Virtual Ultrasound Training in a Multinational Teaching Program

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ABSTRACT

Introduction:
Before the COVID-19 pandemic, a 1-week in-person Clinical Ultrasound Course was taught in African nations as part of a U.S. Department of State-funded program that supports and trains African peacekeepers serving with the United Nations and African Union. In order to maintain active engagement with host nations despite the travel restrictions due to the COVID-19 pandemic, portions of the course were taught virtually in 2021 to providers in Ghana, Senegal, and Rwanda. An abbreviated course was delivered covering the Focused Assessment with Sonography in Trauma (FAST) trauma exam and vascular access. The goal of this study is to assess the effectiveness of the Clinical Ultrasound Course while taught in a virtual classroom.

Materials and Methods:
Thirty-six participants enrolled in the program. Participants completed a pre-course survey before the training. Training consisted of a pre-recorded lecture followed by hands-on ultrasound instruction. After the training, participants completed a post-course survey. Eight participants were excluded from the study because they did not complete both surveys. Survey questions assessed the participants’ comfort with ultrasound mechanics and the FAST exam. Participant responses were measured utilizing a visual analog scale.

Results:
Based on survey results, all participants gained a better understanding of the indications and limitations of the FAST exam from the virtual Clinical Ultrasound Course. All participants also felt more comfortable using ultrasound in clinical practice than they did before the course. Ghanaian and Senegalese participants showed greater improvement in all areas studied than Rwandan participants. This is likely due to the fact that the Rwandan hospital system had prior ultrasound training and a higher baseline understanding than their counterparts. The Rwandan hospital system had previously completed the in-person sessions of the Clinical Ultrasound Course and therefore had some institutional knowledge, while the Ghanaians and Senegalese took the course for the first time during this study.

Conclusion:
Virtual delivery of the Clinical Ultrasound Course was successful. Participants felt more comfortable in all aspects of ultrasound taught during the course and indicated that they were more likely to use ultrasound in clinical practice. This demonstrates that virtual ultrasound teaching is a viable option for international educational programs in the future.

BACKGROUND

The African Peacekeeping Rapid Response Partnership (APRRP) is an initiative funded by the U.S. Department of State to support and train African peacekeepers serving with the United Nations (UN) and African Union. The goal of APRRP is to provide targeted resources focused on developing high-demand capabilities in various fields including but not limited to medical, logistics, communications, and engineering. The medical component’s task is to train partner nation providers to rapidly deploy and support UN level 2 field hospitals. One such training program is the Clinical Ultrasound Course.

The Clinical Ultrasound Course teaches partner nation providers basic ultrasound skills with a goal of preparing military providers to support a level 2 UN field hospital. While there is a heavy focus on trauma evaluation and management, the course includes several other topics and ultrasound applications and skills, as well as a significant amount of time scanning real patients in the host nation’s own hospital. The course is taught by U.S. emergency medicine physicians who are fellowship trained in ultrasound and consists of three separate 1-week sessions occurring at approximately 3-month intervals. All three sessions incorporate lectures/presentations with hands-on practice.

Before travel restrictions and limitations on in-person gatherings imposed by the COVID-19 pandemic, the Clinical Ultrasound Course was taught in-person. In order to maintain active engagement during the pandemic and also provide new and ongoing training opportunities, in 2021 the first session of the Clinical Ultrasound Course was taught virtually to...
three host nations. The goal of this quality improvement study is to assess the effectiveness of a virtual Clinical Ultrasound Course by means of pre-course and post-course surveys.

MATERIALS AND METHODS

Course

Three African nations, each with their own primary language, enrolled in the virtual Clinical Ultrasound Course. The virtual Clinical Ultrasound Course occurred with Ghanaian participants in January 2021, with Senegalese participants in May 2021, and with Rwandan participants in June 2021. All three nations participated in the first session of the course virtually. The Rwandan medical system had already completed the entire 3-session course; they sent individuals to the virtual session who had not previously been trained at the in-person course.

Participants were taught the indications, limitations, and scanning protocol of the Focused Assessment with Sonography in Trauma (FAST) exam. The FAST exam is a rapid, bedside ultrasound examination used in penetrating and blunt trauma to assess for free fluid within the abdomen and thorax. It has a fundamental role in determining which patients require immediate operative intervention. Additionally, participants were taught how to obtain ultrasound-guided vascular access. Trauma patients often require massive transfusions of whole blood and blood components. In order to accomplish this, the patient needs to have reliable and secure vascular access. Ultrasonography can assist providers with this task by guiding catheter placement in real time. The use of ultrasound in vascular access increases the likelihood of procedural success, decreases procedural complications, and improves patient outcomes.

During the virtual session, a series of pre-recorded lectures were delivered via video conference in English with English subtitles. French interpreters were additionally utilized during the Senegalese course. The lectures discussed basic ultrasonography knobology, the FAST exam protocol, and the vascular access protocol. The participants’ objective was to understand the indications, limitations, and procedure for performing these protocols, as well as forming basic interpretation skills. After the lecture, participants were directed to a hands-on ultrasonography lab, where they had the opportunity to practice the skills discussed during the lecture on a live human model volunteer. Participants were also given the opportunity to practice ultrasound-guided vascular access utilizing phantoms. Each site had at least one Sonosite ultrasound machine (various models at the different sites). Two U.S. emergency medicine physicians, who were fellowship trained in emergency ultrasound, oversaw each course via live video conference. These U.S. physicians were able to interact with the participants, answer questions, and direct the hands-on ultrasonography lab. The sessions lasted about 3 hours, and there were no incentives given for participation.

Participants

Participants for this study were military physicians working in UN partner nation hospitals in Ghana, Senegal, and Rwanda. The hospitals they were recruited from ranged from rural to urban institutions; all had access to trauma pathology. To participate in the virtual course, host nations were required to have access to a stable internet connection, at least one ultrasound machine, and a live human model volunteer. Inclusion criteria for this study included those who were staff physicians and attended both the lecture and the hands-on ultrasonography lab. The excluded participants were those who did not consent to participate in the survey or those who did not complete both the pre-course and post-course surveys. Thirty-six providers attended all sessions of the course. Of these 36 providers, 32 completed the voluntary pre- and post-course surveys; four participants were excluded from the study for not completing both surveys. Twenty-eight participants were ultimately included in the study, including 12 participants enrolled in the Ghanaian course, 10 participants enrolled in the Senegalese course, and 6 participants enrolled in the Rwandan course. Participants were all staff physicians from a wide array of specialties that were relatively evenly represented, including obstetrics and gynecology, internal medicine, anesthesia, general surgery, and emergency medicine. The surveys and manuscript were reviewed by the author’s Institutional Review Board and found to be in an exempt category.

Analysis

Participants were instructed to fill out the pre-course survey immediately before the lecture and the post-course survey immediately after the hands-on lab was completed. Both surveys utilized a visual analog scale to measure participants’ responses to eight statements (Fig. 1) with a 10-cm line upon which participants were asked to mark a slash “/” corresponding to their subjective feelings regarding the given statements. The left side of the scale indicated that the participant strongly disagreed with the statement; the right side of the scale indicated that the participant strongly agreed with the statement. Responses were measured by the distance from the left side of the scale to the “/” the participant marked. Upon completion of the program, the pre-course and post-course responses from each participant were measured and compared.

RESULTS

Of the study participants from the Ghanaian course, 67% reported prior formal ultrasound training mostly described as “hours,” and all 12 indicated that their knowledge of ultrasound improved from taking the course. On average, they indicated a 50.3% improvement in their knowledge of ultrasound mechanics and felt 60.7% more comfortable teaching ultrasound mechanics to others. Participants also averaged a 20.7% and a 20.9% improvement in their knowledge of the indications and limitations of the FAST exam, respectively. Participants were 54.2% more comfortable performing
the FAST exam and 47.0% more comfortable interpreting the FAST exam images. They were also 59.2% more comfortable teaching the FAST exam to others. On average, they were 24.4% more likely to utilize ultrasound in clinical practice.

There were 10 participants from the Senegalese course, none reported previous formal ultrasound training, and they averaged a 59.0% improvement in their ultrasound knowledge. Participants also averaged a 16.6% and 59.0% improvement in their understanding of the indications and limitations of the FAST exam, respectively. Participants were 62.0% more comfortable performing the FAST exam and 58.0% more comfortable interpreting FAST exam images. They were also 45% more comfortable teaching the FAST exam to others. On average, they were 24% more likely to utilize ultrasound in clinical practice.

There were six participants from the Rwandan course, 67% reported prior formal ultrasound training mostly described as “weeks to months,” and they averaged a 15% improvement in their ultrasound knowledge. Participants also averaged a 6.6% and a 15.0% improvement in their understanding of the indications and limitations of the FAST exam, respectively. Participants were 3.3% more comfortable performing the FAST exam and 5% more comfortable interpreting FAST exam images. They were also 10.0% more comfortable teaching the FAST exam to others. Rwandan participants did not indicate any improvement or deterioration in their ability to use ultrasound in clinical practice.

**DISCUSSION**

In this study, we utilized pre-course and post-course surveys to measure participants’ evaluation of the virtual course’s effectiveness to teach ultrasonography skills and its application in trauma. Results varied across the three partner nations. However, all nations indicated an improvement in their knowledge of the indications and limitations of the FAST exam, as well as their comfort in performing the FAST exam (Table I).

Ghanaian and Senegalese participants showed greater improvement in all areas studied than Rwandan participants. This is likely due to the fact that the Rwandan participants had a better baseline knowledge of ultrasound than their counterparts. The Rwandan hospital system had previously completed all three of the in-person sessions of the Clinical Ultrasound Course and therefore had some institutional knowledge, while the Ghanaians and Senegalese took the course for the first time during this study.

While all three countries indicated an improvement in comfort with ultrasound, new participants were not expected to practice independently. Participants were encouraged to practice their new skills and utilize reviewers such as local radiologists, other local physicians with ultrasound training, or reach back to the U.S. faculty for remote mentoring.

Several factors limit this study. In the post-course feedback, the most frequently mentioned limitation was the language barrier. English is not the primary language in any of the partner nations involved in this study. Many participants remarked that the language barrier made the course difficult. When translators were utilized, there were several remarks from participants that the translations were inaccurate or incomplete. Another limitation of this study was technology failure. The partner nation hospitals often had poor internet connections, making it difficult to proctor the sessions virtually. There were several time delays in the courses, each lasting no more than 5 minutes, due to poor internet connectivity that resulted in fewer participants completing the entire session. Finally, the small sample size reduces the power of this study.

To our knowledge, this is the first study evaluating the efficacy of a multinational virtual ultrasound course for FAST and vascular access protocols, especially one delivered with several native languages and real-time translation involved. Before the COVID-19 pandemic, the feasibility of

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**TABLE I.** Pre-course and Post-course Survey Questions Were Compared for Each Participant and Then Were Averaged among Each Partner Nation. Percentiles Represent Average Improvement from the Pre-course to the Post-course Survey

| Question                                                                 | Ghanaian | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------------------------------------------------------------------|----------|---|---|---|---|---|---|---|---|
| I understand how to operate the ultrasound machine                      | 50.3%    | 20.9% | 25.9% | 54.1% | 47.0% | 60.7% | 59.1% | 24.4% |
| I understand the indications for the FAST exam                          | 59.0%    | 16.6% | 59.0% | 62.0% | 58.0% | 38.0% | 45.0% | 24.0% |
| I understand the limitations of the FAST exam                           | 15.0%    | 6.6% | 15.0% | 3.3% | 5.0% | 10.0% | 10.0% | 0.0% |

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remote ultrasound training was explored and demonstrated in other studies. As the pandemic limited in-person educational sessions, virtual ultrasound training programs in the USA were described. Virtual ultrasound training has also been described for global outreach from the USA to low-resource international areas. One program similar to ours compared a pre-pandemic in-person course with post-pandemic virtual training; they found pre- versus post-course knowledge testing to be similar initially with USA-based and later with international teaching. Compared to our training which used free, open-access video software, this course used proprietary tele-ultrasound software, their learners were mainly USA-based, and they had a 1:1 or 1:2 faculty-to-student ratio (while our training had a 1:5 ratio). A recent review provided a broad overview of current educational tele-ultrasound training.

Due to worldwide restrictions with the COVID-19 pandemic, we expect more courses to be forced into a virtual classroom. Additional studies assessing the effectiveness of virtual courses covering an array of topics will become increasingly necessary.

CONCLUSION
In conclusion, participants felt more comfortable in all aspects of ultrasonography discussed during the course and indicated that they are more likely to use the FAST exam in clinical practice. The degree to which the virtual course benefited the participants, however, varied by host nation. Reasons for this could include varying degrees of language barriers and baseline ultrasonography knowledge. The participants who seemed to benefit the most from this virtual session were those that had the least baseline knowledge of ultrasonography and the smallest language barrier. This suggests that virtual ultrasound lessons could be an option for educational programs in the future, particularly in nations where participants have limited baseline knowledge of the subject being discussed. Challenges for continued virtual learning include language and technology barriers. Ideally, this study will be repeated in-person, in these same partner nations with a larger sample size. Data from that study could then be compared to this study to determine the efficacy of virtual learning. If virtual lessons prove to be as successful as in-person sessions across an array of topics and locations, it could become a viable option for overseas educational programing even after the pandemic resolves.

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CONFLICT OF INTEREST STATEMENT
None declared.

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