Ultrasound in Med. & Biol., Vol. ■, No. ■, pp. 1–8, 2017

0301-5629

http://dx.doi.org/10.1016/j.ultrasmedbio.2017.05.024

● *Original Contribution*

TRAINING MIDWIVES TO PERFORM BASIC OBSTETRIC POINT-OF-CARE ULTRASOUND IN RURAL AREAS USING A TABLET PLATFORM AND MOBILE PHONE TRANSMISSION TECHNOLOGY—A WFUMB COE PROJECT

SUDHIR VINAYAK,* JOYCE SANDE,* HARVEY NISENBAUM,† and CHRISTIAN PÁLLSON NOLSØE‡

*Department of Imaging and Diagnostic Radiology, Aga Khan University Hospital, Nairobi, Kenya; †Department of Medical Imaging, Penn Presbyterian Medical Center, Philadelphia, Pennsylvania, USA; and ‡Department of Abdominal Surgery and Gastroenterology, Ultrasound Section, Herlev Hospital, University of Copenhagen, Herlev, Denmark

(*Received* 29 *September* 2016; *revised* 22 *May* 2017; *in final form* 27 *May* 2017)

Abstract—Point-of-care ultrasound (POCUS) has become a topical subject and can be applied in a variety of ways with differing outcomes. The cost of all diagnostic procedures including obstetric ultrasound examinations is a major factor in the developing world and POCUS is only useful if it can be equated to good outcomes at a lower cost than a routine obstetric examination. The aim of this study was to assess a number of processes including accuracy of images and reports generated by midwives, performance of a tablet-sized ultrasound scanner, training of midwives to complete ultrasounds, teleradiology solution transmissions of images *via* internet, review of images by a radiologist, communication between midwife and radiologist, use of this technique to identify high-risk patients and improvement of the education and teleradiology model components. The midwives had no previous experience in ultrasound. They were stationed in rural locations where POCUS was available for the first time. After scanning the patients, an interim report was generated by the midwives and sent electronically together with all images to the main hospital for validation. Unique software was used to send lossless images by mobile phone using a modem. Transmission times were short and quality of images transmitted was excellent. All reports were validated by two experienced radiologists in our department and returned to the centers using the same transmission software. The transmission times, quality of scans, quality of reports and other parameters were recorded and monitored. Analysis showed excellent correlation between provisional and validated reports. Reporting accuracy of scans performed by the midwives was 99.63%. Overall flow turnaround time (from patient presentation to validated report) was initially 35 min but reduced to 25 min. The unique mobile phone transmission was faultless and there was no degradation of image quality. We found excellent correlation between final outcomes of the pregnancies and diagnoses on the basis of reports generated by the midwives. Only 1 discrepancy was found in the midwives' reports. Scan results versus actual outcomes revealed 2 discrepancies in the 20 patients identified as high risk. In conclusion, we found that it is valuable to train midwives in POCUS to use an ultrasound tablet device and transmit images and reports *via* the internet to radiologists for review of accuracy. This focus on the identification of high-risk patients can be valuable in a remote healthcare facility. (E-mail: sudhir.vinayak@aku.edu)

Key Words: **Ultrasound, Obstetrics, Midwives, Training, Teamwork, High-risk pregnancies, Screening, Teleradiology.**

INTRODUCTION

Antenatal ultrasound has proven to be an extremely useful examination during pregnancy. In realization of its importance in clinical care, the International Federation of Gynecology and Obstetrics (FIGO 2014) recently issued a recommendation that all pregnant women should be offered at least 2 ultrasound examinations at 11 + 0–13 + 6 wk and at 18–22 wk (FIGO 2014). Indeed, this is the practice in most developed economies; however, many women in low resource regions especially in sub-Saharan Africa will still go through pregnancy without the benefit of even a single ultrasound examination (Ostensen 2000; Rijken et al. 2009; Sippel, et al. 2011). Unfortunately, regions with low access to this technology contribute significantly to the global burden of perinatal morbidity and mortality.

Address correspondence to: Dr. Sudhir Vinayak, P O Box 30270 – 00100 GPO, Nairobi, Kenya. E-mail: sudhir.vinayak@aku.edu

In the developing world, antenatal ultrasound is available to only a few privileged people in urban centers; yet the majority of the population live in rural areas with little or no access to diagnostic services, and patients have to travel long distances to access medical care. The cost of ultrasound machines has decreased significantly in the past few years and good-quality imaging can be performed using portable machines that run off batteries, which can be charged using solar power. As such, ultrasound is inexpensive, easy to perform and train personnel in its use. Ultrasound machines are robust; thereby making them easy to take to a rural setting where patients need it most. Ultrasound as an imaging modality has many advantages such as image resolution and definition of anatomy, real-time imaging that allows immediate diagnosis which can be precisely controlled by the operator, wide availability of ultrasound equipment and the existence of multiple simple and straightforward practical techniques that cover a broad range of applications (Allan et al. 2011). Furthermore, the availability of ultrasound in highly compact form allows its use in virtually any location where medical care can be delivered (Jones et al. 2009).

Another challenge in developing countries is the extreme shortage of sonographers and doctors trained to perform ultrasound. This shortage is so significant that even urban areas have an acute shortage; ironically, the number of trained nurses and midwives is far greater. An innovative proposal would be to train midwives to perform point-of-care ultrasound (POCUS) to identify high-risk pregnant patients who can then be referred to regional hospitals for further management. This arrangement would be similar to a triage service that identifies patients requiring further medical management. A key feature of POCUS is that it is not a replacement for comprehensive ultrasound practice but a focused ultrasound examination, often in suboptimal conditions, with the goal being to identify high-risk patients. Therefore, POCUS training and practice needs to reflect the nuances of the particular region it covers (Dietrich et al. 2015). The specific applications and training methodology should be tailored to suit the local environment (Nathan et al. 2016).

This pilot project in Kenya focuses on training midwives to perform basic ultrasound to identify high-risk pregnancies. The project requires identifying midwives who are up to the task of learning and performing ultrasonography, compiling and implementing a training curriculum, establishing ultrasound facilities, transmitting images and having Radiologists validating reports.

The tablet platform used is light, portable and has the same resolution as a standard ultrasound machine. In addition, the tablet platform has built-in software to transmit images *via* the internet. The inclusion of this software is an advantage over a routine ultrasound machine, which does not usually include transmission capability because the additional software is cost prohibitive. The transmission software compresses the images to make smaller *packets* that are easy to transmit and can be uncompressed after transmission. A lossless image is the final product whereby it does not lose any resolution during transmission; as opposed to lossy images that lose some resolution when uncompressed. Success of the pilot project may be replicated on a national scale to provide cost-effective antenatal care for women in rural areas.

OBJECTIVES

The primary objectives of our project are to: (i) determine the accuracy of images and reports generated by trained midwives performing basic obstetric ultrasound examinations at our satellite sites; (ii) evaluate performance of a tablet-sized ultrasound scanner VISIQ (Philips Ultrasound, Inc., Bothell, WA,USA) as sole ultrasound system for this obstetric *triage* system (Fig. 1).

The secondary objectives of our project are to: (i) implement a teleradiology solution, including protocols to guide communication between sites as a quality control mechanism to review studies from newly trained frontline healthcare providers; (ii) identify components of the education and teleradiology model, which need to be further improved to facilitate ultrasound examinations by inexperienced users.

MATERIALS AND METHODS

Design

This was a prospective cross-sectional study. A curriculum was designed to teach midwives who had no previous training in ultrasound to independently work at a healthcare facility to identify high-risk pregnancies. Images and provisional reports were sent to the main hospital using an innovative online teleradiology solution for

Fig. 1. VISIQ ultrasound machine with transducer (Philips Ultrasound, Inc., Bothell, WA).