Remote tele-mentored ultrasound for non-physician learners using FaceTime: A feasibility study in a low-income country

Thomas E. Robertson, MD a,1, Andrea R. Levine, MD b,1, Avelino C. Verceles, MD c, Jessica A. Buchner, MD c, James H. Lantry III, MD d, Alfred Papali, MD c,e, Marc T. Zubrow, MD c,f,g, L. Nathalie Colas, MD h, Marc E. Augustin, MD h, Michael T. McCurdy, MD c,i,e, for the Haiti Resource Limited Intensive Care (Haiti-RELIC) Study Group

1. Introduction

Low- and middle-income countries (LMICs) carry a substantial burden of critical illness worldwide [1], but material and human resource constraints limit the availability and role of diagnostic modalities in these environments [2,3]. Point-of-care ultrasound (PCUS) is a valuable tool that improves diagnostic ability when managing critically ill patients, especially in resource-constrained settings [4-8]. PCUS is a sensitive, non-irradiating, noninvasive, portable technique available in many areas where traditional imaging is either too expensive or entirely unavailable [9-11]. However, human resource limitations and lack of ultrasound skills training often prevent widespread application of this technology.

Tele-mentored ultrasound, whereby a geographically removed expert can mentor local untrained personnel to perform PCUS, represents one method to overcome these workforce challenges in resource-constrained settings [12]. Remote tele-mentored ultrasound systems require at minimum some form of two-way audio-visual communication technology and an ultrasound machine. However, tele-ultrasound is not without its own limitations. Formal remote tele-mentored ultrasound (RTMUS) programs are expensive to implement and require significant resources to maintain [13,14].

Purpose: Ultrasound (US) is a burgeoning diagnostic tool and is often the only available imaging modality in low- and middle-income countries (LMICs). However, bedside providers often lack training to acquire or interpret US images. We conducted a study to determine if a remote tele-intensivist could mentor geographically removed LMIC providers to obtain quality and clinically useful US images.

Materials and methods: Nine Haitian non-physician health care workers received a 20-minute training on basic US techniques. A volunteer was connected to an intensivist located in the USA via FaceTime. The intensivist remotely instructed the non-physicians to ultrasound five anatomic sites. The tele-intensivist evaluated the image quality and clinical utility of performing tele-ultrasound in a LMIC.

Results: The intensivist agreed (defined as “agree” or “strongly agree” on a five-point Likert scale) that 90% (57/63) of the FaceTime images were high quality. The intensivist felt comfortable making clinical decisions using FaceTime images 88% (56/63) of the time.

Conclusions: Non-physicians can feasibly obtain high-quality and clinically relevant US images using video chat software in LMICs. Commercially available software can connect providers in institutions in LMICs to geographically removed intensivists at a relatively low cost and without the need for extensive training of local providers.

© 2017 Elsevier Inc. All rights reserved.

Keyterms: Telemedicine, Point-of-care ultrasound, Critical care, Global health
equipment, transport, maintenance, and training can be prohibitive in resource-constrained settings [15,16]. Thus, novel approaches must be developed that maintain quality of image transmission in an economically feasible manner.

Compared to formal RTMUS systems, simpler modalities, such as commercially available smartphone video chat software, have demonstrated promise [17]. This technology allows for transmission of high quality, clinically useful images that may render the use of smartphone video chat software as more feasible to use in resource constrained settings [17]. However, these more simplistic means of image acquisition and transfer have unclear feasibility and utility in this setting. We therefore performed a feasibility study to determine whether high quality PCUS images obtained locally in a low-income country could be transmitted in real-time and interpreted remotely by a tele-intensivist in the United States using commercially available video-chat software. We hypothesized that ultrasound images transmitted from an LMIC institution using a low-bandwidth Internet connection could be of sufficient quality to guide a tele-intensivist’s clinical decision-making.

2. Materials and methods

We performed a feasibility study to determine whether a RTMUS system using commercially available video chat technology could connect non-physician ultrasound learners in a LMIC with a tele-intensivist in the United States. Nine non-physician health care workers were recruited from a small pool of available non-physicians at St. Luke Family Hospital in Port-au-Prince, Haiti. At the time of study, St. Luke Hospital was an 80-bed, religiously affiliated charitable hospital whose resources included a 35-bed combined emergency department and inpatient unit, a six-bed intensive care unit, a cholera ward, and elective surgical services. Radiology capabilities included brain CT, portable digital radiography, and PCUS. Physicians, only one of whom had formal ultrasound training, were the only providers who routinely performed PCUS at this facility. With the help of a Haitian medical interpreter, a standardized 20-minute didactic teaching session was delivered to the study participants by a member of the research team followed by a hands-on practicum. The study participants included nurses, a healthcare advocate/interpreter, a radiology technician, and a custodian. These non-physician trainees were selected to participate to highlight the applicability of this easily acquired skillset in areas devoid of physicians. The didactic session focused on basics of ultrasonography, terminology, “knobology”, and appropriate technique for obtaining US images of the internal jugular vein, the lung apices and bases, cardiac subxiphoid, and bladder. These anatomic locations were chosen because they provide relevant clinical information for common medical issues encountered in clinical practice, including central venous catheter placement and evaluation for pneumothorax, pleural effusion, pericardial effusion, or Foley catheter placement. Ultrasound views of these anatomic sites guide common clinical practice or intervention that is most feasible in a LMIC.

We constructed an RTMUS system in a simulated patient room. A member of the research team, a healthy 28-year-old female with a BMI of 30, volunteered as the member of the research team, a healthy 28-year-old female with a BMI of 30, volunteered as the videographer. The nine Haitian volunteers were aged 22–60 years, consisted of six nurses, one custodian, one radiology technician, and a health care advocate/interpreter. Three were male (33%) and all were black. Findings related to image quality are summarized in Table 1. The tele-intensivist either agreed or strongly agreed that 57/63 (90%) of images were of high quality. The tele-intensivist agreed or strongly agreed that he could make clinical decisions using 56/63 (85%) of the images obtained. The tele-intensivist found the process of performing remote tele-mentored ultrasound efficient 100% of the time at all anatomic locations. In addition, he felt comfortable instructing ultrasonographers and found the non-physicians easy to instruct at all anatomic locations 100% of the time. Findings related to the tele-intensivist’s perception of the ease or efficiency of performing RTMUS by anatomic site are summarized in Table 2.

3. Results

Nine non-physician Haitian volunteers performed 63 ultrasound acquisitions. The non-physician volunteers were aged 22–60 years, consisted of six nurses, one custodian, one radiology technician, and a health care advocate/interpreter. Three were male (33%) and all were black. Findings related to image quality are summarized in Table 1. The tele-intensivist either agreed or strongly agreed that 57/63 (90%) of images were of high quality. The tele-intensivist agreed or strongly agreed that he could make clinical decisions using 56/63 (85%) of the images obtained. The tele-intensivist found the process of performing remote tele-mentored ultrasound efficient 100% of the time at all anatomic locations. In addition, he felt comfortable instructing ultrasonographers and found the non-physicians easy to instruct at all anatomic locations 100% of the time. Findings related to the tele-intensivist’s perception of the ease or efficiency of performing RTMUS by anatomic site are summarized in Table 2.

4. Discussion

Critical illness exacts a particularly high toll on LMICs, and patients rarely have access to an intensivist’s expertise [18,19]. Although telemedicine addresses this deficiency by providing remote access to clinical expertise and guidance to resource-limited areas, the barriers of team function, procedural skill, bedside nursing care, cost, efficiency, and feasibility remain. The tele-ICU infrastructure can smoothly integrate remotely mentored ultrasonography into the diagnostic options available to bedside providers who may not have sufficient experience or skill using ultrasound [6,17,20]. To our knowledge, no study has previously assessed the feasibility and utility of using affordable, commercially available video-chat software to connect an LMIC institution to a high-income country for real-time mentored US image acquisition and interpretation.

In our study, the interpreting intensivist, who was separate from the ultrasound instructor, rated the FaceTime video images as high quality and clinically useful. These findings suggest that a telementored RTMUS system using commercially available and affordable software can feasibly connect an LMIC institution to one in a high-income country to acquire and transmit high quality ultrasound images. Notice

---

**Table 1. Quality and clinical utility of ultrasound images.**

<table>
<thead>
<tr>
<th>Anatomic location</th>
<th>High quality image (%)</th>
<th>% Response</th>
<th>Clinically useful (%)</th>
<th>% Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right internal jugular vein (n = 9)</td>
<td>4.6 ± 0.5</td>
<td>100%</td>
<td>4.6 ± 0.5</td>
<td>100%</td>
</tr>
<tr>
<td>Right lung apex (n = 9)</td>
<td>4.0 ± 0.9</td>
<td>89%</td>
<td>3.9 ± 0.6</td>
<td>78%</td>
</tr>
<tr>
<td>Left lung apex (n = 9)</td>
<td>3.8 ± 0.8</td>
<td>78%</td>
<td>3.8 ± 0.7</td>
<td>67%</td>
</tr>
<tr>
<td>Right lung base (n = 9)</td>
<td>4.1 ± 0.9</td>
<td>89%</td>
<td>4.1 ± 0.6</td>
<td>89%</td>
</tr>
<tr>
<td>Left lung base (n = 9)</td>
<td>4.3 ± 0.5</td>
<td>100%</td>
<td>4.2 ± 0.7</td>
<td>89%</td>
</tr>
<tr>
<td>Subxiphoid (n = 9)</td>
<td>4.3 ± 0.5</td>
<td>78%</td>
<td>4.1 ± 1.2</td>
<td>100%</td>
</tr>
<tr>
<td>Bladder (n = 9)</td>
<td>5.0 ± 0</td>
<td>100%</td>
<td>5.0 ± 0</td>
<td>100%</td>
</tr>
</tbody>
</table>

* 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات