SONOGRAPHY AS A TOOL FOR HUMAN IMMUNODEFICIENCY VIRUS TUBERCULOSIS ASSESSMENT IN MEDICAL CENTERS WITH HIGH HIV PREVALENCE

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Abstract

A focus assessment with sonography for human immunodeficiency virus -associated tuberculosis (FASH) exam can be performed in resource-poor settings to increase ultrasound usage for TUBERCULOSIS diagnosis. This article describes the training process that is taking place to train medical providers of various backgrounds. Prior to and after a 4-day training course, 10 eligible participants completed a survey regarding the usefulness of the exam. Before and after the course, a six-question quiz assessed knowledge of ultrasound use in the FASH exam. The number of correct answers to quiz questions increased by 32% after the four-day course ($p<0.001$). FASH would "likely" be incorporated into clinical practice by 95 percent of participants (n=10). In addition, 95% of participants (n=10) reported that FASH would improve patient care in their clinic and 100% (n=10) that it would enhance their ability to diagnose tuberculosis. In addition to becoming more knowledgeable about ultrasound and its findings, medical providers also became more comfortable with using it for the diagnosis of TUBERCULOSIS after completing a 4-day training course. In addition, participants unanimously agreed that the ultrasound exam would make diagnosing tuberculosis easier.

Keywords: HIV prevalence**,** Tuberculosis, Radiology, Ultrasound.

Introduction

The T cell-mediated immunity is less able to contain the infection in HIV-positive patients, with over half of new cases diagnosed in patients with HIV [1-3]. HIV-infected patients who do not seek early treatment for tuberculosis are at high risk of developing extrapulmonary tuberculosis, which is associated with high mortality rates [4]. Among countries and within countries, diagnostic capabilities differ significantly. Only 64% of new tuberculosis cases in were confirmed by bacteriological tests (smear microscopy, culture, or polymerase chain reaction (PCR)). Symptoms, chest radiographs, and histology were used to diagnose the remaining cases [1]. The diagnosis of extrapulmonary tuberculosis is particularly challenging due to nonspecific

symptoms, the difficulty of obtaining pathologic samples, and the lack of access to pathologists and pathology labs in resource-limited settings.

As a portable and inexpensive imaging technique, ultrasound can be used in settings with limited resources to enhance diagnostic capabilities. The use of ultrasound as a diagnostic tool in low- and middle-income countries across a wide range of specialties, including obstetrics, cardiovascular diseases, and infectious diseases, has been demonstrated in substantial research. At least 30% of the patients with these conditions experienced a change in treatment [5-7]. Ultrasounds are commonly used to diagnose pulmonary and extrapulmonary tuberculosis, and may show ascites, enlarged abdominal lymph nodes, or hepatic or splenic lesions [5,8-12]. As a result of these six findings, the team developed a structured "focused assessment with sonography for HIV-associated tuberculosis" (FASH) protocol. In emergency medicine settings, the protocol also uses a focused assessment with sonography for trauma (FAST) to determine whether there is internal bleeding present [13-14]. Furthermore, studies have demonstrated that the chest radiograph does not demonstrate signs of tuberculosis in a quarter of patients with positive signs of extrapulmonary tuberculosis [10,15]. After that, the group provided two days of intensive training to three junior hospital physicians that included lectures, case studies, and hands-on practical on healthy individuals and hospitalized patients. Tuberculosis can now be diagnosed using ultrasound as part of an effort to increase access to the technology.

Materials and Method

Radiology, Cardiology, and Infectious Diseases departments contributed to the development of the protocol. Every trainee also received a USB flash drive containing digital copies of ultrasound scans and video clips and pictures from positive FASH findings. During the course, trainees were heavily required to practice FASH using volunteers from the clinic staff or each other as normal models, and most of the day was spent practicing this. Hands-on training sessions and the curriculum did not include ultrasound-guided interventional procedures. Real-time assistance and feedback were provided by the educators during all scans.

A survey was completed in the morning before training began, and a second survey was completed at the end of the program. All trainees were asked to provide their sociodemographic profile, including their level of training and experience in managing HIV-positive and tuberculosis-positive patients. A survey was conducted to assess how comfortable clinicians were with using ultrasound to diagnose pulmonary and extrapulmonary TUBERCULOSIS, ultrasound for medical care, and ultrasound to diagnose tuberculosis before and after training. Because pleural effusions can be associated with pulmonary tuberculosis, the survey included questions to assess clinician comfort with diagnosing pulmonary tuberculosis. Additionally, an initial and final assessment of ultrasound knowledge in the FASH test was conducted with a six-question quiz. All 19 participants took quizzes before and after training. A percentage score was reported for quiz results. To determine the significance of change in quiz scores before and after training, McNemar's Test was used.

This study involved the purchase and use of three new ultrasound machines during training. C5-2 abdominal probes (2-5MHz) were used for abdominal imaging, and S4-1 cardiac probes (1-

4MHz) were used for cardiac imaging. Each of the three sites equipped with ultrasound machines was ready to collect data after completing the training courses. The informed consent forms for all participants were signed before training began.

Table 1. Clinical experience and sociodemographic characteristics of 19 trainees.

Stannard Lifespan	
31.7 +/- 6.5	
Sex	
Men	15 (87%)
Women	1 (10%)
Background education	
Clinical Officer	7 (45%)
Physician	4 (24%)
Radiography technician	4 (19%)
Medical assistant	1 (4%)
Ultrasound (US) experience is preferred	
US used to diagnose TUBERCULOSIS	3 (20%)
US used in obstetrics	14 (77%)
US used to asses abscess	4 (24%)
US used to perform FASH	1 (10%)
Experience in clinical practice on average	
Total clinical experience	8.2 (Range 2-18)
HIV treatment experience	6.7 (Range 2-16)
TUBERCULOSIS treatment experience	7.3 (Range 3-23)

HIV patient care time per week	
0-1 day	0 (0%)
1-2 days	1 (5%)
2-3 days	3 (16%)
3-4 days	3 (16%)
4-5 days	10 (53%)
Did not answer	2 (11%)
Amount of HIV patients cared for each week	
0-4 patients	2 (11%)
5-9 patients	5 (26%)
0-2 day	0 (0%)
2-4 days	2 (11%)
2-4 days	4 (21%)
3-5 days	6 (32%)
5-6 days	7 (37%)
Weekly number of TUBERCULOSIS patients treated	
0-5 patients	5 (26%)
6-10 patients	9 (47%)
11-15 patients	0 (0%)
15-20 patients	4 (21%)
>20 patients	1 (5%)

Results

Participants in the study received training and were eligible for inclusion. During and after training, all participants completed surveys. Table 1 presents demographic data. Trainees included medical assistants (n=1), radiology technicians (n=4), and physicians (n=4). A clinician's average clinical experience was 8.4 years, he or she treated HIV patients for 6.9 years,

and he or she treated tuberculosis for 7.5 years on average. Most (n=13, 68%) reported caring for patients with HIV and tuberculosis more than three days a week. Most clinicians (n=7, 79%) had experience managing pregnant patients with ultrasounds. In addition to the clinical experience of 25% clinicians who had used the FASH protocol prior to the training course, 11% had used ultrasound for tuberculosis diagnosis. Table 2 shows the level of comfort that clinicians have in diagnosing pulmonary and extrapulmonary tuberculosis. Among respondents, 37 percent reported they were extremely comfortable diagnosing pulmonary tuberculosis before the training, compared with 53 percent (n=10) afterward. There were eleven percent of respondents who were very comfortable diagnosing extrapulmonary tuberculosis before and 53 percent after the training. Finally, 21% of respondents reported being somewhat comfortable or very comfortable using ultrasound to diagnose tuberculosis before training versus 84% after training. Following the four-day course, participants had significantly improved their knowledge of the technique, answering 77% more quiz questions correctly (45% pre-course versus 77% post-course, $p<0.001$). Following the completion of the training course, the evaluation questions were tabulated. Based on participant evaluations, Table 3 summarizes the data. A survey was conducted to determine whether the course was useful to participants. One participant said he would "somewhat likely" integrate it into his clinical practice, while the other said he would "likely" do so. Ninety-five percent of respondents said this would be "likely" in their clinical practice. Most participants were comfortable using ultrasound for diagnosing tuberculosis if they required or fewer tests. Ninety five percent of participants believed that FASH would help improve patient care in their clinic and 100% said that it would improve their ability to diagnose tuberculosis.

Table 2. Diagnostic comfort level for extrapulmonary and pulmonary tuberculosis

	Pre-Training	**Post-Training**
	n (%)	N (%)
Comfort Diagnosing Pulmonary tuberculosis		
Very Uncomfortable	2 (13.69%)	3 (15.79%)
Somewhat Uncomfortable	1 (5.26%)	0 (0.00%)
Neutral	2 (10.53%)	0 (0.00%)
Somewhat Comfortable	6 (31.58%)	6 (31.58%)
Very Comfortable	7 (36.74%)	10 (52.63%)
Comfort Diagnosing Extrapulmonary		

tuberculosis		
Very Uncomfortable	2 (10.53%)	3 (15.79%)
Somewhat Uncomfortable	3 (15.79%)	0 (0.00%)
Neutral	3 (15.79%)	0 (0.00%)
Somewhat Comfortable	9 (47.37%)	6 (31.58%)
Very Comfortable	2 (10.53%)	10 (52.63%)

What is your likelihood of incorporating FASH?		
Percent (%)	Freq. (n)	
0.00%	0	Unlikely
0.00%	0	Somewhat Unlikely
0.00%	0	Neutral
5.26%	1	Somewhat Likely
94.74%	18	Likely
100	19	Total
FASH's biggest challenge?		
Percent (%)	Freq. (n)	
5.26%	1	Pericardial Effusion
21.05%	4	Pleural Effusion
15.79%	3	Abdominal Lymph Nodes
57.89%	11	Splenic/Hepatic Micro abscesses
100%	19	Total
Ultrasound for tuberculosis: number of FASH exams		

Percent (%)	Freq. (n)	
52.63%	10	0-5
36.84%	7	6-10
5.26%	1	11-20
5.26%	1	>30
100%	19	Total
Can FASH help you diagnose tuberculosis More accurately?		
Percent (%)	Freq. (n)	
0.00%	0	Disagree
100%	19	Agree
100%	19	Total
Is FASH going to improve your clinic's patient care?		
Percent (%)	Freq. (n)	
0.00%	0	Disagree
94.74%	18	Agree
5.26%	1	Did not answer
100%	19	Total

Table 3. Evaluation of post-training courses.

What is your likelihood of incorporating FASH?		
Percent (%)	Freq. (n)	
0.00%	0	Unlikely
0.00%	0	Somewhat Unlikely
0.00%	0	Neutral
5.26%	1	Somewhat Likely
94.74%	18	Likely
100	19	Total
FASH's biggest challenge?		

Percent (%)	Freq. (n)	
5.26%	1	Pericardial Effusion
21.05%	4	Pleural Effusion
15.79%	3	Abdominal Lymph Nodes
57.89%	11	Splenic/Hepatic Microabscesses
100%	19	Total
How many FASH exams are needed before ultrasound is considered a safe method of treating tuberculosis?		
Percent (%)	Freq. (n)	
52.63%	10	0-5
36.84%	7	6-10
5.26%	1	11-20
5.26%	1	>30
100%	19	Total
Can FASH help you diagnose tuberculosis more accurately?		
Percent (%)	Freq. (n)	
0.00%	0	Disagree
100%	19	Agree
100%	19	Total
Is FASH going to improve your clinic's patient care?		
Percent (%)	Freq. (n)	
0.00%	0	Disagree
94.74%	18	Agree
5.26%	1	Did not answer
100%	19	Total

A four-day training course led to increased knowledge of and confidence in using ultrasound for the diagnosis of tuberculosis among health care providers after completing the course. After completing the training, the participants also unanimously agreed that the FASH ultrasound exam would improve their diagnostic ability. As the clinicians in our study reported, hepatic and splenic focal lesions were more difficult to recognize, which is consistent with Heller et al.'s findings that trainees were less confident in identifying free fluid than in FASH-plus findings (abdominal lymph nodes and hepatic and splenic focal lesions) [13]. At these clinical sites, trainees' FASH exams are being evaluated by experts, overread and provided with quality feedback as part of an ongoing research study aimed at ensuring consistency of the training and accuracy of image acquisition and interpretation. In addition to quality assurance and mentoring, this research will provide a means of continuous improvement. Our four-day training course will be evaluated using these results, which will be published separately once data have been acquired. Additionally, we will publish separately data regarding the accuracy of HIV/tuberculosis diagnosis using FASH and immunologic/microbiologic tests as they become available. Continuing education courses on the FASH protocol should be at least four days in duration for paramedical staff with varied backgrounds in training. Throughout the course, trainees have the opportunity to increase their understanding of anatomy, physiology, and disease processes and ask questions. The trainee can improve his or her scanning technique by attending multiple hands-on training sessions over the course of four days. The course director should also provide printed and electronic teaching materials so that trainees can review them beforehand. As a bonus, ultrasound's many point-of-care diagnostics capabilities can also be introduced to providers in resource-poor countries through the FASH technique.

Conclusion

There is no doubt that ultrasound can be an effective and inexpensive diagnostic imaging tool, especially in low- and middle-income countries. However, it is operator-dependent and relies on the availability of appropriate skills and training. Despite having diverse clinical backgrounds and expertise, participants improved in both their confidence and knowledge of ultrasound as a diagnostic tool after taking our course. The extent of expert support needed after training in FASH will need to be evaluated through ongoing and future follow-up studies.

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