management, and sustainability. The TexLa TRC also educates policy makers about legislative and regulatory barriers in the use of telehealth in Texas and Louisiana and works to improve reimbursement for telehealth services with third party payers and the Centers for Medicare and Medicaid services.

The Institute initiated an application, and received approval in early 2015, to begin a Lubbock Chapter for the national Healthcare Information Management Systems Society (HIMSS) professional organization. At the time, only four chapter approvals had been granted within the previous ten years. HIMSS is a not-for-profit organization focused on providing global leadership for the optimal use of information technology and management systems for the advancement of health care. The chapter is on its fourth year, and it consists of IT professionals, consultants, administrators, physicians, nurses, professors, and students who actively work together to raise awareness of upcoming changes in health information technology.

CONCEPTS OF DESIGN

In 2015, the FMHIRCH pulled together a team of multidisciplinary faculty and staff, including experts from the TexLa TRC, Telemedicine Program, and HIMSS Lubbock Chapter, to help create a one-of-a-kind training program. Unlike external programs that had gone before, the Institute desired to create a hands-on training facility that allowed clinicians to practice with equipment and become comfortable with it in the clinical setting. Prior to this time, national online trainings were available in limited number and an occasional "live" training could be found, but they did not have a hands-on component. One student reported to that they had searched for months and were very unhappy with the training options available at that time.

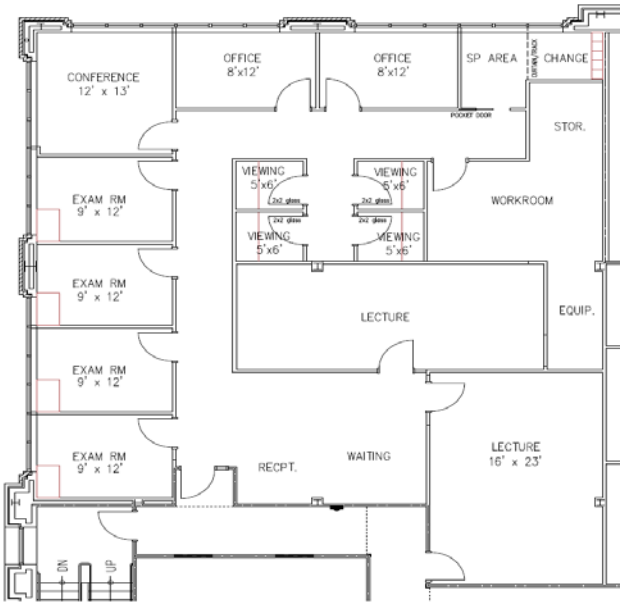
The hands-on component is very important in telemedicine education. Healthcare professionals who have worked in a clinical setting for most or all of their careers are familiar with caring for people using standardized medical equipment that has been around for generations. Telemedicine equipment and telehealth terminology are foreign concepts to most, and the field can be intimidating to even the most advanced professional. There are varied peripheral devices that can be used in telemedicine, including the general patient examination camera, an electronic stethoscope, tele-ophthalmoscope, video-otoscope, electronic dermascope, digital endoscope, electronic scale, and even smart phones and wearable devices [11]. It is accurate to state that, "the application of telecommunication technology to health care requires an integration of technology, tools, and training with medical care practices and problems" [12].

Integrating telemedicine equipment into the clinical setting has been a large barrier for most practices. It is important for clinicians to become comfortable with the equipment in a non-threatening practice environment. Ultimately, "the key to successful telemedicine is *not* the technology but the delivery of care" and clinicians need to feel comfortable to use the equipment competently, as just another tool to deliver care [13].

At TTUHSC, there is a clinical simulation center called the F. Marie Hall Sim*Life* Simulation Lab. This lab was created to train nursing and medical students in a simulated clinical setting. Students are regularly trained using objective structured clinical examinations (OSCEs). In an OSCE, a student is presented with a standardized patient (SP) who has a pre-determined ailment. It is the medical or nursing student's job to appropriately triage, treat, or otherwise diagnose the patient within an allotted timeframe in order to pass the examination successfully. Many times, the examination also includes appropriate charting of the patient's ailment in an electronic health record, as standard for the student's discipline.

It was decided that since clinicians regularly learn in a simulated hospital or clinic setting, and clinical assessment of competency is a recognized standard, that a similar model should be used for the training of telemedicine. A training lab blueprint was drawn up with examination rooms, faculty/provider viewing rooms, an SP preparation area, classrooms, and office space (Figure 1).

Figure 1. Floor plan of the FIT Lab.



The Institute set to work building this lab, installing state-of-the-art video monitoring and audio-visual equipment as well as classroom and conference room capabilities. They purchased several of the newest telemedicine carts on the market and displayed them side-by-side with legacy equipment to show the evolution of telemedicine equipment across the years. Additionally, the Institute purchased portable/handheld telemedicine equipment, including remote patient monitoring systems, all-in-one vital sign monitors, transportable exam pieces, and remote-controlled robotic systems.

Each simulated exam room was set up to include the following equipment:

- Two laptops: One laptop inside and another one just outside of the exam room in fold-down desks, for ease of student and patient documentation.
- A telemedicine cart for practice and testing purposes: Three rooms have brand new top-of-the-line equipment. One room has older legacy equipment that is still being used at many rural clinics in west Texas. The TTUHSC model of Telemedicine has been standards-based video conferencing: H.320 over ISDN-based networks, and now H.323 over IP-based packet networks. This allows the most flexibility of connectivity. Each new Telemedicine cart has the capability to connect with a hardware-based H.323 system as well as the manufacturer's proprietary cloud-based system. Cloud-based systems software typically adds options such as Electronic Health Record (EHR), store and forward, and varied types of diagnostic cameras and equipment.
- Ceiling mounted IP-based Pan, Tilt, and Zoom (PTZ) camera and wide-array microphone, controlled from a Network Video Recorder (NVR) with state-of-the-art software to allow multiple configurations of viewing, recording, and archiving of each student's OSCE encounter. The video recording equipment allows each exam room to be monitored by faculty and staff who can see and hear what is going on inside the rooms. This also enables recording of the student practice and testing sessions so that the encounters can be reviewed later.

There are four consecutive Provider viewing rooms at the back of the lab, one viewing room per exam room, where faculty and staff sit to interact with the students and patients in the exam rooms. Each viewing room is equipped with a standards-based H.323 video conferencing software solution installed on a windows-based computer and dual monitor setup. NVR software is available on one monitor and H.323 software is available on the other. A high quality Hi-Definition webcam and audio headset is installed for the best experience during the video conferencing connection. It is also set up to allow for multiple stethoscope connections, either cloud-based or direct-connect through the H.323 systems.

Once complete, the Frontiers in Telemedicine (FIT) Lab boasted of 3,200 square feet of space fitted with the latest technological advancements in telemedicine. The interactive and hands-on component made this lab the first of its kind in the nation.

At the same time, the faculty and staff began to create a competency-based curriculum designed to train licensed healthcare professionals about telemedicine clinical procedures, technology, and business models. They used a "hybrid course" format, creating online modules that students would complete before attending live sessions in the simulation lab. These modules lay a foundation for each learner, providing a basic understanding of telemedicine terminology, technology, multidisciplinary team roles, and appropriate rules and etiquette for a successful encounter.

Following completion of the online modules, the curriculum shifts to a live, in-person learning format. Lectures and educational games were created to give students up-to-date information on the legal and ethical aspects of telemedicine, the ever-changing billing and coding rules, and to review the online content to ensure proficiency with the material. Since legalities and billing/coding for telemedicine are constantly in flux, bringing the student into the classroom for these lectures allowed them to receive the most accurate information at the time of the class, as well as interact with and ask questions of the lecturers.

Another part of the hands-on curriculum in the simulation lab is an opportunity for students to work toward proficiency with various pieces of telemedicine equipment. This happens through small group training and individualized practice with the

equipment. The goal is for every student to put their hands on the equipment, to test it, to practice with it, and to be comfortable with its use by the end of the class. The equipment represents a wide range of companies and it varies from handheld peripheral devices, to remote-controlled robotic systems, to full telemedicine carts.

Following equipment demonstration and practice, the students are moved to practice clinical cases with standardized patients. Checklists were created, detailing the steps of the telemedicine clinical encounter, covering roles and responsibilities of various Telemedicine Team members, including the Coordinator, IT Support, and Presenter duties.

The Institute recognizes that the telemedicine clinical encounter occurs in five stages. The below steps are not exhaustive of all actions that should be taken, but they are a basic model overview:

a. Pre-Encounter: The office staff at the Patient Site confirms the telemedicine visit with the Provider's Office and ensures appropriate and HIPAA-compliant communication of electronic health information to the Provider's office. Any labs or tests that need to be done before the patient visit would be done at this time.
b. Equipment Check: The Coordinator and/or IT Support Specialist check the telemedicine equipment for connectivity and to ensure that the peripheral devices are working correctly.
c. Patient Orientation: The Presenter discusses the visit with the patient, letting them know what to expect and explaining the basics of telemedicine. If needed, vital signs and any pre-visit clinical information would be gathered from the patient at this time.
d. Patient Encounter: The Presenter makes the connection to the Provider and assists with the patient examination as needed. They receive next steps of patient management from the Provider and disconnect the call.
e. Post-Encounter: The Presenter is responsible for following through with the Provider's orders for the patient, ensuring the patient receives their post-visit paperwork. The Presenter charts appropriately, and cleans/resets the telemedicine equipment for the next patient.

Within each stage of the Telemedicine visit, a checklist provides multiple steps to complete. Students receive a checklist and are put into groups of four. A complete telemedicine encounter is demonstrated from start to finish by a staff member, and then the students have time to practice the steps.

Each student has an opportunity to demonstrate the telemedicine visit, as well as coach one or more of their fellow students through the process, using the checklists as a guide, while staff members oversee the session. The "see one, do one, teach one" method (common in medical education), with the checklists, engages the visual, auditory, verbal, kinesthetic, logical, and interpersonal learning styles. For the remaining solitary/intrapersonal learner who prefers to work alone, time is allowed later in the day for those students to practice on their own.

To test the students for competency, they are assigned a timeslot to come back to the lab and complete an OSCE. The OSCE is a new telemedicine encounter with a new SP and case. The student's demonstration of competency is timed, and students receive feedback from the Program Manager at the end of their testing period. This format is similar to the OSCEs used by nursing and medical schools across the nation, so it is familiar for most students.

To date, thirteen OSCE cases have been written and three more are currently being written. The cases range from mental health to congestive heart failure to urology to diabetes (Table 1). They demonstrate the treatment of patients from young adult to geriatric. They are used for both practice and testing purposes and students can be tested from either the Provider or the Presenter standpoint. Each OSCE tests the student on a set of competencies, depending on their role in the encounter. An example of the Presenter Competencies can be seen in Table 2.

Table 1. List of current OSCEs.

FRONTIERS IN TELEMEDICINE – OSCE LIST

Case Name	Pt Gender	Age
Addiction Counseling – Alcohol	Male/Female	45
Addiction Counseling – Cannabis	Male/Female	25
Addiction Counseling – Gambling	Male/Female	52
Congestive Heart Failure – Initial Onset	Female	75
Congestive Heart Failure – Remote Patient Monitoring	Female	75
Diabetes Mellitus Type II	Male/Female	47
Mental Health Counseling – Bereavement	Male/Female	29
Mental Health Counseling – Bipolar Disorder	Male/Female	30
Mental Health Counseling – Depression	Male/Female	40
Psychiatry – Dementia	Male/Female	70
Psychiatry – Depression	Male/Female	67
Psychiatry – PTSD	Male	54
Rehab Counseling – Anxiety	Male/Female	53
Rehab Counseling – PTSD	Male/Female	34
Rehab Counseling – Suicidal/Major Depressive Disorder	Male/Female	29
Urology	Male	52

One final key that is important for nursing and medical education is the provision of continuing education hours. The Institute applied for and was approved to provide 16.5 Category 1 ™ physicians credits and Continuing Nursing Education credits for clinicians who desired to take the class.

OUTCOMES

At the time of this publication, the FIT Lab has been in operation for just over two years, and the 214th student has been enrolled in the class. Students come from a wide range of specialties (Figure 2), including Correctional Managed Care, Dermatology, Internal Medicine, Mental Health (to include Counseling), Nursing, Pediatrics, and Psychiatry. They have a wide variety of credentials (Figure 3), ranging from medical assistants to physicians. The "other" category in Figure 3 includes Community Health Workers, Licensed Marriage and Family Therapists, Social Workers, Respiratory Therapists, and Administrative staff.

Table 2. Example of Presenter competencies.

Objective Structured Clinical Examination Presenter Competencies
This exercise is intended to provide an evaluation of the student in the role of clinical presenter. This case will provide an evaluation of Core Competencies as demonstrated by the student in the:
I. Utilization of Knowledge Required for Presenting and/or Managing the Patient:
a. Ability to prepare for, support, and conclude a successful encounter with a plan appropriate to the condition(s) presented.
b. Ability to perform presentation skills in a live encounter.
II. Application of Technology Skills:
a. Ability to ensure technology preparedness appropriate to the condition(s) identified.
b. Technical skills, appropriate equipment checks, and positioning the equipment as needed for the visit.
c. Capacity to ensure a HIPAA-compliant encounter.
III. Application of Communication and Assessment Skills with a Patient in the Telemedicine Setting:
a. Effective verbal/non-verbal communication.
b. Ability to provide appropriate patient orientation to telemedicine protocols.
c. Proper assessment/documentation at the direction of a consulting provider.
d. Ability to provide appropriate patient education, discharge, and follow-up after the encounter.
IV. Application of Communication Skills in Medical Team Communications:
a. Ability to coordinate with a consulting provider to ensure a successful encounter.
b. Effective verbal/non-verbal communication in interactions with team members.
c. Ability to provide effective written communication to members of the care team.

No student has failed an OSCE to date, and the feedback from the course has been overwhelmingly positive. Overall impression of the course content from January 1, 2016 – December 31, 2017 was 79% "Excellent" and 18% "Good," with only 3% of respondents rating the course as "Satisfactory" or "Fair." There were zero respondents who rated the course as "Poor."

Students are asked to complete pre- and post-course knowledge evaluation forms, rating themselves on their familiarity and ease with telemedicine on a five-point Likert scale. Response options range from "Not At All Familiar" to "Very Familiar." The students' self-reported increase in knowledge has been astonishing:

- In answer to the question, "Are you familiar with telemedicine rules and regulations for your state?" respondents saw an 82% increase, jumping from 11 students who were "mostly familiar" and "very familiar" before the class to 139 students in those categories after the class.
- Student familiarity with firewalls and security requirements increased from 18 attendees who were mostly/very familiar before the class to 148 students after the class; an 88% increase.
- Comfort level on preparing for and assisting with a telemedicine encounter rose from 33 students who were mostly/very comfortable before the course to 156 students after the course. This is a 79% increase in confidence for clinicians who are preparing for and assisting with telemedicine visits.
- Only 20 students rated themselves as mostly/very familiar with telemedicine clinical procedures before the course, and this rose by 88% following the course, to 168 students.
- The highest gains can be seen in student familiarity with telemedicine equipment. There were 18 students who indicated they were mostly/very familiar with telemedicine equipment prior to the course. Following the course, however, 166 students selected this option. This is a 90% increase in knowledge (Figure 4).

Figure 2. Range of student specialties.

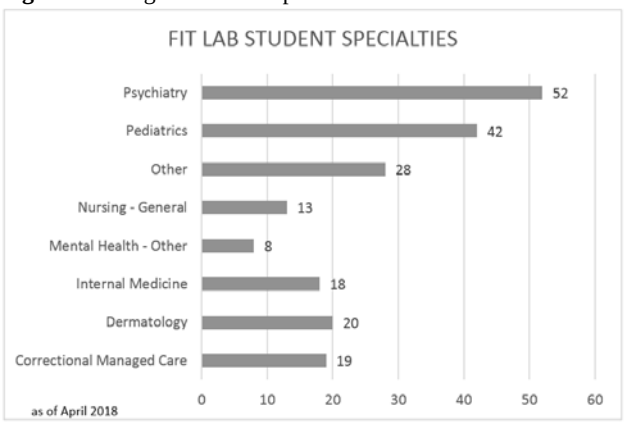


Figure 3. Percentage of student credentials.

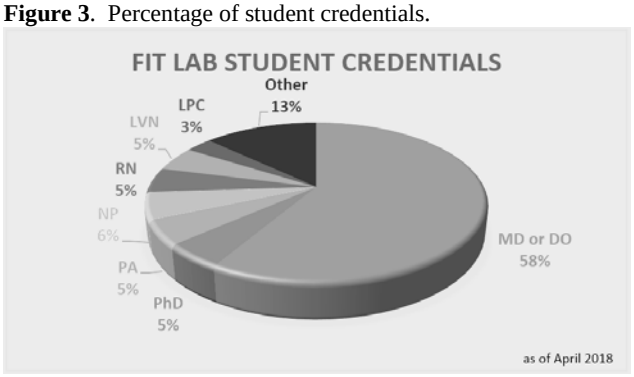
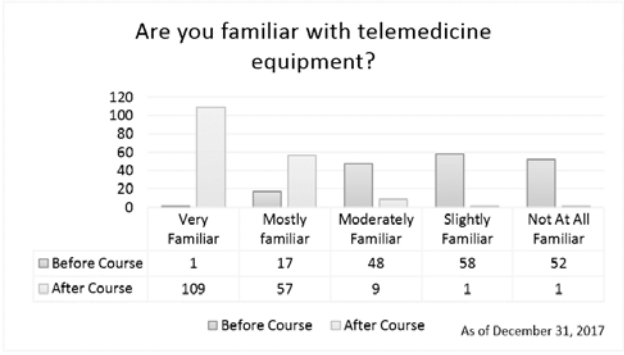


Figure 4. Self-reported student familiarity.



CONCLUSION

Telemedicine is clinically efficacious and cost-effective. The positive effects of telemedicine include "therapeutic effects, increased efficiencies in the health services, and technical usability" [14]. "Several systematic reviews of the literature support the effectiveness of telemedicine in numerous clinical studies" [15]. Further, the benefits of telemedicine are frequently discussed and hard to refute. It makes healthcare more convenient, allows specialty providers to increase their patient base, "has proven less-expensive than conventional in-person examinations for small clinical care facilities" [5], helps to triage patients and direct them to the most appropriate level of care, keeps healthcare dollars in the patient's local economy, enhances educational opportunities for clinicians, and improves collaboration between local and specialty providers.

Telemedicine is not going away, in fact, it is growing more rapidly today than ever before. "Telemedicine has the potential to have a greater impact on the future of medicine than any other modality and will profoundly alter the medical landscape of this century" [16]. The technology is readily available and it is decreasing in cost on a daily basis. Smart phones are already integrating mobile health technology with online portals for patients and providers alike to track their health progress. From dieting apps recording caloric intake to fitness apps tracking steps and heart rates, all of these applications are designed to bring users closer to health providers. It is important for forward-thinking clinicians to adopt the use of telemedicine technology or risk being left behind. One only has to look at companies like Blockbuster, Kodak, and Blackberry to see what happens when service providers fail to accept innovation and the evolution of technology.

Telemedicine can be taught. Taking away the stigma of the technology, putting equipment into the hands of the clinician, and providing a simulated clinical environment brings interdisciplinary clinical teams one step closer to seamless integration of telemedicine technology in clinics and hospitals nationwide. The creation of standardized training in telemedicine promotes "best practice" as well as improves "the consistency and efficiency of health-care, based on scientific and clinical research" [17].

TTUHSC FMHIRCH has seen success in the Frontiers in Telemedicine Simulation Lab and Certificate Course. The framework of this course, the learning models used, and the simulation center design are tools that can provide clinicians with the confidence they need to integrate telemedicine successfully into their existing practices.

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*All degree requirements for Traci Butler Carroll's M.Ed credential will be met by August 3, 2018, less than four weeks from the publication of this article.