



## ORIGINAL RESEARCH

### Role of portable ultrasound during a short-term medical service trip to rural Guatemala: a collaborative mission of trainees and physicians

#### AUTHORS

Ahmed K Elsayes<sup>1</sup> BS, Biology Student

Scott A Rohren<sup>2</sup> BS, Medical Student \*

Nadim B Islam<sup>3</sup> MD, Emergency Medicine Physician

Katherine J Blair<sup>4</sup> MD, Radiologist

Alicia V Silvestre<sup>5</sup> MD, Radiologist

Daniela C Segura<sup>6</sup> MD, Radiologist

Theodore J Dubinsky<sup>7</sup> MD, Radiologist

#### CORRESPONDENCE

\*Mr Scott A Rohren [scott.rohren@bcm.edu](mailto:scott.rohren@bcm.edu)

#### AFFILIATIONS

<sup>1</sup> Department of Biology, The University of Texas at Austin, Austin, TX 78712, USA

<sup>2</sup> School of Medicine, Baylor College of Medicine, Houston, TX 77030, USA

<sup>3</sup> Department of Emergency Medicine, Houston Methodist, Houston, TX 77030, USA

<sup>4</sup> Department of Radiology, The University of Texas MD Anderson Cancer Center, Houston, TX 77030, USA

<sup>5</sup> Department of Radiology, TecniScan De Guatemala, Guatemala City, Guatemala

<sup>6</sup> Department of Diagnostic Radiology, Clínica Universitaria, Bogotá, Columbia

<sup>7</sup> Department of Radiology, University of Washington, Seattle, WA 98195, USA

#### PUBLISHED

29 May 2021 Volume 21 Issue 2

#### HISTORY

RECEIVED: 23 April 2020

REVISED: 7 March 2021

ACCEPTED: 18 March 2021

#### CITATION

Elsayes AK, Rohren SA, Islam NB, Blair KJ, Silvestre AV, Segura DC, Dubinsky TJ. Role of portable ultrasound during a short-term medical service trip to rural Guatemala: a collaborative mission of trainees and physicians. *Rural and Remote Health* 2021; 21: 6056. <https://doi.org/10.22605/RRH6056>

This work is licensed under a [Creative Commons Attribution 4.0 International Licence](https://creativecommons.org/licenses/by/4.0/)

## ABSTRACT:

**Introduction:** Access to health care in developing countries is scarce. One solution to this problem has been for doctors from the USA to provide single-visit care through short-term medical service trips. There is interest in using ultrasound imaging as a portable diagnostic tool; however, data describing its usefulness are scarce. Therefore, the goal of this study was to determine the usefulness of portable ultrasound imaging during a medical service trip to rural Guatemala.

**Methods:** A multidisciplinary team of physicians examined patients at a mobile clinic in Antigua, Guatemala. Patients with clinical indications for ultrasound had their suspected diagnoses recorded before ultrasound testing. After imaging, updated diagnoses were recorded and compared with the pre-test suspected diagnoses to determine how often ultrasound results

changed the medical management of the patients and to assess the most common indications for ultrasound imaging.

**Results:** During the trip, 205 patients were seen. Of these, 24 (12%) were given ultrasound exams. The results of 13 (54%) exams altered their medical management, and the remaining 11 (46%) exams confirmed the pre-test suspected diagnoses. The most common indications for ultrasound testing were suspected cardiac (11 patients, 46%) and gastrointestinal (8 patients, 33%) diseases.

**Conclusion:** Portable ultrasound imaging improved the medical team's ability to diagnose disease and clinically manage patients in a rural medical service trip. Ultrasound imaging may provide a low-cost solution to the growing demand for care in developing countries.

### Keywords:

evidence-based care, Guatemala, primary health care, radiology, South America.

## FULL ARTICLE:

### Introduction

Access to health care in developing countries is scarce and subject to many barriers such as lack of medical equipment, high poverty rates, and poor infrastructure<sup>1</sup>. Recently, the implementation of short-term medical service trips (MSTs) from high-income countries has become a possible solution to providing for the healthcare needs of these countries<sup>2</sup>. A typical MST lasts from 1 day to 4 weeks and goes to a developing country, establishes a temporary clinic, and offers outpatient services to local communities. Treatment generally takes place during single visits where follow-up care is often not available. Due to the logistical challenges of transporting diagnostic equipment, MST clinics mainly use inexpensive portable tests that provide immediate results to inform treatment plans. New methods to effectively deliver care given these constraints are of great interest to global healthcare organizations.

Point-of-care ultrasound (POCUS) imaging shows promise as a diagnostic tool in developing countries because it is relatively inexpensive and has a broad range of applications<sup>3</sup>. Moreover, it is safe and accurate, provides immediate results within the clinical scope of physicians on MSTs, and aids clinical decision-making in remote mobile clinics. Providers have widely incorporated portable ultrasound machines into MSTs; it has been reported that up to 40% of trips have them<sup>3</sup>.

However, despite widespread use, few studies have examined how often ultrasound imaging is used and whether its use changes the medical management of patients. Furthermore, to the best of the authors' knowledge, there are currently no studies regarding the appropriateness of ultrasound exams on MSTs, and no criteria have been developed by the American College of Radiology (ACR)<sup>4</sup>. A prior study conducted in Nicaragua showed the promise of

ultrasound imaging in MST clinics; however, further work must be done to explore ultrasound use in these settings<sup>5</sup>. Accordingly, the purpose of this study was to determine the usefulness of portable ultrasound imaging during a short-term MST to rural Guatemala. Specifically, the primary objective was to determine how often ultrasound results changed the medical management of the patients and to assess the most common indications for ultrasound imaging. The secondary objective was to assess how appropriate each POCUS examination was in accordance with established ACR appropriateness criteria.

### Methods

A multidisciplinary group of physicians set up a mobile clinic in Antigua, Guatemala, during a 3-day MST in December 2019. This was a retrospective observational study, analyzing the collected data. As the collected data contained minimal identifying data, a waiver of consent was obtained.

In the months preceding the trip, the organizing agency advertised their upcoming health clinic through local community leaders. The trip to Guatemala used the city of Antigua as a centralized location. The group then traveled to the communities of La Trinidad, Santa Catarina Barahona, and San Miguel Dueñas to provide care in a rural setting. All patients who arrived were eligible for care and subsequently included in the dataset. Patients were seen in a single-visit outpatient setting. Medications were distributed as needed. All patients who had indications for ultrasound had their suspected diagnoses and treatment plans recorded before receiving a POCUS. Indications for ultrasound reflected the common clinical use in normal practice settings, such as visualizing heart function or quantifying hepatomegaly. Additionally, ultrasound was used instead of other imaging modalities, as resources were limited. The premedical students and

medical students helped prepare each patient for the scan. Examinations were performed solely by a US-licensed emergency medicine physician with credentials in emergency ultrasonography and with over a decade of experience. US-trained diagnostic radiologists were available for consultation by web-call as needed. A highly trained US-licensed cardiologist was available on site for cardiac consultation. Following ultrasound imaging, each patient's updated clinical diagnoses and treatment plans were recorded.

The collected data were retroactively analyzed to determine how frequently patients had indications for ultrasound imaging, what the main indications for ultrasound imaging were, how often treatment plans were changed following ultrasound imaging, and how appropriate each study was according to ACR appropriateness criteria. Indications for ultrasound imaging were grouped by organ system (cardiac, genitourinary, gastrointestinal, and musculoskeletal). Patients were considered to have a change in medical management if they had a change in diagnosis or treatment instructions or addition or withdrawal of pharmacotherapy. POCUS examinations that ruled out a suspicion but did not diagnose a cause were defined as 'excluded diagnosis' and considered a change in management.

#### ***Inclusion criteria***

All adult patients (age  $\geq 18$  years) were included in the data analysis.

#### ***Exclusion criteria***

Patients aged less than 18 years were excluded from the data analysis. All ultrasound tests were compared to the ACR appropriateness criteria to determine if the performance of ultrasound would be considered best practice in the USA given full availability of medical equipment. Ultrasound scanning was characterized as 'usually appropriate', 'may be appropriate', or 'usually not appropriate' as per the ACR appropriateness criteria.

#### ***Ethics approval***

This study was approved by the Baylor College of Medicine (IRB approval H-47069)

#### **Results**

During the 3-day MST, 205 patients were examined. Of these

patients, 24 (12%) underwent POCUS imaging (average age 51.9 years). Seventy-one percent of the patients who received POCUS imaging were female. The use of POCUS imaging confirmed the pre-test suspicion in 11 (46%) patients, changed the medical suspicion and management in 5 (21%) patients, and excluded the leading diagnosis subsequently changing management in 8 (33%) patients (Table 1). The most common indication for ultrasound testing was suspected cardiac disease (11 patients, 46%) followed by suspected gastrointestinal (8 patients, 33%), genitourinary (2 patients, 8%), and musculoskeletal (2 patients, 8%) conditions (Table 2).

For gastrointestinal diagnoses, the POCUS confirmed the majority of cases (6 patients, 75%), and changed the diagnoses on the others (2 patients, 25%). For diagnoses that were confirmed, ultrasound was used to rule out anatomical abnormalities, which, combined with the clinical picture, were used to arrive at a more accurate diagnosis. The most common confirmed diagnosis of gastric pain was gastritis, for which proton pump inhibitors were prescribed. An example of a changed diagnosis was the presentation of generalized stomach pain, for which an enlarged post-voiding bladder was visualized, shifting the leading diagnosis to urinary retention and infection.

For cardiovascular disease, POCUS was used to visualize the heart and valvular flow. While altering the leading diagnoses and subsequent management, POCUS did not provide the etiology of many cardiovascular cases. In total, POCUS resulted in mostly excluded diagnoses (8 patients, 73%). A smaller subset of cardiac indications resulted in a confirmed diagnosis (3 patients, 27%). There were no changed cardiac diagnoses. The excluded cardiac diagnoses presented with a manifestation of shortness of breath or chest pain, for which no abnormalities were visualized on the heart. Depending on the severity of the symptoms, several patients with chest pain were referred for further work-up. An example of a confirmed diagnosis was the presence of a prolapsed mitral valve.

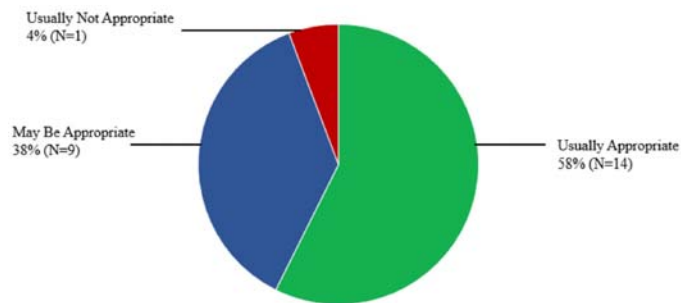
All ultrasound tests were indicated given the available equipment during the MST. Comparing the clinical presentation to the ACR's appropriateness criteria for ultrasound use, 14 (58%) tests were consistent with 'usually appropriate', nine (38%) were deemed 'may be appropriate' and one (4%) was deemed 'usually not appropriate' (Fig1).

**Table 1: Confirmed and changed diagnoses using ultrasound examination**

Clinical suspicion	Test	Findings	Updated clinical suspicion	Management	Number of patients
Gastritis	Abdominal ultrasound	No anatomical abnormalities	Epigastric pain (gastritis)	Confirmed	6
Urinary tract Infection	Bladder ultrasound	No anatomical abnormalities	Presumed urinary tract infection	Confirmed	1
Valve blockage	Transthoracic cardiac ultrasound	Abnormal mitral valve opening – mitral stenosis	Mitral stenosis	Confirmed	1
Benign mass behind ear	Ultrasound of mass	Fluid-filled mass	Likely benign mass	Confirmed	1
Mitral valve Prolapse	Transthoracic cardiac ultrasound	Mitral valve flattened and thickened	Prolapse in mitral valve	Confirmed	1
Occluded varicose veins	Lower extremity ultrasound	No flow in vessels	Occluded varicose veins	Confirmed	1
Urinary tract infection	Bladder ultrasound	Fluid-filled mass	Fluid-filled tumor (likely not malignant)	Changed	1
Urinary tract infection	Abdominal and bladder ultrasound	Extensive adhesions throughout pelvis	Pelvic inflammatory disease	Changed	1
Gastritis	Abdominal and bladder ultrasound	No gastrointestinal abnormalities Post-void urinary retention	Urinary tract infection	Changed	1
Gastritis	Abdominal ultrasound	Enlarged gallbladder with stones	Cholelithiasis	Changed	1
Neck tenderness – lymph node malignancy	Neck ultrasound	Fluid-filled mass in neck	Likely non-malignant neck mass	Changed	1
Heart dysfunction	Transthoracic cardiac ultrasound	Heart anatomy normal Heart function normal	Excluded heart dysfunction	Excluded	4
Coronary artery disease	Transthoracic cardiac ultrasound	No coronary artery disease	Excluded coronary artery disease	Excluded	3
Cardiac hypertrophy	Transthoracic cardiac ultrasound	Normal cardiac wall thickness	Excluded cardiac hypertrophy	Excluded	1

**Table 2: Management changes by organ system**

System	Confirmed (%)	Changed (%)	Excluded (%)
Gastrointestinal (n=8)	75	25	0
Cardiac (n=11)	27	0	73
Genitourinary (n=2)	50	50	0
Musculoskeletal (n=2)	50	50	0



**Figure 1: Radiology appropriateness designations for performed ultrasound examinations.**

**Discussion**

Portable ultrasound integrated into outpatient care helped physicians more accurately diagnose diseases in the patients seen during the MST as compared to physical exams alone. While the majority of patients seen in the rural outpatient clinic did not have indications for ultrasound testing, a small yet substantial portion of patients had issues that warranted POCUS testing. Of the patients who received POCUS testing, over half had management changes resulting from the use of the POCUS.

Ultrasound was particularly effective in guiding clinicians to properly treat gastrointestinal diseases. Often the presenting symptoms were non-specific. By visualizing the anatomy of the abdomen, the ultrasound provided clues to the underlying pathology and required treatment. Moreover, ultrasound was vital in excluding potentially life-threatening conditions with non-specific presentations such as the presence of an ectopic

pregnancy or appendicitis in instances of abdominal pain.

Ultrasound was likewise helpful in diagnosing cardiac problems, as it allowed for visualization of heart chambers and valves. For many of the patients who underwent POCUS imaging for cardiac indications, traditional physical examinations alone did not provide enough information to confidently treat patients. The POCUS was useful in confirming or excluding the presence of valvular diseases and other cardiac abnormalities. In 73% of the patients with suspected cardiac disease, the suspected diagnoses were excluded upon visualization of normal heart function, although this raises the question of how to provide follow-up care for indications that were not determined. Moreover, several disease states, such as cardiomegaly, can be suspected through the use of POCUS, but determining the etiology cannot be done in the MST setting<sup>6</sup>.

Physicians on MSTs have limited diagnostic equipment available, especially in rural regions<sup>7</sup>. The present study's results showed

that, in over half of the POCUS tests performed in the present study, ultrasound imaging was deemed 'usually appropriate' according to ACR appropriateness criteria. Ultrasound is generally the best practice for initial work-up of chest pain as it can be useful in evaluating suspected valvular disease or determining the presence of pneumothorax<sup>8,9</sup>. As such, the ultrasound was a great tool for physicians evaluating chest pain and shortness of breath in the rural outpatient setting. Moreover, many of the gastrointestinal indications were deemed as 'may be appropriate' as an abdominal CT with contrast is considered best practice for diagnosing generalized pain. However, POCUS is one of the several modalities that are suggested if CT is not available. The single case in which POCUS imaging was deemed 'usually not appropriate' was an evaluation of neck tenderness. In this instance, radiographic imaging was the only modality deemed appropriate by the ACR. Currently, there are no guidelines guiding clinicians as to best practices for ultrasound use, despite how widely they are used<sup>10</sup>. The establishment of appropriateness criteria for MST specific ultrasound use will help guide providers to proper treatment giving the available diagnostic equipment.

During the duration of this MST, patients were provided for by pre-medical students, who handled initial processing; medical students and residents, who assisted in acquiring the relevant histories; and practicing physicians, who performed physical examinations, conducted ultrasound tests, and determined treatment plans. One of the reasons for the growth of MSTs is the ability to incorporate trainees from all levels into the care of patients. Due to the heightened need in the countries that are served, all levels of interactions serve a distinct purpose in the care for the patient.

Recently, there has been an increasing interest in quantifying the use of ultrasound on MSTs as many organizations employ them on their trips. A study assessing an MST in Nicaragua found that POCUS changed management for 36% of patients<sup>5</sup>. Moreover, a study in Nigeria found that 46% of scans detected an abnormality<sup>11</sup>. In conjunction with the present study's data, these results are promising; however, more work is needed. One promising avenue to explore is the parallels between MSTs and disaster medicine. Notably, sonography has long been used in disaster triage, and insights can be gained by paralleling the two<sup>12</sup>. More specifically, it has been found that POCUS can diagnose many abdominal and cardiac conditions rapidly and conclusively<sup>13,14</sup>. MSTs can use the gained knowledge of disaster triage to provide guidelines on proper POCUS use.

While MSTs serve as a temporary solution to the medical needs of

rural under-served communities, there is a focus on permanent implementation. Historically, there has been a focus on supplying medications<sup>1</sup>. However, with MSTs finding value in ultrasound, efforts should increasingly focus on finding ways to bring ultrasound machines to communities, and training local doctors in their use. Notably, ultrasounds have already found their bearing within rural communities due to their ease of use and real-time feedback<sup>15</sup>. However, such implementation is not without challenges. There is a barrier to education dissemination in many rural parts of Central American countries<sup>16</sup>. Additionally, the cost of ultrasound machines may be costly for resource-limited communities. A possible solution is utilizing the longstanding relationships that medical service organizations have built with local communities to bring ultrasound equipment that will remain at the site and then educating local doctors in its use. Training of local doctors in POCUS would likely improve their ability to determine which patients could be treated locally, compared to which patients would require travel to a higher level of care.

This study had several limitations. Although the results are promising, the number of enrolled patients was low. Moreover, there was a significant selection bias such that every adult patient who received treatment was included. There is also an issue in blinding, as the physicians who made the initial diagnoses were the same ones who performed POCUS testing and updated the diagnoses. However, in the resource-limited communities, using the same individual for both diagnoses was necessary to effectively offer a diagnosis in a single-visit encounter. A final limitation is that there was no follow-up of patients, limiting the ability for definitive confirmation of several etiologies.

## Conclusion

The results of the present study suggest that the use of portable ultrasound imaging improves physicians' ability to diagnose diseases and manage patients seen during MSTs. Ultrasound is particularly useful in determining the cause of cardiac and gastrointestinal problems and provides a low-cost solution to the growing demands for care in developing countries. Moreover, ultrasound can be useful in excluding potentially life-threatening conditions that would require transfer to more advanced care. Further studies should analyze MST data from several locations to expand the size of the study populations and further assess the appropriateness of ultrasound imaging in a variety of settings.

## Acknowledgements

Thank you to Scientific Publications, Research Medical Library at MD Anderson Cancer Center for help editing the manuscript.

## REFERENCES:

**1** Watson SI, Sahota H, Taylor CA, Chen YF, Lilford RJ. Cost-effectiveness of health care service delivery interventions in low and middle income countries: a systematic review. *Global Health Research and Policy* 2018; **3**: 17. DOI link, PMID:29930989

**2** Spencer JK, Ronald SA. Utility of portable ultrasound in a

community in Ghana. *Journal of Ultrasound in Medicine* 2008; **27(12)**: 1735-1743. DOI link, PMID:19022999

**3** Dainton C, Shah N, Chu CH. Prevalence of portable point of care tests used on medical service trips in Latin America and the Caribbean. *Annals of Global Health* 2018; **84(4)**: 736-742. DOI link, PMID:30779524

- 4** American College of Radiology. *ACR Appropriateness Criteria*®. Available: [web link](#) (Accessed 10 March 2020).
- 5** Barron KR, Lai JC, Menkingsmith LP, Lee JS, Humphrey ME, Hall JW. Point-of-care ultrasound as part of a short-term medical mission to rural Nicaragua. *Southern Medical Journal* 2018; **111(7)**: 434-438. DOI link, PMID:29978230
- 6** Spencer KT, Kimura BJ, Korcarz CE, Pellikka PA, Rahko PS, Siegel RJ. Focused cardiac ultrasound: recommendations from the American Society of Echocardiography. *Journal of the American Society of Echocardiography* 2013; **26**: 567-581. DOI link, PMID:23711341
- 7** Anticona Huaynate CF, Pajuelo Travezaño MJ, Correa M, Mayta Malpartida H, Oberhelman R, Murphy LL, et al. Diagnostics barriers and innovations in rural areas: insights from junior medical doctors on the frontlines of rural care in Peru. *BMC Health Services Research* 2015; **15**: 454. DOI link, PMID:26438342
- 8** El Sabbagh A, Reddy YNV, Nishimura RA. Mitral valve regurgitation in the contemporary era: insights into diagnosis, management, and future directions. *JACC Cardiovascular Imaging* 2018; **11(4)**: 628-643. DOI link, PMID:29622181
- 9** Dahmarde H, Parooie F, Salarzaei M. Accuracy of ultrasound in diagnosis of pneumothorax: a comparison between neonates and adults – a systematic review and meta-analysis. *Canadian Respiratory Journal* 2019; **2019**: 5271982. DOI link, PMID:31933707
- 10** Dainton C, Chu CH, Lin H, Loh L. Clinical guidelines for Western clinicians engaged in primary care medical service trips in Latin America and the Caribbean: an integrative literature review. *Tropical Medicine & International Health* 2016; **21(4)**: 470-478. DOI link, PMID:26919697
- 11** Ikpeme A, Ani N, Ago B, Effa E, Kosoko-Lasaki O, Ekpenyong A. The value of mobile ultrasound services in rural communities in South-South Nigeria. *Open Access Macedonian Journal of Medical Sciences* 2017; **5(7)**: 1011-1015. DOI link, PMID:29362637
- 12** Wydo SM, Seamon MJ, Melanson SW, Thomas P, Bahner DP, Stawicki SP. Portable ultrasound in disaster triage: a focused review. *European Journal of Trauma and Emergency Surgery* 2015; **42(2)**: 151-159. DOI link, PMID:26038019
- 13** Zanza C, Longhitano Y, Artico M, Cammarota G, Barbanera A, Racca F. Bedside cardiac Pocus in emergency setting: a practice review. *Reviews on Recent Clinical Trials* 2020; **15(4)**: 269-277. DOI link, PMID:32738872
- 14** Balan M, Haroon B. Evaluation of abdominal pain. In: B Nelson, E Topol, A Bhagra, S Mulvagh, J Narula (Eds). *Atlas of handheld ultrasound*. Cham: Springer, 2018. DOI link
- 15** Flynn CJ, Weppler A, Theodoro D, Haney E, Milne WK. Emergency medicine ultrasonography in rural communities. *Canadian Journal of Rural Medicine* 2012; **17(3)**: 99-104.
- 16** Colon-Gonzalez MC, El Rayess F, Guevara S, Anandarajah G. Successes, challenges and needs regarding rural health medical education in continental Central America: a literature review and narrative synthesis. *Rural and Remote Health* 2015; **15(3)**: 3361. Available: [web link](#) (Accessed 6 March 2020). DOI link, PMID:26402719