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ORIGINAL RESEARCH

The Confidence and Abilities to Assess a Simulated Patient Using Telemedicine

Zachary Winkelmann, PhD, SCAT, ATC*; Lindsey E. Eberman, PhD, LAT, ATC†
*Department of Exercise Science, University of South Carolina, Columbia; †Department of Applied Medicine and Rehabilitation, Indiana State University, Terre Haute

Context: Telemedicine is the practice of providing diagnostic consultations and therapeutic interventions to patients at a distance using some form of technology. Typically, health care students do not have the opportunity to practice telemedicine.

Objective: To investigate athletic training students' ability to transfer telemedicine skills confidently and accurately in a standardized patient (SP) encounter.

Design: Single cohort.

Setting: Simulation center.

Patients or Other Participants: Fifty-five second-year athletic training students (age = 25 ± 3 years) from 6 professional master's athletic training programs volunteered for the study after a 1-week online learning experience about telemedicine.

Intervention(s): We scheduled individual SP encounters that were completed at a distance using telepresence robots.

Main Outcome Measure(s): Pre– and post–SP encounter validated confidence assessment and a 50-item content checklist (yes or no) scored by one evaluator.

Results: During the SP encounter, 87.3% of participants correctly diagnosed the SP actor with a lateral ankle sprain. We identified a significant improvement in confidence ($P \leq .001$) for using telemedicine technology. On the content checklist, participants scored poorly in the constructs of data gathering (mean = 7.44 ± 2.36 of 15, 49.58% ± 15.75%) and telemedicine (mean = 6.02 ± 2.74 of 14, 42.99% ± 19.56%), but scored well in the constructs of communication/interpersonal skills (mean = 12.05 ± 2.00 of 15, 80.36% ± 13.36%) and patient education (mean = 4.64 ± 1.06 of 6, 77.27% ± 17.67%). The mean sum score of all constructs on the SP encounter was moderate (30.15 ± 5.79 of 50, 60.29% ± 11.59%).

Conclusions: Exposure to telemedicine via an SP encounter improved confidence in performing the tech-based evaluation. Athletic training students performed well in demonstrating communication/interpersonal skills and patient education, yet struggled in their data gathering and telemedicine skills. Overall, participants accurately diagnosed a musculoskeletal condition using telemedicine.

Key Words: Telehealth, standardized patient, technology

Dr Winkelmann is currently Clinical Assistant Professor and Clinical Education Coordinator for the Postprofessional Athletic Training Program in the Department of Exercise Science at the University of South Carolina. Please correspondence to Zachary Winkelmann, PhD, SCAT, ATC, Department of Exercise Science, University of South Carolina, 1300 Wheat Street, Columbia, SC 29208. winkelz@mailbox.sc.edu

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The Confidence and Abilities to Assess a Simulated Patient Using Telemedicine

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KEY POINTS

- Athletic training students performed well in demonstrating communication/interpersonal skills and patient education but struggled collectively in their data gathering and telemedicine skills during a telemedicine standardized patient encounter.
- Several learners (n = 15) demonstrated over 70% of the content checklist behaviors during the standardized patient encounter and even more (87%) were able to accurately diagnose a musculoskeletal condition when using telemedicine.
- A standardized patient experience improved the athletic training students' confidence in performing patient care with telemedicine.

INTRODUCTION

With the changing environment of health care comes the addition of technology and innovative approaches to managing patient cases, including recent federal efforts in preventative medicine.[1] The simultaneous influx of technology in health care places individuals, including future and current clinicians, in an endless loop of continual improvement. Moreover, there has been an increase of digital telecommunication software that has changed how the public interacts with each other both personally and professionally (eg, social media, videoconferencing, and smartphones).[2] This change in communication is not limited to our personal lives, as research[3–6] has identified that medical providers have started using telecommunication devices to schedule and provide efficient and effective patient care.

The increase in the number of patients seeking preventative and physical medicine, the rising number of high school and collegiate students participating in sport and recreational activity, and the rising number of emerging settings, such as those of tactical athletes, weekend warriors, and industrial workers has resulted in a simple fact: there are not enough athletic trainers (ATs) to assist all physically active patients who could benefit from athletic training services. Athletic training standards of practice continue to evolve on the same continuum as the changing climate of health care in the United States. To address the demand for qualified health care, especially in remote and rural areas, innovative approaches to patient-provider interactions are necessary. One mechanism to accomplish this interaction is through technology-based delivery, termed *telehealth* or *telemedicine*, which simply means providing patient care services from a remote location with the use of a technology device.[7] Telehealth is specifically defined as the electronic means to support a broad range of remote services, such as prevention, education, and disease monitoring, whereas telemedicine is focused on providing diagnostic consultations and therapeutic interventions to patients.[8] There are three main delivery methods of telemedicine, including (1) synchronous, (2) asynchronous, and (3) remote monitoring (Figure 1).[9] The use of telemedicine has expanded drastically since the 1990s because of the increasing health care cost in the United States, the convenience of the telemedicine visit relative to wait time, and the benefit of having a professional opinion before going to the emergency room. The promise of telemedicine to connect and strengthen the patient-provider relationship, as well as provider-provider collaboration, demonstrates how technology can and will continue to influence medicine and the traditional patient encounter.[10] However, the influx of new patients interactions through technology leads to an important moment for health care providers to reflect that the delivery of care is from a patient-centered mindset.[9,11]

To achieve a high level of patient satisfaction from telemedicine encounters, teaching, training, and continual improvement of health care providers is necessary to ensure best practices are achieved.[12] It is imperative that health care disciplines educate future providers regarding how to facilitate telemedicine encounters, just as educators must continue to prepare the next generation of ATs for jobs and skills that do not yet exist in the standards for educational programs.[13] As such, there should be opportunities within the development of ATs to practice the skills of telemedicine necessary for future patient interactions. Therefore, the purpose of this project was to investigate athletic training students' ability to transfer telemedicine skills confidently and accurately in a standardized patient (SP) encounter.

METHODS

Participants

A total of 77 athletic training students from 6 accredited athletic training programs (ATPs) volunteered for this study. From this sample, 2 students were removed, as they were not enrolled in the ATP at the time of the study (n = 75). After initial recruitment, 8 students chose not to participate, leaving 67 eligible and willing participants. All 67 participants completed the informed consent; however, only 55 participants completed all parts of the study to be included in the

Figure 1. Types of telemedicine.

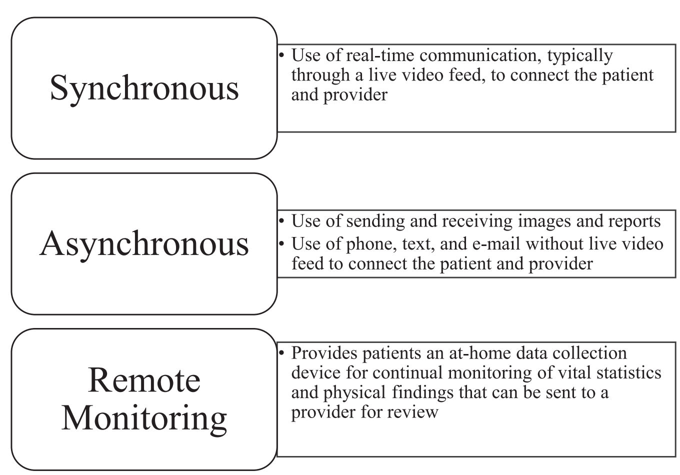


Figure 2. Ecchymosis moulage completed by the standardized patient before each encounter.

final data set, meaning that some individuals completed the SP encounter but were not included in the analysis. Most participants stated they had no previous experience with telemedicine as a provider or patient (n = 53, 96.4%). Half of the participants stated they had had previous SP experiences (n = 27, 49.1%) in their professional ATPs, and the other half had not or were unsure if they had had a previous SP experience (n = 28, 50.9%).

SP Case Development and Training

Simulation-based training is a method that allows learners to engage in skill development in low-stakes situations.[14] This method of training attempts to recreate characteristics of the real world. As a result, simulation experiences typically involve high- (eg, breathing and has a pulse) and low-fidelity (eg, cardiopulmonary torso) mannequins, part-task trainers (eg, venipuncture arm, wound closure skin pads, rectum for core temperature assessment), and simulated patients. Simulated patients are live actors who portray persons with conditions, diseases, or ailments for the mechanism of skill practice, communication, and teamwork assessment.[15] Moreover, standardization of the simulated patient to depict the case multiple times for a group of learners allows for a consistent form of evaluation and skill practice. In order for the experience to replicate a potential real-life scenario, the simulation must encompass the three dimensions of fidelity, including (1) equipment fidelity, (2) environmental fidelity, and (3) psychological fidelity.[14] Simulation experiences have been used in professional athletic training preparation for the evaluation of clinical proficiencies.[16] The benefits of simulation are well referenced in the athletic training literature,[17,18] specifically regarding the translation of learning outcomes into clinical practice.[19]

This study used an evaluative SP encounter with the goal of learners applying skills accurately. The case was based on a college-aged patient seeking a musculoskeletal evaluation from an AT for an ankle injury. The case was developed with assistance from 2 researchers who had content and methods expertise developing SP encounters. The case was evaluated for content and face validity through external review by three practicing clinicians. Members of the panel reported between 4 and 14 years of athletic training experience and were used to confirm that the case appropriately represented a typical presentation of the injury.[20] Appendices 1 through 3 provide the SP case presentation, training information for the live actors, and the presenting situation provided virtually to all athletic training students.[20] The unique presentation of this case included the patient's being a recreational sport athlete, having no direct access to an AT, and engaging in harmful self-pharmacological interventions because of the lack of patient education on the differences in medications. After case development, 2 individuals were trained to serve as the live actors for the SP encounters. The training of the live actors occurred over several sessions and followed best-practice recommendations from the literature.[21] Specifically, the live actors had over 1 year of experience working the for an accredited simulation center as SPs for various health care programs before the onset of the study. The training totaled 4 hours both individually and in group sessions over 3 occurrences. The first session included a 2-hour group training session on the specific case to the live actors. The training included portrayal of limitations for gait, range of motion, and how to react to suggested palpations or testing asked by the athletic training students. The principal investigator (PI) practiced the use of the telepresence robots with the SP actors used for each encounter, as well as moulage application (the use of makeup to enhance the realism of the simulation). Figures 2 and 3 display these techniques practiced during the training sessions for the ecchymosis and applying the elastic wrap in an ineffective manner consistent with the case that was later executed during each SP encounter. One week after learning the case and 2 weeks before the start of data collection, the live actors met individually for 1 hour with the PI to review the case details and practice a dry run with immediate feedback on their performance. The goal of this training was to ensure the live actors had memorized key concepts of the case and accurately portrayed the musculoskeletal limitations.

One week before the start of data collection, one AT with previous experience engaging in SP encounters and with telemedicine was recruited to serve in a calibration exercise as part of the training. The purposes of the calibration exercise were to gather feedback from the AT on the instrumentation, to allow the patient actors to practice or refine their presentations, and to gain reliability in scoring by the evaluator. The individual had earned a clinical doctorate in athletic training and had 5 years of clinical experience at the time of the calibration exercise. The individual completed the SP encounter and participated in a debriefing session twice to allow both patient actors to practice the case and receive feedback on their performance from the PI. In addition, this experience provided the investigative team the opportunity to review 2 video recorded mock performances before beginning

Figure 3. Elastic wrap applied inappropriately over the bruise.

the data collection. After the calibration exercises, the PI contacted the individual to ask for feedback related to the content, flow, patient actor presentation, and debriefing session. There were minor refinements of the actor's portrayal of the case that occurred because of the feedback. This final formal training lasted 1 hour, including feedback to both live actors. Throughout the study duration, the PI continually checked in with the live actors to provide any directed feedback on performance, review key elements of the case, and discuss any questions that arose during the individual SP encounter.

Instrumentation

For the assessment of the SP encounter, learners completed a preintervention and postintervention confidence instrument. The tool was previously developed by Armstrong and Jarriel[22] in 2015, with face and content validity established by 5 content experts, and was determined to have an internal consistency of 0.971. The tool contained 17 items measured on a 5-point Likert scale, with 1 additional item added for the purpose of this study related to using telemedicine technology.

The participants for each SP encounter were evaluated using a checklist approach, similar to that of previous research.[23–25] The authors developed the encounter checklist using pertinent literature relevant to aspects of patient-centered care,[26] data gathering aligning with the diagnosis and management of acute ankle sprains,[27] and congruence with telemedicine competencies.[28,29] An item on the 50-item content checklist was scored as yes only if the participant completed the behavior during the encounter (ie, the participant needed to perform an assessment for swelling rather than just asking the SP actor if there was swelling). After the content checklist was created, the tool was reviewed by 2 athletic training educators with expertise in SP encounters to establish face validity. The content checklist was used in a previous study[24] and had well established interrater reliability. We established intrarater reliability of the instrument (Cronbach $\alpha = 0.941$ for telemedicine application, which was the items added and modified from the previous tool; Cronbach $\alpha = 0.664$ for the overall SP sum score) respective to this case.

Procedures

This study was approved by the Indiana State University Institutional Review Board. All participants received a preintervention survey containing demographic items and the confidence assessment by e-mail 2 weeks before their SP encounter. One week before the SP encounter, all participants enrolled in a 1-week online learning experience. The learning experience, facilitated by the lead author, was divided into modules and learning activities on the background and facilitation of telemedicine in health care. The online learning experience included learning materials such as peer-reviewed articles, authored lectures, and supplemental videos. The final module of the online learning experience specifically highlighted how to conduct a physical examination, including best practices related to facilitating a telemedicine encounter for the participants.

After the 1-week online learning experience about telemedicine, all participants scheduled individual SP encounters held in an accredited simulation center with supervision from a clinical simulation specialist who organizes and executes SP encounters for health care education. The SP encounters spanned several days over the same week for each institution, with all SP encounters occurring between August and November 2018. Before the start of the SP encounters, all learners received a prebriefing video that explained the expectations for the SP encounter, including a review of how to facilitate a telemedicine interaction, navigating and using the telepresence robots, and the patient's reason for the visit (pain that occurred during a game and trying to decide whether to make the 1-hour drive into the city to see the physician). The participants were notified in the prebriefing video that the patient room was equipped with a large and small goniometer, a tuning fork, a reflex hammer, a Wartenberg pinwheel, a tape measure, and a timer. Visual representation of telemedicine skill application via the live SP actor with telepresence robot is pictured in Figure 4.

The participants engaged in the SP encounter from a distance via their personal laptop from a remote location to the telepresence robots (Double Robotics, Inc, Burlingame, CA) with the live patient actor in the simulation center. Although the purpose was to the use the telepresence robots that the participants had learned about using during the online learning experience, there were occurrences in which the participant had to troubleshoot and use another mode to conduct their individual SP encounter from a distance. Seventy-eight percent of the SP encounters (n = 43) were

Figure 4. The standardized patient actor completes a tuning fork test.

completed using the telepresence robot. However, 12 participants encountered technological issues before or during the encounter that required them to troubleshoot. As a result, 6 participants (10.9%) used asynchronous telemedicine (eg, phone call with no video feed) with another 6 participants (10.9%) using a combination of asynchronous and synchronous telemedicine (eg, using the telepresence robot for the video feed coupled with their cell phones for the audio, or using video telephony such as FaceTime [Apple Inc, Cupertino, CA]). Regardless of the mechanism used for the telemedicine encounter, all individual SP encounters were video recorded in real time for scoring using the content checklist.

The delivery of feedback after a simulation experience should come in the form of a facilitated debriefing session. Debrief is an essential component of effective learning.[30] After the SP encounters for each institution, the PI scheduled a 1-hour group debriefing session using the diamond debrief model of meaningful learning via live videoconferencing (Zoom Video Communications, San Jose, CA).[31] The diamond debrief model incorporated a series of prompts and questions that tasked the learners to describe, analyze, and apply the information from the SP encounter in a pedagogically sound format.[31,32] This session included all learners from the same institution with the PI and lasted approximately 1 hour.[31] Although the focus of the debrief was on the SP experience, the session also allowed an opportunity for reflective practice of athletic training clinical practice and skills. After the debriefing session, the learners received the postintervention questionnaire via e-mail, which included the postintervention confidence assessment.

Statistical Analysis

The data from the confidence questionnaires collected during the study were downloaded from Qualtrics (Qualtrics, Inc, Provo, UT) and entered in a custom spreadsheet program (Microsoft Excel 2016; Microsoft Corp, Redmond, WA). The preintervention and postintervention SP confidence tool was assessed using mean individual item and total sum scores. We compared preintervention and postintervention confidence sum scores and individual item scores using a paired-samples t test to determine change in confidence. As there were not multiple groups, a Bonferroni correction could not be performed to set a corrected probability value for the analysis. To reduce the risk of a type 1 error for multiple comparisons, the significance level for the paired-samples t test was set at the .01 α level.

To assess performance on the SP encounter, we used the content checklist (50 prompts), accurate diagnosis, and mode of transmission related to the encounter. We calculated measures of central tendency including means, standard deviations, ranges, and sum scores. The participant rating was categorized as poor if performance was <62.5%, which is consistent with the cutoff score for the Board of Certification exam for ATs.[33] Before completing the analysis, we performed a 1-way analysis of variance (ANOVA) to assess the SP encounter summary score of the participants based on their ATP. The 1-way ANOVA identified that the ATP from which the participant was enrolled as compared with the SP summary scores was not significantly different, $F_{5,49} = 1.546$, $P = .193$. This finding denotes that participants from the same ATP did not score differently as compared with learners from other ATPs. A follow-up, nonparametric analysis (Mann-Whitney U) was performed to compare performance on the content checklist for learners who completed the SP encounter with the telepresence robots with performance with other methods if the participant had to troubleshoot. Finally, a linear regression and a 1-way ANOVA were performed to explore if the participants' preintervention confidence sum score was related to SP encounter sum percentage score. All data were analyzed with commercially available statistical software (IBM SPSS Statistics for Windows, version 25.0; IBM Corp, Armonk, NY) with an α level set at .05 except as noted.

RESULTS

SP Confidence

Overall, the mean sum confidence score reported by the participants improved from 68.41 ± 8.13 at preintervention intervention to 69.35 ± 9.44 (of 90) measured on the postintervention survey. We did not identify any significant differences ($P = .439$) when comparing sum preintervention and postintervention scores of all 18 items. To determine the differences in confidence before and after the SP encounter, a paired-samples t test was performed to analyze the differences for each of the 18 items individually. We identified a significant improvement in confidence for "knowing when I have obtained enough information from a patient history" ($t_{53} = -2.040$, $P = .046$) and "interpreting special or diagnostic test results" ($t_{53} = -2.259$, $P = .028$). We identified a significant decrease in confidence for "using appropriate professional language when interacting with patients" ($t_{54} = 2.283$, $P = .026$). We also identified a significant improvement in confidence at the .01 α level for "using telemedicine technology" ($t_{54} = -6.412$, $P \leq .001$). The full confidence scores for preintervention and postintervention measures are presented in Table 1.

Table 1. Preintervention and Postintervention Confidence Scores

Confidence Rating Item	Preintervention		Postintervention	
	Mean ± SD	Mode	Mean ± SD	Mode
Identifying questions	4.26 ± 0.65	4	4.20 ± 0.65	4
Generating follow-up questions	4.17 ± 0.61	4	4.16 ± 0.63	4
Obtaining adequate history	3.93 ± 0.77	4	4.15 ± 0.62	4
Selecting appropriate palpation	4.13 ± 0.65	4	4.15 ± 0.85	4
Selecting special or diagnostic tests	3.78 ± 0.77	4	4.00 ± 0.84	4
Interpreting special or diagnostic tests results	3.67 ± 0.89	4	4.04 ± 0.82	4
Formulating differential diagnosis	3.85 ± 0.59	4	4.00 ± 0.77	4
Formulating treatment plan	3.96 ± 0.61	4	4.15 ± 0.73	4
Providing patient education	3.96 ± 0.82	4	4.15 ± 0.68	4
Dealing with difficult patients	3.78 ± 0.81	4	3.84 ± 0.83	4
Evaluating and treating diverse patients	4.22 ± 0.63	4	4.16 ± 0.76	4
Using verbal communication	4.24 ± 0.63	4	4.16 ± 0.76	4
Using nonverbal communication	4.07 ± 0.74	4	3.96 ± 0.72	4
Using professional language	4.31 ± 0.66	4	4.11 ± 0.63	4
Evaluating a patient holistically	3.69 ± 0.84	4	3.85 ± 0.62	4
Knowing my limitations and when to refer	4.29 ± 0.71	4	4.13 ± 0.67	4
Abilities as an athletic trainer	4.02 ± 0.71	4	4.15 ± 0.52	4
Using telemedicine technology	2.60 ± 0.83	2	3.49 ± 0.92	4

SP Encounter Content Checklist

The average SP encounter lasted 18 minutes 55 seconds ± 6 minutes 22 seconds of the allotted 30-minute period. After review of all recorded videos, 87% of participants (n = 48) correctly communicated the diagnosis of a lateral ankle sprain with another 3.6% (n = 2) correctly communicating the diagnosis but referring the patient to another provider to confirm the diagnosis. All 5 of the participants (9.1%) who did not specifically state the patient's condition as a lateral ankle sprain in fact did not provide a diagnosis at all, but rather provided either an appropriate care plan (n = 3, 5.5%) or a referred directly to another provider (n = 2, 3.6%). Overall, there were no participants who communicated an incorrect diagnosis during the telemedicine encounter (eg, stating a different pathology than that on which the case was based).

Table 2 displays the number of participants who correctly completed each of the 50 tasks during the SP encounter with mean and percentage conversions (including ranges) for the 4 constructs of the tool. On the SP encounter, the participants' mean percentage score was poor (<62.5%) for the constructs of data gathering and telemedicine application. The participants' mean percentage score was high (>62.5%) for the constructs of communication/interpersonal skills and patient education. Overall, the sum score of all constructs on the SP encounter resulted in an average score of 30.15 ± 5.79 of 50 (range, 15–42) or 60.29% ± 11.59% (range, 30.0%–84.0%).

We compared those who completed the SP encounter using the telepresence robots (n = 43) with those who used some other form (n = 12). A Mann-Whitney U test indicated that those who used the telepresence robots (mean = 62.61% ± 1.51%) scored significantly higher as compared with participants using a modified version of telemedicine technology (mean = 52.00% ± 3.99%; $U = 136.5$, $P = .013$). Regardless of the method of telemedicine used, the preintervention confidence sum score and SP encounter sum percentage score identified no significant relationships ($r = 0.048$) and no significant difference ($P = .731$) in these outcomes.

DISCUSSION

The purpose of this study was to explore athletic training students' abilities to perform telemedicine confidently and accurately during an SP encounter. These data provide insight that despite athletic training's being a face-to-face and hands-on profession, technology to connect the patient and provider can help in one's clinical practice. The results identified that exposure to telemedicine did improve one's confidence in the health care delivery mechanism; however, proper skill performance varied depending on the associated tasks during the encounter.

Confidence

The results of this study suggest that a telemedicine SP encounter is an effective method to assess athletic training student clinical performance with telemedicine. Specifically, the SP encounter significantly improved the athletic training students' confidence in using telemedicine technology. Confidence gains are crucial for the student to move from a novice and advanced beginner on the Dreyfus model of skill acquisition to a minimally competent AT.[34] As the student approaches minimal competence, a converse relationship with confidence typically occurs, which allows for the provider to shift focus from that of one's own skills to that of the individualized needs of their patients.[34,35] Although confidence is important, it is not synonymous with proper execution of the skills.

This finding is similar to previous research in athletic training education in which simulation-based learning improved confidence in skills such as football facemask removal, cardiopulmonary resuscitation, and cardiovascular screening.[36–38] In each of these three studies, the researchers also identified that competence and skill application improved

Table 2. Standardized Patient Encounter Content Checklist

Content Checklist by Category	Correct, No. (%)
Telemedicine application	
(mean = 6.02 ± 2.74 of 14 [42.99% ± 19.56%; range, 21.43%–92.86%])	
The student assessed the room for equipment and setup.	27 (49.1)
The student arrived on time, dressed professionally and prepared for the encounter.	44 (80.0)
The student was in a quiet room.	54 (98.2)
The student provided the patient information on setting up the patient's camera, as well as checking and adjusting the student's camera display for the patient.	21 (38.2)
The student ensured the lighting and room were arranged for the encounter.	2 (3.6)
The student ensured the student's device and the patient's device were charged or plugged in.	1 (1.8)
The student performed a sound and Internet check.	20 (36.4)
The student established privacy in the room (eg, showed room, provided consent).	16 (29.1)
The student thoroughly explained the encounter using the technology.	12 (21.8)
The student explained troubleshooting plan (eg, exchanged phone numbers, who would call back, etc).	14 (25.5)
The student selected appropriate troubleshooting solutions.	13 (23.6)
The student communicated what the student was doing off-screen.	13 (23.6)
The student announced the end of the visit.	49 (89.1)
The student allowed the patient to disconnect first.	45 (81.8)
Communication and interpersonal skills	
(mean = 12.05 ± 2.00 of 15 [80.36% ± 13.36%; range, 40.00%–100%])	
The student established a personal connection (eg, introduced self, used patient's name).	42 (76.4)
The student established goals for the encounter.	25 (45.5)
The student asked open-ended questions appropriately.	53 (96.4)
The student asked closed-ended questions appropriately.	54 (98.2)
The student actively listened using nonverbal techniques (eg, head nods, eye contact).	46 (83.6)
The student actively listened using verbal techniques (eg, verbal prompting, words of encouragement).	48 (87.3)
The student avoided medical jargon and used concise language that was understandable.	46 (83.6)
The student accurately summarized the information he or she gained during the interaction.	38 (69.1)
The student asked questions only one at a time.	55 (100)
The student avoided interrupting while the patient was talking.	48 (87.3)
The student asked follow-up questions about contextual factors (eg, family history, culture, society, gender, age).	9 (16.4)
The student used a nonjudgmental approach to communication and interaction.	53 (96.4)
The student expressed concern, sympathy, and/or compassion (ie, webside manner).	50 (90.9)
The student allowed and/or encouraged the patient to ask questions.	45 (81.8)
The student responded to patient questions appropriately.	52 (94.5)
Data gathering	
(mean = 7.44 ± 2.36 of 15 [49.58% ± 15.75%; range, 13.33%–80.0%])	
The student conducted a thorough medical history of the chief complaint (eg, mechanism, treatment, symptoms, footwear).	55 (100)
The student conducted a thorough past medical history (eg, personal, family, social).	42 (76.4)
The student inspected the injured area (eg, removal of clothing and shoes).	47 (85.5)
The student used appropriate patient-reported outcome measures (eg, FAAM, LEFS, VAS).	1 (1.8)
The student used methods to quantify and measure observations of swelling.	3 (5.5)
The student used appropriate methods to inspect and analyze gait.	14 (25.5)
The student asked the patient to palpate appropriate bony structures.	39 (70.9)
The student asked the patient to palpate appropriate soft tissue structures.	45 (81.8)
The student assessed necessary active range of motion.	48 (87.3)
The student assessed neurological and circulatory function.	7 (12.7)
The student assessed balance or postural stability.	8 (14.5)
The student assessed strength and functional measures (eg, hopping, calf raises, cutting, squats, movement screening).	11 (20.0)
The student selected the appropriate provocation tests.	24 (43.6)
The student used the Ottawa Ankle Rules to determine a need for radiographs.	14 (25.5)
The student considered patient safety and comfort in the examination.	51 (92.7)

Table 2. Continued

Content Checklist by Category	Correct, No. (%)
Patient education (mean = 4.64 ± 1.06 of 6 [77.27% ± 17.67%; range, 16.67%–100%])	
The student was able to communicate a differential and/or a definitive diagnosis to the patient in an understandable way.	49 (89.1)
The student provided an appropriate immediate care treatment plan.	54 (98.2)
The student discussed short- and long-term goals.	50 (90.9)
The student incorporated the patient into the long- and short-term goals.	36 (65.5)
The student communicates the plans/next steps in an organized way.	52 (94.5)
The student used supporting materials (examples and explanations) to help communicate the injury and plan.	13 (23.6)

Abbreviations: FAAM, Foot and Ankle Ability Measure; LEFS, Lower Extremity Functional Scale; VAS, Visual Analog Scale.

from preintervention to postintervention assessment. A recent study completed at the University of Iowa Carver College of Medicine integrated a similar educational intervention into the curriculum involving telemedicine for second-year medical students.[39] Knowledge and confidence improved for these medical students as well.[39] However, application of patient care constructs during the telemedicine encounter were not studied, as the instructional strategy used a mock scenario versus an SP encounter.[39] A mock scenario is a method in which one student portrays a case to another student with each taking turns in the role of the health care provider. Mock scenarios do not have the same fidelity as it relates to consistent portrayal for interpersonal and clinical skill assessment.[21,40] Therefore, we suggest educators use simulated patients, rather than mock scenarios, when assessing both communication and technical skill.

The findings of our study also indicate that one's confidence before the onset of the study had no relationship to future outcomes on the SP encounter. Although confidence did improve for most of the content checklist items, we did identify a decrease in confidence when using appropriate professional language when interacting with patients. We believe this finding was true of the study due the case's unique factors, characteristics of a real patient case, relevant to their participation in recreational sports and pharmacological interventions of using nonprescribed narcotics. These factors highlight the need for additional student development relevant to proper and professional language when unfamiliar circumstances arise.

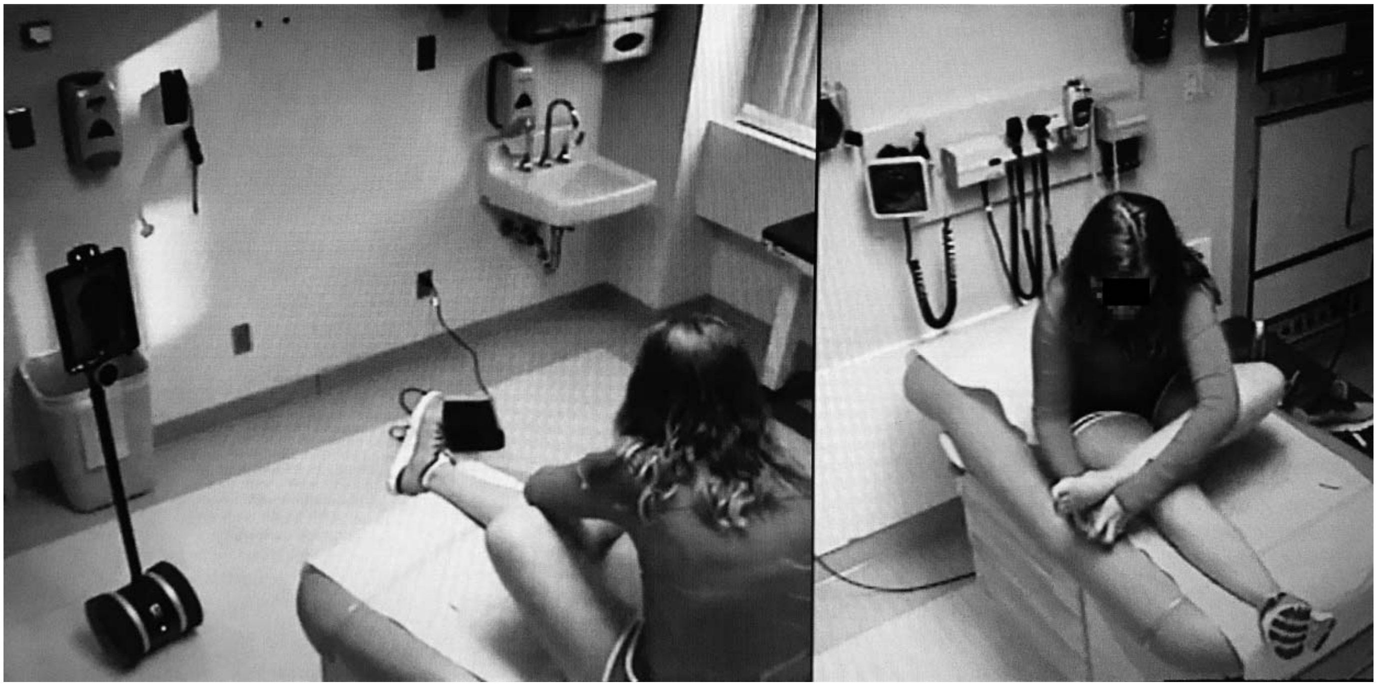
Telemedicine Skills

Health care providers such as dermatologists, neurologists, and mental health counselors have all been quick to adopt telemedicine in their care. However, the same is not true of physical medicine and rehabilitation, whereby providers direct their evaluation and treatment of injury and illness by physical means. These professionals often include providers such as sports medicine physicians, physiatrists, physical therapists, occupational therapists, and ATs. When exploring the use of telemedicine in physical medicine and rehabilitation, health care providers are often hesitant about their abilities to practice through digital communication systems before exposure to telemedicine technology.[41] However, telemedicine has been identified as an effective tool to manage the comprehensive care of a patient using Internet-based, real-time video to assess and treat musculoskeletal disorders.[42] Despite the perceived self-limitation of the technology, the accuracy of diagnosis in our study was 90.9%, which was on par with previous research[43] in which 93% of participants had the same diagnosis when conducting a physical therapy assessment face-to-face or via telemedicine. These studies were both completed using cases requiring the physical examination of a sprained ankle, which warrants the need for future investigations relative to orthopedic exams for other more complex regions such as the shoulder and low back.

The potential role of telemedicine in physical medicine and rehabilitation is also evidenced in postoperative care of adolescent patients after knee arthroscopy in which traditional face-to-face encounters had 100% agreement with telemedicine encounters when gathering data on incision color and effusion size, and minor discrepancies that were not clinically meaningful for knee range of motion assessment.[44] Nevertheless, physical therapists have faced difficulty with adoption envisioning how they provide care in the digital age specifically with licensure and billing.[45,46] As physical therapy and athletic training both explore future implementation, educators should consider how professional programs for both groups could create interprofessional opportunities for collaboration in the delivery of telemedicine for patient care. Physician assistant studies and pharmacology students have used telemedicine as an interprofessional education opportunity in a virtual room for patient care.[47] We believe this professional partnership could create opportunities for skill development with telemedicine in a collaborative environment.

On the telemedicine construct checklist, the participants performed poorly in the areas of data gathering and telemedicine application yet scored well in communication and interpersonal skills and patient education with an overall sum score around 60%. The SP encounter improved participants' communication skills. This is similar to the findings of a nursing study using simulation to assist students in developing empathy and patient-centered communication stratgeies.[48] Although the participants in this study did not necessarily score well overall on the construct checklist, the communication and interpersonal skills was one of the highest scored performance categories during the encounter. We speculate that the participants performed poorly in the data gathering construct because of an unfamiliarity with how to assess and perform palpations, range of motion, selective tissue tests, and swelling from a distance using technology. The data could also be representative of clinical practice

Figure 5. Participant delivers patient education on how to properly apply the elastic wrap with evidence of the additional camera on top of the telepresence robot for the wide-angle frame.



specifically physical examinations in athletic training. For example, the use of patient-reported and clinician-rated outcome measures were infrequent. However, the same findings have also been identified in the practice characteristics of athletic training students during clinical education.[49] Therefore, regardless of the medium for delivery (telemedicine or face-to-face patient care), we have evidence of implementation challenges by athletic training students when it comes to data gathering.

During the SP encounters, the participants used the telepresence robot to navigate the room. Previous research using the telepresence robot suggests that task performance is improved when a wide-angle and a panoramic periphery view rather than a forward-facing view are provided.[50] The telepresence robots were equipped with both a forward-facing view from the integrated iPad (Apple Inc, Cupertino, CA) camera as well as a panoramic wide-angle–view camera added to the robot for improved clarity (Figure 5). We believe the results of the current study, specifically the data gathering during the SP encounter, were improved by use of the view camera, as over 80% of students inspected the injured area, palpated soft tissue structures, and assessed active range of motion. These patient measurements were achieved by the athletic training student asking the live actor to perform the skill on themselves using clear directions, examples, and feedback for what they were wishing to achieve. All these skills were taught to the athletic training students before the SP encounter via the 1-week online module on facilitating a telemedicine encounter making it a viable option and expectation for them to practice the skill during the encounter. Additionally, the telepresence robot moved on 2 wheels, using a gyroscope to orient itself for balance, as the participant navigated the robot from their computers throughout the room while also adjusting the height of the robot's iPad up to 50 cm vertically.[51] The ability to move the robot throughout the room and to the patient's eye level may have influenced the higher case-construct checklist scores for communication/interpersonal skills, including asking open- and closed-ended questions, using a nonjudgmental approach in the interaction, and answering patient questions appropriately as they felt more connected to the patient despite the distance. The results of the study did identify overall SP encounter performance deficits when using some other form of telemedicine as compared with synchronous telemedicine, which may suggest that those ATs wishing to integrate the skill into their practice should consider telepresence robots until skill acquisition is achieved.

Future Directions for Telemedicine in AT Education

A recent study in nursing education used telepresence robots to connect distance learners during clinical simulation experiences.[52] The viability for its use in nursing does lend to possible options for athletic training educators to consider. The telepresence robots in this study were used to connect live patient actors and participants for the means of assessment, yet the potential exists for ATPs to connect students at distance during their immersive clinical education with their ATP faculty for campus events and simulation-based learning opportunities.[53]

The new 2020 Commission on Accreditation of Athletic Training Education standards require ATPs to provide clinical education with varied patient populations, including patients participating in nonsport activities such as the military and performing arts.[54] The current climate in athletic training is to select preceptors based on geographical convenience. Depending on the locations of the institutions, nonsport venues such as military bases, ballet studios, and industrial plants may limit the abilities for athletic training students to have exposure to these patient panels. There exists a call to action to be innovative in the pursuit of clinical education sites that are not based solely on the distance to the institution. The US Army sought to alleviate its geographical divide with a telemedicine program that provides orthopaedics and behavioral health services to enlisted personnel.[55,56] With over 50 000 telemedicine encounters per year throughout the United States and abroad,[56] something like the US Army's telemedicine program as a clinical site would afford several opportunities for meaningful encounters across the domains of athletic training practice in the nonsport population. A previous study[57] from Jefferson University, Philadelphia, PA highlighted the use of a digital health rotation. During the clinical experience, the health care student engaged in 2 to 4 weeks on how to integrate telemedicine into clinical practice, with a culminating experience in which the student engaged in digital calls with preceptor supervision to learn about remote monitoring and community medicine. The implementation of telemedicine in athletic training education must be studied as an avenue for either delivery of health care or advanced clinical skill development. The success of using telemedicine in the athletic training clinical setting should be further studied to help clinical education coordinators to develop robust and unique opportunities for clinical education.

Limitations

The study used telepresence robots, which are the most accurate form of synchronous telemedicine; however, the cost and acquisition of models such as these for an ATP may not be reasonable. This is a limitation of the application of these findings for future use in educational programming. Yet, there exists several methods, means, and platforms to include telemedicine into one's curriculum.

Several findings in the literature[36,58–60] support knowledge, confidence, and skill improvement from preintervention to postintervention assessment after an educational intervention in athletic training. In the present study, the participants did not engage in a preintervention telemedicine SP encounter, and only one participant had had previous exposure to telemedicine before the study. Previous researchers[61] have asserted that a preintervention-then-postintervention test design is not adequate. Our experiences with this study align in that it is unfair for researchers to introduce a new skill or novel concept with little to no base knowledge, teach an intervention, assess through a simulation-based encounter, and claim that that the method is an effective strategy to improve knowledge and skills. The design of this study simply highlights that people are sponges, absorbing what they hear, read, and see.[62] Future studies should consider exploring the assessment of short-term competence and confidence in the skill after an intervention followed by the continual evaluation of its integration into clinical education and clinical practice on real patients through what are called post-then-pre designs to minimize response-shift bias.[61,63] Longitudinal educational research has been previously called for,[58] in order to determine if practice behaviors are changed after educational interventions.

CONCLUSIONS

The information gathered in this study suggests that athletic training students can accurately and confidently apply telemedicine skills during an SP encounter after an eLearning module. Additionally, the study contributes to the growing body of literature stating that simulation-based assessment is an effective method for health care education programs. The use of the SP encounter and debriefing session allowed for study of an uncommon patient assessment method while simultaneously refining skills common to clinical practice. The data gathered during this study highlight the continued need for innovative uses of technology in the athletic training facility that will improve the quality of patient care provided by ATs and athletic training students.

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Appendix 1. Standardized Patient Case Information

Presenting Complaint	Ankle Pain
Gender and age	Any gender, age 20–23
Case name	Sam
Key objectives	Patient interviewing, using telemedicine technology, webside manner, patient education, and patient satisfaction
Brief summary	College student; plays intramural softball as the outfielder, practices once a week, plays 2–3 games per week during the fall intramural season (3–4 months) Chief complaint: left ankle pain Limitations: difficulty with ambulation, significant pain PMH: right syndesmosis sprain last year; wisdom teeth removal 6 months prior Social history: single, full-time college student, no children FMH: type II diabetes (paternal) and osteoarthritis (maternal and paternal)
Differential diagnosis (diagnosis in bold)	**Grade 2 anterior talofibular ligament (lateral ankle) sprain**, other lateral ankle (PTF, CF) ankle sprain, syndesmosis sprain, metatarsal stress fracture, peroneal neuritis, peroneal group strain
Task(s) for athletic training student	Patient interviewing, Web-based exam, diagnosis, patient education and goal planning
Technology needs	Computer, telemedicine platform or device, webcam, private room, stable Wi-Fi connection, physical exam tools
Web-based exam needs	Chair to sit in, computer with stable connection, lamp/lighting nearby
Data collection tool(s)	Patient-reported outcomes; if completed during the exam, use the same information from the patient information to answer the questions appropriately.
Designed for	Professional athletic training students

Abbreviations: CF, calcaneofibular ligament; FMH, family medical history; PMH, personal medical history; PTF, posterior talofibular ligament.

Appendix 2. Standardized Patient Case Training Information

Case Name	Sam
Presenting situation	You complain of ankle pain that began after an intramural league softball game the night before. The pain is located mostly on the lateral side with some minor pain on the medial side. The incident occurred when you slid into second base and collided with the bag and "felt something in your ankle." The pain was immediate and you removed yourself from the game. There is pain with walking (rating of 6 out of 10). The evaluation is taking place the day after the situation occurred.
Psychosocial profile	You are appropriately dressed in loose-fitting pants and shorts. In addition, you are wearing a poorly wrapped elastic wrap around your ankle and foot with a shoe and sock on top. You are cooperative with the examiners if they ask you to roll up the pants or to remove your shoes during the exam. You have taken prescription pain medication 1 hour before the visit, which has caused some drowsiness. You are alert and oriented. Your mood is worried. You understand and asks questions regarding injury pathology.
Opening statement	"I hurt my ankle last night during intramurals and it is killing me. I think it is pretty serious and want to see a doctor."
History of present illness	Last night The footwear you were wearing during activity was normal athletic training sneakers. You were not braced or taped at the time of injury. The shoes are relatively new and do not present issues during activities of daily living. You had difficulty walking to the car, as well as driving, after the incident. Your ankle did not present with any abrasions or wounds. Upon your arrival back to campus, there was pain going up to your dorm room on the third floor. A feeling of stiffness set in during the evening. You wrapped your ankle in an elastic wrap that you had in your house but did not do any other self-treatment. Current complaint (today) The stiffness in the ankle has worsened as you got out of bed. Localized swelling (notification or presentation) and minor bruising on the lateral side when you woke up today. Pain is a 5/10 currently while sitting and 6/10 while walking across campus to the clinic. You are having trouble finding a comfortable position and feel like the pain is affecting everything during the day, especially walking. Took 2 leftover hydrocodone this morning to take the edge off. The pills were from a visit 6 months ago when you had your wisdom teeth removed.
Past medical history	Moderately healthy; poor health behaviors including eating fast food 3–4 times a week and sporadic alcohol consumption of beer and liquor at college parties Wisdom teeth removal 6 months prior Previous activities: played high school soccer (4 years); plays intramural softball 2 days a week during the fall season (August to November) since graduating high school; suffered a right syndesmosis sprain last season that took approximately 2 months to heal. Did not do rehabilitation but was on crutches and in a boot for walking. Previous surgeries: None
Social history	Single, male Current employment: Student; part-time stocker at local grocery store Significant limits on daily activities as the day has played out in terms of getting laundry, twisting to put up dishes, navigating the stairs in the dorm building
Family medical history	Type II diabetes (paternal) Osteoarthritis (maternal and paternal)

Appendix 2. Continued

Case Name	Sam
Physical exam findings	Inspection: Patient presents sitting with ankle extended in about 5–10 degrees of flexion. The patient should not fully bend the ankle or extend it completely during any moment of the exam. Swelling is noted around the ankle that was not there last night at the time of injury, as well as some minor bruising. Apprehensive to bend the ankle and difficulty bearing weight. Gait analysis: Slower walking speed, shorter step length, shorter single support time, reduced and delayed maximum plantar flexion Balance: Difficulty with single-legged stance on affected limb resulting in limitations of functional reach test and star excursion balance test. Able to do tandem balance testing with eyes open but difficulty with eyes closed. Double-leg stance balance with eyes open and closed is not different. Palpation: Tender to palpation over the sinus tarsi, anterior lateral malleolus, anterior talofibular ligament, calcaneofibular ligament, inferior lateral malleolus (not at the edge or tip), and peroneal musculature; minor sensitivity over the deltoid and base of the fifth metatarsal. Range of motion: Limited motion in active ankle dorsiflexion (with pain), inversion, and eversion on affected limb. No limitations at the hip or knee. Limitations are similar to those on the unaffected (right) ankle, which had a previous injury, for ankle dorsiflexion. Manual muscle testing: Difficulty for peroneal group on affected limb. All other muscles (hamstrings, trunks, gastrocnemius, etc) are 5/5. Selective tissue tests: *Laxity has been removed from the positive findings as the patient may not be able to know what this feels like* Ottawa ankle rules: (rules out need for x-ray) 1. Pain noted in the malleolar zone 2. No bone tenderness at the posterior edge or tip of the medial or lateral malleolus 3. Able to bear weight for 4 steps Kleigers: Negative Inversion talar tilt: Positive (pain on medial and lateral sides) Eversion talar tilt: Positive (pain on lateral side) Anterior drawer: Positive (pain; seems to move more than other side) Cotton: Negative Heel Tap: Negative Squeeze: Negative Valgus/varus of MTP: Negative Neurological testing: Normal dermatome/myotome assessment; normal circulation for capillary refill Patient-Reported Outcomes: **Please use the prepared outcome measures to share the information either verbally or through the share screen option; review these beforehand** FAAM LEFS VAS AOFAS SF-12 FADI (score of 64) DPAS Functional testing: Able to perform a calf raise and toe raise, but slow to perform calf raise and toe raise causes more pain. Able to perform body-weight squat, but causes pain during downward motion Unable to single-leg hop, unwilling to perform any hop tests.

Appendix 2. Continued

Case Name	Sam
Special instructions	If the athletic training student asks to see something on you, present with difficulty moving and repositioning the camera. Take directions from the student to ensure and follow cues. In addition, when the technical difficulties arise, allow the clinician to provide context and suggestions for you. Be persistent about seeing a “real doctor” and having imaging done. Be nervous about getting to town, continued care, and paying for these bills if you have to miss time at work. Also, emphasize the importance of intramural softball with playoffs approaching. This is your only source of social interaction outside of work. The call may drop during the call. Please have a phone nearby and let the student walk you through what they wish to do next to either reconnect and use other means for the consultation. You have taken prescription hydrocodone that was leftover. If the student addresses it, be open to stop taking it but ask for alternatives or what else would be best.

Abbreviations: AOFAS, The American Orthopedic foot and Ankle Score; DPAS, The Disablement in the Physically Active Scale; FAAM, Foot and Ankle Ability Measure; LEFS, Lower Extremity Functional Scale; MTP, metatarsophalangeal; SF-12, The 12-item Short form Health Survey; VAS, Visual Analog Scale; FADI, Foot and Ankle Disability Index.

Appendix 3. Presenting Situation

Patient Name	Sam, College Senior
Setting	Village University—Virtual Athletic Training Facility. Village University is a small college located in a rural community about 1 hour from city with a major hospital and health care network.
Complaint	Sam complains of a pain that occurred last night during an intramural league softball game, which limited their ability to finish the game. Sam is trying to decide whether to make the 1-hour drive into the city to see the physician.
Background	As an intramural athlete at Village University, there is no access to an on-site athletic trainer at games or practices. Instead, the athletic trainer (you) is hired on to provide telemedicine encounters from a distance. The patient will go to the virtual athletic training facility located in the recreation center, where a private exam room, Double Robot, and some generic medical supplies will be available. Sam presents to this room for the appointment scheduled online last night with you.
Task	You will have 30 minutes to complete the patient interview and Web-based exam, and to discuss your findings and plan with your patient.