

Focused Cardiac Ultrasound by Nurses in Rural Vietnam

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Background: Multiple studies investigating the use of focused cardiac ultrasound (FCU) in lower and middle-income countries and in medically underserved areas of the United States have demonstrated utility in echocardiographic screening algorithms performed by a variety of operators at different levels of training. No study to date has employed previously untrained nurses in a medically underserved setting to identify older adults with cardiac disorders. The aim of this study was to assess the accuracy of nurse-performed FCU to screen adult subjects at a village health center in Vietnam.

Methods: Vietnamese nurses ($N = 8$) underwent structured training conducted by sonographers and physicians during an outreach event sponsored by the American Society of Echocardiography Education and Research Foundation. The nurses were trained to detect abnormalities from a single echocardiographic view (parasternal long-axis) with a laptop-sized device and underwent pre- and posttraining testing. Following training, cardiac ultrasound examinations were performed on subjects >50 years of age at a village health center. First, the nurses performed focused cardiac ultrasound using two-dimensional and color Doppler imaging in the parasternal long-axis view using the M7 device and recorded their assessments. Two-dimensional color and spectral Doppler echocardiography was thereafter performed using the same machine by a sonographer ($n = 5$) or a Vietnamese echocardiography-trained cardiologist ($n = 1$). Interviews and electrocardiography were performed at the time of FCU.

Results: Each nurse improved from pre- to posttraining (average improvement in correct answers, 21%; range, 2%–31%). During the scanning phase, nurses' sensitivity, specificity, and accuracy for identifying subjects with any abnormality were 51.5% (85 of 165), 78.1% (82 of 105) and 61.9%, respectively. There were 60 subjects with significant findings (22.2%); all of these subjects had significant abnormalities visible on parasternal long-axis images. Overall sensitivity, specificity, and accuracy for identifying subjects with major abnormalities were 83.3% (50 of 60), 78.1% (164 of 210), and 78.6%, respectively. Nurse-performed FCU demonstrated much higher sensitivity with lower specificity than electrocardiography alone. The combination of nurse-performed FCU plus ECG identified all of the significant findings on echocardiography and increased accuracy to 91.5%.

Conclusions: Nurses with no prior echocardiographic experience and with limited training can identify patients with significant cardiac abnormalities using FCU with acceptable accuracy. Screening strategies involving FCU may play a role in improving access to health care and triage in underserved areas. (*J Am Soc Echocardiogr* 2018; ■: ■-■.)

Keywords: Echocardiography, Focused cardiac ultrasound, Education, Nurse screening, Health care access

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Abbreviations**ECG** = Electrocardiography**FCU** = Focused cardiac ultrasound**LVEF** = Left ventricular ejection fraction**NURSEFCU** = Nurse-performed focused cardiac ultrasound**PLAX** = Parasternal long-axis

Vietnam is one of the fastest developing countries in Asia. Concurrent with improvements in public health and decreases in morbidity and mortality from communicable diseases, the population in Vietnam is aging. The rates of cardiac risk factors, including smoking and hypertension, are increasing, and noncommunicable, acquired cardiovascular disease is playing a larger and larger role in Vietnam's morbidity and

mortality. Despite overall improvements in the health care infrastructure, access to diagnostic technology remains limited in many areas.

Multiple studies investigating the use of focused cardiac ultrasound (FCU) in lower and middle-income countries¹⁻⁹ and in medically underserved areas of the United States¹⁰ have demonstrated utility in echocardiographic screening algorithms performed by a variety of operators at different levels of training. Novice users in most of these studies have been physicians. A recent study from Uganda examined the use of FCU by nurses to identify children with rheumatic heart disease,¹¹ and another study from sub-Saharan Africa examined nurse-performed cardiac ultrasound in a heart failure population that included adults.¹² No study to date has used previously untrained nurses in a medically underserved setting to identify older adults with cardiac disorders.

We sought to assess the accuracy of a nurse-performed FCU (NURSEFCU) program to assess older adults at a village health center in northern Vietnam.

METHODS**Nurse Training**

The study was approved by the local research ethics oversight body at Bach Mai Hospital in Hanoi, Vietnam. Eight Vietnamese nurses were recruited to participate in this study. Three of the nurses were recent graduates from Hanoi University College of Nursing. Five of the nurses practiced at rural village health centers. None of the nurses had undergone any formal training in cardiac ultrasound acquisition or interpretation before participation in the study.

The nurses underwent a structured training program conducted by sonographers and physicians during an outreach event in August 2015 sponsored by the American Society of Echocardiography Education and Research Foundation. Training consisted of 2 hours of lectures on basic ultrasound principles, cardiac anatomy, and image acquisition; 2 hours of group image review (consisting of normal and pathologic examples); and 2 hours of adjudicated scanning practice guided by sonographers. All training took place at the Vietnam National Heart Institute at Bach Mai Hospital with a laptop-sized device (M7; Mindray, Shenzhen, China). Didactic sessions were delivered in English with concurrent in-person Vietnamese translation. English-to-Vietnamese translation was also used during scanning practice. The nurses were trained to detect abnormal scans from a single echocardiographic view (parasternal long-axis [PLAX]). Pre- and posttests on recognition of abnormal PLAX images were administered before and after training.

Scanning in a Village Health Clinic

The day after the training, the nurses, sonographers, and echocardiographers traveled to a village health clinic (Xuan Canh commune, Dong Anh district, Vietnam; population 10,063 at the time of the study). Residents of the local health district who were ≥ 50 years of age were invited via letter from the local ministry of health representative to participate in a 1-day outreach at the village health center.

As part of the health outreach, participants underwent a brief interview by outreach clinic triage coordinators addressing demographics and risk factors, electrocardiography (ECG), and cardiac ultrasound assessment. The nurses performed FCU using two-dimensional and color Doppler imaging in the PLAX view only using the M7 device and recorded their assessments. Two-dimensional color and spectral Doppler echocardiography was thereafter performed using the same machine by a sonographer ($n = 5$) or a Vietnamese echocardiography-trained cardiologist ($n = 1$) using a standard protocol (Table 1). The images were interpreted immediately by a visiting American Society of Echocardiography echocardiographer ($n = 3$) or a Vietnamese echocardiographer ($n = 2$) using a standardized form (Figure 1). Results were transcribed and made available to a Vietnamese physician, who evaluated and treated the patient on site or made an appropriate referral. Electrocardiograms were interpreted by Vietnamese physicians on site and re-reviewed for study purposes to determine whether they showed normal or abnormal findings according to a published algorithm used in Vietnam.¹³ Nurses were blinded to the interview and electrocardiographic data. Abnormalities on echocardiography were pre-categorized as any finding (abnormal, whether or not it is likely to be clinically important) or significant (clinically important; Table 2). Descriptive statistics were used, and sensitivity, specificity, and accuracy comparing ECG, NURSEFCU, and echocardiography in terms of identifying subjects with abnormal scans were calculated to test the strategy of ECG and NURSEFCU in identifying subjects with findings on echocardiography. In recognition that some of the findings could not be identified by PLAX-only images, echocardiographic findings were analyzed according to whether any and significant findings were identifiable by the PLAX view only.

RESULTS

During the training phase, each nurse improved from pretraining test to posttraining test (average improvement in correct answers, 21%; range 2%–31%).

During the scanning phase, 279 subjects were recruited; four were excluded for inadequate data and five because they were < 50 years of age. Average age was 65 ± 8.6 years, and 54.8% were women. Substantial percentages of subjects reported family history of heart disease (41.8%) and had hypertension (57.4%; Table 3). The nurses scanned an average of 32 subjects each (range, 20–40). The three nurses who were recent graduates scanned 158 subjects and the five nurses from the local medical station scanned 112 subjects.

On echocardiography, the mean left ventricular ejection fraction (LVEF) was $65 \pm 5.9\%$. There were no subjects with LVEFs $< 50\%$. All echocardiographic findings are detailed in Table 4. There were 218 significant findings in 60 subjects (22.2%). The majority (182 of 218 [83%]) of these findings involved abnormalities potentially visible from the PLAX view. Compared with the sonographer-performed study, nurse sensitivity, specificity, and accuracy for identifying subjects with any abnormality were 51.5% (85 of 165), 78.1% (82 of 105), and 61.9%, respectively (with significant internurse variability; Table 5). The nurses who

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