Development of a Pilot Family Medicine Hand-carried Ultrasound Course

Felix Wong, MD; Zeno Franco, PhD; Mary Beth Phelan, MD; Cesar Lam, MD; Alan David, MD

ABSTRACT

Background and Objectives: A hand-carried ultrasound training session was organized as an initial step in developing a long-term ultrasound education program for family medicine residents and faculty. Comparative effectiveness studies examining the potential benefits, risks, and any possible cost savings associated with this technology will be predicated on having a sufficient number of primary care physicians trained and able to use hand-carried ultrasounds as part of routine care. The proposed training described here is a first step toward this broader conversation and empirical study of hand-carried ultrasound use in family medicine.

Methods: An 8-hour training consisting of didactic lectures, case review, and hands-on experience imaging standardized patients with ultrasound machines and an ultrasound simulator. The objective of the course was to introduce focused ultrasound acquisition and interpretation of the gall bladder, kidney, heart, and abdominal aorta to family medicine physicians. Participating physicians were evaluated for changes in self-perceived comfort and proficiency with the hand-carried ultrasound before and after the training.

Results: Statistically significant changes for most comfort and proficiency items were demonstrated. Importantly, the only item that did not show significant change dealt with basing clinical decisions on information obtained from the device.

Conclusion: The subjective improvement suggests this approach is one potentially useful hand-carried ultrasound training framework. Future work should attempt to further develop curricula and address issues such as longitudinal training assessments and certification and the development of competency in the necessary skill sets.

INTRODUCTION

Innovation in ultrasound technology has led to the development of the hand-carried ultrasound.[1] With their small size and increased mobility, hand-carried ultrasounds allow for the possibility for all physicians to carry ultrasounds for use in patient care, regardless of the care setting. In conjunction with a history and physical, the use of a hand-carried ultrasound has implications in screening and diagnosing certain pathology[2,3] through point-of-care ultrasonography. Point-of-care ultrasound is defined as ultrasonography that can be brought to the patient and performed by the provider in real time.[4] Point-of-care ultrasonography done with hand-carried machines has been shown to be effective in supplementing the cardiovascular examination in selected patient populations[5] while identifying cardiovascular and abdominal pathology[6-11] with comparable accuracy to stand-alone ultrasound units.[12,13,14] It also has demonstrated that it has a role in inpatient internal medicine, emergency medicine, and obstetrics/gynecology.[11,12]

The concept of using point-of-care ultrasonography with hand-carried ultrasounds in a family medicine setting is a relatively novel idea that, from our literature review, has yet to be substantially explored. The success that hand-carried ultrasound has had on patient care in other medical specialties inspired our family medicine department to begin to investigate potential applications in our residency training programs. We began to consider how point-of-care ultrasonography with hand-carried ultrasounds may be used in a family medicine setting. For example, one scenario might involve a 65-year-old male with a smoking history and a palpable abdominal mass. The US Preventative Task Force provides a Grade B recommendation of abdominal aortic aneurysm screening in male patients 65 to 75 years of age with a smoking history.[15] Instead of having the patient wait to schedule an appointment with radiology and risk being lost to follow-up, the ultrasound examination can be done instantaneously and managed much earlier.

Another possible scenario would be one in which a teenager is undergoing a sports physical. A quick cardiac scan with a hand-

• • •

Author Affiliations: Medical College of Wisconsin, Milwaukee, Wis (Wong); Medical College of Wisconsin, Department of Family and Community Medicine, Milwaukee, Wis (Franco, David); Medical College of Wisconsin, Department of Emergency Medicine, Milwaukee, Wis (Phelan); Medical College of Wisconsin, Department of Radiology, Milwaukee, Wis (Lam).

Corresponding Author: Zeno Franco, PhD, Department of Family and Community Medicine, Medical College of Wisconsin, 8701 Watertown Plank Rd, Box 26509, Milwaukee, WI 53226-0509; phone 414.915.4372; fax 414.955.6523; e-mail zfranco@mcw.edu.

Table 1. Review of Focused Ultrasound Training Courses

Author	Title of Paper	Trainee	Training Lecture	Practice	Results
Alexander et al[19]	Training and accuracy of non-cardiologists in simple use of point-of-care echo: A preliminary report from the Duke Limited Echo Assessment Project	16 internal medicine residents and 4 beginning cardiology fellows	3 hour HCU training program consisting of 30 minutes of introduction to ultrasound and the HCU device, 75 minutes of case review, 75 minutes of hands-on practice	75 minutes of hands-on practice	Average time to complete HCU echo was 8.5 minutes and was able to improve assessment of LV function and pericardial effusion
Croft et al[20]	The echo stethoscope: Is it ready for prime time by medical students?	Medical students	30 hours of didactic lecture and observation of echo exams	40 supervised practice echocardiograms	Students were able to use ultrasound to be diagnostic in >90% of the patients, interpreted correctly in >80% of patients
Croft et al[21]	Impact of front-line, limited, focused, and expedited echocardiography in the adult emergency department using a compact echo machine	Medical student and echo cardiologist			Changed diagnosis in >25% of patients and management in >15% of patients
DeCara et al[17]	The use of small personal ultrasound devices by internists without formal training in echocardiography	3 internal medicine residents	20 hours of didactic lecture	20 supervised practice echocardiograms	Residents and echocardiographers had similar sensitivity and specificity, but echocardiographers had higher PPV and sensitivity
Kimura et al[5]	Usefulness of a hand held ultrasound device for bedside examination of left ventricular function	13 internal medicine residents	1 hour of review lecture, 1 hour of videotaped examples of normal and abnormal systolic function	5 practice echocardiograms on normal volunteers	10 residents showed improvement in accuracy, 2 residents no net improvement, 1 resident worsened in diagnostic accuracy
Rugolotto et al[22]	The new generation of hand-carried echocardiographs: the Stanford view	Internal medicine residents	10 hour training curriculum		Residents used HCUs to decrease discrepancies from physical exam from 33.2% to 27.8%

Abbreviations = HCU, hand-carried ultrasound ; LV, left ventricular.

carried ultrasound might reveal hypertrophic cardiomyopathy and prevent a sudden cardiac arrest. These are both hypothetical scenarios in which point-of-care ultrasonography with hand-carried ultrasounds may have a positive impact on patient care. However, since there is little literature on the impact of point-of-care ultrasonography on clinical decision-making and patient care cost/benefit in the family medicine setting, more research is needed. Before this research can be conducted broadly, family medicine physicians must learn how to use hand-carried ultrasounds.

In addressing ultrasound training, studies have shown that it is possible to train residents and medical students using 5 to 20 hours of focused ultrasound training courses to perform various narrowly defined tasks.[5,11,13,14,16-18] These findings are summarized in Table 1. While there are lengthy medical school ultrasound curriculums designed to teach medical students how to use ultrasound,[23] these curriculums may not be the best choice for busy family medicine residents and faculty due to time and budget constraints.

The current effort describes an evaluation of a pilot short course for hand-carried ultrasound training specifically designed for and implemented within the family medicine context. It emphasized brief, focused training strategies, and assisted us in identifying participants with a strong interest in adopting hand-carried ultrasound point-of-care ultrasonography in our residency programs. The study attempted to identify positive and negative aspects of the various components of the hand-carried ultrasound training session, explored areas of need for future training, and assessed impact on participants' self-perceived comfort and proficiency performing hand-carried ultrasound tasks.

METHODS

A hand-carried ultrasound training session was organized for 8 faculty members from the Medical College of Wisconsin's Department of Family and Community Medicine who volunteered to participate. The study was granted exempt status by the institutional review board.

The majority of the participants had 0 to 10 hours of ultrasound experience, with 1 participant having over 40 hours and completion of a prenatal ultrasound course. An emergency department physician who completed an emergency medicine ultrasound fellowship, with American Registry for Diagnostic

Medical Sonography certification and 20 years of point-of-care ultrasonography experience, led a training session consisting of lectures, case review, and hands-on experience imaging 4 standardized patients with normal anatomy using Vscan and LOGIQ E ultrasound machines (GE Healthcare, Waukesha, Wisconsin) and an Ultrasim ultrasound simulator (Med Sim Inc., Fort Lauderdale, Florida) which demonstrated commonly encountered sonographic pathology. The Vscan is a hand-carried ultrasound, while the LOGIQ E is a stand-alone ultrasound machine. The larger LOGIQ E was used to provide the participants with the ability to see images on a larger display in higher resolution. The LOGIQ E allowed the participants to orient themselves to the images first and then transfer their understanding of what the images look like to the smaller interface of the Vscan. The areas of clinical focus included identification of normal anatomy and pathologic findings of the abdominal aorta, heart, liver, gall bladder, and kidney. These anatomical areas of focus were chosen based on the assumption that they would be most relevant for a family medicine setting. The amount of time spent on each topic is found in Table 2.

Table 2. Topics and Time Spent

Topic	Time Spent (minutes)
Machine use and knobology	15
Ultrasound physics and areas of clinical focus	15
Abdominal aorta and gall bladder review of exam techniques	45
Hands on with standardized patients and ultrasound simulator	120
Abdominal aorta and gall bladder	
Case reviews	30
Cardiac review of exam technique	60
Hands on with standardized patients - cardiac	60
Evaluation of participants	30

Table 3. Frequency of Participants Ordering and Performing Certain Ultrasound Exams

Type of Ultrasound Exam	Modal Responses of Participants' Rate of Ordering Exam	Modal responses of Participants' Rate of Performing Exam
Aorta	Rarely	Never
Kidney	Sometimes	Never
Liver	Frequently	Never
Cardiac	Frequently	Never

Participants completed a pretraining and posttraining survey to gauge change in their self-perceived confidence and proficiency in performing a hand-carried ultrasound exam. A questionnaire with a 7-point Likert-type scale was developed with each item ranging from 1 (strongly disagree) to 7 (strongly agree) and additional open-ended responses. The open-ended responses allowed for participants to provide input and thoughts about various topics such as how hand-carried ultrasound would be used in a family medicine setting. The scaled items are summarized in Table 4. The instrument was not validated, but may serve as a starting point for hand-carried ultrasound-specific perception and performance assessment. The pretraining and posttraining surveys and evaluations were anonymous and number coded to allow for linkage of the instruments.

RESULTS

Participants assessed their level of confidence and self-perceived proficiency with hand-carried ultrasounds before and after training. The Wilcoxon Signed Rank Sum test was used to compensate for non-normality due to the small sample size and near uniform unfamiliarity with hand-carried ultrasounds among the participants (Table 4).

Significant improvement was found for all items post-test except for 1 item on participants' comfort basing clinical decisions on point-of-care ultrasounds they performed. Following the training, all the participants appeared to be able to locate all sonographic anatomy as judged by the course evaluators. However, this evaluation was performed in an observational manner using a checklist and was not standardized due to time constraints.

Participants rated their level of frequency of ordering and performing of different ultrasound exams using the responses "never," "rarely," "sometimes," and "frequently," scaled from 1 to 4 (Table 3).

In response to the open-ended training evaluation questions, the participants stated that the hands-on experience with standardized patients was the most effective education, followed by the review and discussion of case studies and the use of the ultrasound simulator. All participants believed it was important to learn how to use ultrasound for both patient care and resident education. Prior to the training, participants rated the importance of performing abdominal (85% agreement) and cardiac ultrasounds (50% agreement). No change in agreement was observed after the training. The higher level of importance in performing the abdominal exam may be due to participants treating more patients with abdominal issues than those with cardiac issues. All participants stated they would be willing to use a hand-carried ultrasound in clinic.

DISCUSSION

In this sample of family physicians, a statistically significant change in several important components required for successful ultrasound utilization was noted. These include comfort and confidence in selecting the appropriate ultrasound probe, and adjusting variables such as gain and depth in order to maximize image quality and limit artifact. Performing and interpreting

Table 4. Assessment of "Level of Agreement" with Various Statements

Statement	Pretraining Median	Posttraining Median	Signed Rank	*P*-value	Median of Change From Pretraining to Posttraining	Range
I am *comfortable* with choosing correct probe orientation.	2.5	6	S(8) = 14	>0.05	3.5	6
I am *comfortable* with adjusting depth gain.	2.5	6	S(8) = 18	>0.01	3	4
I am *comfortable* with performing aorta ultrasound exam.	1	6	S(8) = 18	>0.01	5	5
I am *comfortable* with performing the liver/gallbladder ultrasound exam.	1	6	S(8) = 18	>0.01	4.5	4
I am *comfortable* with identifying the anatomy on ultrasound.	2	5.5	S(8) = 12.5	>0.05	4	6
I am *comfortable* with performing the kidney ultrasound exam.	1	5	S(8) = 10.5	>0.05	4	5
I am *comfortable* with performing the cardiac ultrasound exam.	1	5	S(7) = 13	>0.05	4	6
I am *comfortable* with making clinical decisions based on the ultrasound exam.	2	5	S(8) = 9	>0.10	1.5	5
I consider myself *proficient* using the ultrasound for the aorta exam.	1	5	S(8) = 18	>0.01	5	4
I consider myself *proficient* using the ultrasound for the liver exam.	1	4.5	S(8) = 18	>0.01	2.5	3
I consider myself *proficient* using the ultrasound for the kidney exam.	1	4	S(8) = 14	>0.05	2.5	5
I consider myself *proficient* using the ultrasound for the cardiac exam.	1	4	S(7) = 10.5	>0.05	3	6

sonographic images requires knowledge of ultrasound physics for accurate image acquisition, which in turn must be appropriately interpreted and then applied correctly to the clinical scenario at hand. The time spent on ultrasound physics for this course was very limited and may have contributed to the decreased confidence providers expressed related to the clinical application of ultrasound. Future courses should invest more time in this important education area. An additional broader reason for the lack of improvement is that that technology is a tool that alone cannot improve clinical decision-making. The hand-carried ultrasound can be used to further the differential diagnosis, but not without a proper history and physical. Regardless, this change in comfort and proficiency is an important step toward future ultrasound education.

The participants expressed that the education experience they valued the most was the hands-on session in which they scanned standardized patients. This is important feedback; however, standardized patients are expensive and alternatives such as simulation may be explored to build tactile skills and eye-hand coordination, as well as to practice the interpretation of normal and abnormal pathology. Prior research has noted that utilization of an ultrasound simulator for training surgical residents and medical students produced posttest results similar to those in resident training with live patients/models.[24,25] The use of ultrasound simulators may prove to be an excellent method for both training and assessment of ultrasound skills.

To help direct further training, it is important to identify the role of hand-carried ultrasounds in family medicine; for example, whether the device will be used for screening or diagnostic purposes. Participants stated that possible indications would be aortic aneurysm screening, ventricular wall thickening, abscesses, foreign bodies, joint injections, and gall bladder pathology. Future training sessions may focus more on abdominal ultrasound, since more participants felt that abdominal ultrasound was important when compared to the cardiac ultrasound.

Participants highlighted problems that may arise with hand-carried ultrasound use, such as billing, certification, medical legal liability, adequate training, lack of probes with different frequencies to allow of imaging of various depths, low usability time due to battery and overheating, and time demand in a clinic. There may be additional concerns with false positive findings and costs that are incurred as a result. These issues may be barriers to adoption of hand-carried ultrasound in family medicine.

CONCLUSION

In conducting our study, we were unable to identify a standardized, well-validated survey instrument that evaluated these concepts specifically related to hand-carried ultrasound use. Additionally, budgetary constraints limited the sample size of our study. We also were unable to assess the impact of the training on ultrasound skill due to the lack of standardization of the anatomy assessment. Despite the limitations in our study, the objective of the study was to serve as a starting point in the discussion of point-of-care ultrasonography use in family medicine. We believe that point-of-care ultrasonography with hand-carried ultrasounds has the potential to revolutionize how family medicine is practiced, but this cannot be validated without further discussion and research from the family medicine community. The literature reveals little about possible impact on point-of-care ultrasonography in a family medicine setting, which is why we feel it is important to bring this issue into the forefront of the family medicine community. It is important to reiterate that we cannot proceed to evaluate impact of hand-carried ultrasounds or their relative effectiveness compared to more traditional exam techniques without having trained family medicine physicians using hand-carried ultrasounds in the real world.

Our study has helped reveal areas of possible interest and concern in using point-of-care ultrasonography in family medicine. We believe that it is important to encourage further discussion and research from the community to see if point-of-care ultrasonography will affect clinical decision-making and patient cost/benefit in a family medicine outpatient setting.

Further development of the ultrasound-training course will focus on categorizing the indications of ultrasound in a family

medicine setting, addressing the highlighted problems with hand-carried ultrasound use, and creating a long-term training education plan. The ultimate goal of this project is to integrate hand-carried ultrasound education into our family medicine residency so that faculty and residents can use hand-carried ultrasounds in an outpatient setting.

Funding/Support: GE Healthcare provided extra GE Vscan units and the GE LOGIQ E unit for use during the training session, and a GE representative was present throughout the training session. GE had no input on the study design, data analysis, or writing of this manuscript.

Financial Disclosures: None declared.

REFERENCES

1. Roelandt JR. A personal ultrasound imager (ultrasound stethoscope). A revolution in the physical cardiac diagnosis! *Eur Heart J.* 2002;23(7):523-527.

2. Kimura BJ, Demaria AN. Empowering physical examination: The "laying on" of ultrasound. *JACC Cardiovasc Imaging.* 2008;1(5):602-604.

3. Mondillo S, Giannotti G, Innelli P, Ballo PC, Galderisi M. Hand-held echocardiography: Its use and usefulness. *Int J Cardiol.* 2006;111(1):1-5.

4. Moore CL, Copel JA. Point-of-care ultrasonography. *N Engl J Med.* 2011;364(8):749-757.

5. Kimura BJ, Amundson SA, Willis CL, et al. Usefulness of a hand-held ultrasound device for bedside examination of left ventricular function. *Am J Cardiol.* 2002;90(9):1038-1039.

6. Lin PH, Bush RL, McCoy SA, et al. A prospective study of a hand-held ultrasound device in abdominal aortic aneurysm evaluation. *Am J Surg.* 2003;186(5):455-459.

7. Flu WJ, van Kuijk JP, Merks EJ, et al. Screening for abdominal aortic aneurysms using a dedicated portable ultrasound system: Early results. *Eur J Echocardiogr.* 2009;10(5):602-606.

8. Vourvouri EC, Poldermans D, Schinkel AF, et al. Left ventricular hypertrophy screening using a hand-held ultrasound device. *Eur Heart J.* 2002;23(19):1516-1521.

9. Senior R, Galasko G, Hickman M, et al. Community screening for left ventricular hypertrophy in patients with hypertension using hand-held echocardiography. *J Am Soc Echocardiogr.* 2004;17(1):56-61.

10. Coletta C, De Marchis E, Lenoli M, et al. Reliability of cardiac dimensions and valvular regurgitation assessment by sonographers using hand-carried ultrasound devices. *Eur J Echocardiogr.* 2006;7(4):275-283.

11. Kirkpatrick AW, Simons RK, Brown R, Nicolaou S, Dulchavsky S. The hand-held FAST: Experience with hand-held trauma sonography in a level-I urban trauma center. *Injury.* 2002;33(4):303-308.

12. Kobal SL, Atar S, Siegel RJ. Hand-carried ultrasound improves the bedside cardiovascular examination. *Chest.* 2004;126(3):693-701.

13. Vourvouri EC, Poldermans D, De Sutter J, et al. Experience with an ultrasound stethoscope. *J Am Soc Echocardiogr.* 2002;15(1):80-85.

14. Rugolotto M, Hu BS, Liang DH, Schnittger I. Rapid assessment of cardiac anatomy and function with a new hand-carried ultrasound device (OptiGo): a comparison with standard echocardiography. *Eur J Echocardiogr.* 2001;2(4):262-269.

15. Recommendations of the US Preventive Services Task Force. Guide to Clinical Preventive Services [Abstract]. Agency for Healthcare Research and Quality, September 2010. http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/guide/abstract.html. Accessed October 30, 2013.

16. Langlois Sle P. Focused ultrasound training for clinicians. *Crit Care Med.* 2007;35(5 Suppl):S138-143.

17. DeCara JM, Lang RM, Koch R, et al. The use of small personal ultrasound devices by internists without formal training in echocardiography. *Eur J Echocardiogr.* 2003;4(2):141-147.

18. Duvall WL, Croft LB, Goldman ME. Can hand-carried ultrasound devices be extended for use by the noncardiology medical community? *Echocardiography.* 2003;20(5):471-476.

19. Alexander JH, Peterson ED, Chen AY, et al. Training and accuracy of non-cardiologists in simple use of point-care-echo: a preliminary report from the Duke limited echo assessment project (LEAP). *Thoraxcentre J.* 2001;13:105-110.

20. Croft LB, Cohen B, Dorantes T, et al. The echo stethoscope: is it ready for prime time by medical students? *J Am Coll Cardiol.* 2002;39(s2):448. doi:10.1016/S0735-1097(02)82012-5.

21. Croft LB, SM, Harish S, Shapiro R, Jacobson S, Goldman ME. Impact of front line, limited, focused and expedited echocardiography in the adult emergency department using a compact echo machine. *Circulation.* 2001;104(Suppl II):334.

22. Rugulotto M, Schnittger I, Liang D. The new generation hand-carried echocardiographs: the Stanford view. *Thoraxcentre J.* 2001;13:100-102.

23. Bahner DP, Royall NA. Advanced ultrasound training for fourth-year medical students: a novel training program at The Ohio State University College of Medicine. *Acad Med.* 2013;88(2):206-213.

24. Knudson MM, Sisley AC. Training residents using simulation technology: experience with ultrasound for trauma. *J Trauma.* 2000;48(4):659-665.

25. Damewood S, Jeanmonod D Cadigan B. Comparison of a Multimedia Simulator to a Human Model for Teaching FAST Exam Image Interpretation and Image Acquisition. *Acad Emerg Med.* 2011;18(4):413-419.

advancing the art & science of medicine in the midwest

WMJ

WMJ (ISSN 1098-1861) is published through a collaboration between The Medical College of Wisconsin and The University of Wisconsin School of Medicine and Public Health. The mission of *WMJ* is to provide an opportunity to publish original research, case reports, review articles, and essays about current medical and public health issues.

© 2013 Board of Regents of the University of Wisconsin System and The Medical College of Wisconsin, Inc.

Visit www.wmjonline.org to learn more.