ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE

DEPARTMENT OF EMERGENCY MEDICINE

A CROSS-SECTIONAL STUDY ON THE ACCURACY OF FOCUSED CARDIAC ULTRASOUND (FoCUS) PERSPECTIVE AMONGST EMERGENCY AND CRITICAL CARE MEDICINE RESIDENTS IN ADDIS ABABA, ETHIOPIA

Lead Investigator: Dr. Nahom Mesfin

A research thesis submitted to Addis Ababa University, College of Health Sciences, School of Medicine, Department of Emergency Medicine in partial fulfillment of the requirements for a postgraduate specialty certificate in Emergency and Critical Care Medicine

January 2024

Addis Ababa, Ethiopia

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Declaration

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Advisors' declaration

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In the end, I wish to convey my appreciation to the Department of Emergency and Critical Care Medicine at Addis Ababa University for presenting me with this learning experience and the fortunate to perform this research project.

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Abbreviations

AAU: Addis Ababa University

ACEP: American College of Emergency Physicians

AP4: Apical-4-chamber

AP2: Apical-2-chamber

ASE: American Society of Echocardiography

EACVI: European Association of Cardiovascular Imaging

ECCM: Emergency and Critical Care Medicine

FoCUS: Focused Cardiac Ultrasound

IVC: Inferior Vena Cava

LMICs: Low and Middle-income Countries

LV: Left Ventricle

PLAX: Parasternal Long Axis

PSAX: Parasternal Short Axis

ROC: Receiver Operating Characteristics

RV: Right Ventricle

SPHMMC: St. Paul Hospital Millennium Medical College

TAAAC-EM: Toronto Addis Ababa Academic Collaboration in Emergency Medicine

TASH: Tikur Anbessa Specialized Hospital

US: Ultrasound

Abstract

Background: The employment by non-cardiologists of Focused Cardiac Ultrasound (FoCUS) to promptly identify the organizational framework of the heart in critically sick patients attracted the first significant amount of public interest in early 90s. It was demonstrated that individuals with potentially life-threatening medical or surgical disorders might benefit from a quick FoCUS conducted by Emergency Physicians (EPs).

Objectives: To assess emergency medicine residents' accuracy of FoCUS interpretation in Tikur Anbessa Specialized Hospital (TASH) and Saint Paul Hospital Millennium Medical College (SPHMMC).

Methods: A cross-sectional investigation among TASH and SPHMMC attending Emergency and Critical Care Medicine (ECCM) residents. 80 senior residents partook in the study. Data was obtained utilizing Google Forms and cleaned and analyzed using the 27th version of SPSS. Descriptive statistics were used to study the population's sociodemographic and background characteristics. The study lasted for 5 months from August to December 2023 G.C. by using a structured questionnaire. The data was analyzed using descriptive statistics, chi-square and bivariate and multivariate binary logistic regression.

Results: This study was able to discover that 38 (47.7%) among the respondents were able to accurately identify FoCUS videos provided to them with an average score of 11 and SD of 2.267. Of the 80 senior residents, 73 (91.3%) were able to properly identify collapsing Inferior Vena Cava (IVC) and 72 (90%) of them identified cardiac standstill which were the most correctly identified pathologies and Regional Wall Motion Abnormality (RWMA) was the least correctly identified by 37 (46.3%). Binary logistic regression was performed for the independent factors over the dependent factor, and third-year residents were 12.434-fold likely to accurately identify FoCUS videos compared to second-year residents. [AOR = 12.434, 95% CI (1.189,129.990)].

Conclusion: This study worked on investigating the accuracy of FoCUS among ECCM residents of AAU and SPHMMC. 38 (47.7%) among the respondents were able to accurately identify FoCUS videos. The commonest identified pathologies were collapsing IVC and cardiac standstill and the least identified was RWMA. The independent factor with the most significant effect on the accuracy of the residents was the year of residency.

1. Introduction

Background

The application of Focused Cardiac Ultrasound (FoCUS), a streamlined, physician-performed echocardiography application, is quickly growing in popularity, particularly in Emergency Department (ED). FoCUS, carried out by adequately qualified clinicians—typically not cardiologists—determines the crucial data required in urgent clinical decision-making situations. High-quality reviews based on evidence and clinical suggestions on the application of FoCUS are required.[1]

FoCUS has overtaken other evaluation methods as the medical community has gotten more technologically literate, becoming the standard approach in both the ED and the Intensive Care Unit (ICU).[2] Even though most cardiovascular emergencies that call for a conventional echocardiography are time pressing, it is either not widely accessible or results in a significant delay, hence international organizations advise doing a FoCUS as the initial test in the ED and critical care units to hasten decision-making in these kinds of situations.[3]

As per the European Association of Cardiovascular Imaging (EACVI), FoCUS is normally utilized by non-cardiologists with just elemental training, and based on the clinical scenario, technology at their disposal, and level of experience, both cardiologists and non-cardiologists can do a FoCUS.[4] The level of performance exhibited by ECCM residents in conducting FoCUS is on par with that of cardiologists in performing echocardiography.[5] Distinct from conventional echocardiography, a "focused" echo is often dedicated to addressing very comprehensive clinical inquiries that arise in response to a specific diagnosis, employing minimal and highly effective echocardiography scans and procedures.[6]

Specific clinical indications for FoCUS include trauma, hypotension, suspected myocardial ischemia and aortic dissection, syncope, chest pain, or dyspnea. Use of FoCUS in the ED has the potential to enhance survival rates in cases of penetrating cardiac injury. Additionally, it can effectively assess systolic function of the heart, detect an effusion of the pericardium, diagnose heart failure, identify strain of the right heart, evaluate fluid status and responsiveness, and forecast short-term cardiac arrest consequences.[7-12]

Guidelines for FoCUS were devised by the American Society of Echocardiography (ASE) in 2013, and by the ESCVI in 2014 and the guideline observes five images (Sub-xiphoid, Inferior Vena Cava, Parasternal long- and short-axis and 4-chamber views).[13] The Cardiopulmonary Limited Ultrasound Examination (CLUE) protocol, which was developed by Kimura et al. in 2011, combines lung and heart ultrasound examinations and is carried out by general practitioners in outpatient clinics.[14] Furthermore, the Focus Assessed Transthoracic Echocardiography (FATE) protocol was created mostly by EPs, whereas the Focused Echocardiographic Evaluation in Life support (FEEL) protocol was developed primarily by anesthesiologists.[15, 16]

The majority of Emergency Medicine (EM) residency programs are required to offer training on ER ultrasound performed by EPs. Bedside FoCUS is one system scan that is integrated into ultrasound guidance for emergency physicians in various associations and training centers, including ACEP (American College of Emergency Physicians).[17] Advances in practitioners' abilities, such as in correctly capturing visuals and deciphering the outcomes, have not been thoroughly explored in other investigations.

Statement of the problem

When patients present with chest pain, breathing difficulties, syncope, or palpitations, emergency medicine residents are required to perform ultrasound scans in the emergency department. However, there is a considerable discrepancy in their ability to provide accurate and timely diagnoses of cardiovascular conditions in emergencies. Nevertheless, there are current problems with the availability of cardiac probes for emergencies and interpretation mistakes made by inexperienced trainees.[18] The ACEP Council of Directors Policy Statement advises that EM doctors complete 40 hours of training, including 150 ultrasound exams in total, of which 25 to 50 would include cardiac investigations.[19]

Many other low- and middle-income countries (LMICs) including Ethiopia face challenges in meeting the urgent need for echocardiographic examinations for critically ill patients due to a small number of cardiologists, cardiac sonographers, and well-trained Emergency Physicians (EPs) among several reasons.[20]

Many professional societies agree that teaching non-cardiologists how to perform FoCUS in acute care settings increases the effectiveness of care in urgent or pressing cardiac emergencies. Nevertheless, this training has not been widely implemented in many LMICs, and its educational effectiveness has not yet been verified, even though its utility is presumably greatest in these settings.[1, 21-23]

No study has yet to be performed to assess the competency of FoCUS interpretation among EM residents in Ethiopia that this study intended to do that by analyzing collected cardiac ultrasound pictures, to assess emergency medicine residents' FoCUS performance and interpretation skills.

Significance of the study

This study's primary goals are to evaluate the accuracy of ECCM residents' interpretations of FoCUS in TASH and SPHMMC, to uncover gaps in the evidence, and to investigate the reasons behind these discrepancies.

This study provides additional insight into how well EPs evaluate frequent life-threatening cardiovascular pathologies they encounter in the emergency room by determining their sensitivity, specificity, and Area Under Receiver Operator Characteristics (AUROC) curve of interpretations of some deadly cardiac emergency conditions.

The study suggests ways for the relevant department executives to enhance the FoCUS interpretation abilities of their residents.

2. Literature review

Global

According to Spencer, Kirk T. and Flachskampf, Frank A., FoCUS is the utilization of ultrasound as a supplemental test at the bedside to a physical examination. There is a great deal of evidence to suggest that non-cardiology-trained individuals who use smaller and compact US devices can evaluate enlargement of the Left Ventricular (LV), Right Ventricular (RV) or Left Atrial (LA), LV systolic failure, fluid around the heart, hypertrophy of the LV, and risen pressure gradient of Right Atrial (RA) with greater accurately than doing a physical medical evaluation. Furthermore, FoCUS-trained physicians may have the ability to do US imaging of bodily systems on top of the heart to support their cardiac evaluation.[24]

In a unanimous statement of the ASE and the ACEP, the time-sensitive evaluation of the symptomatic patient is the primary function of FoCUS. The main components of this examination include the detection of effusion of the pericardium, sizes of the chambers, overall cardiac ejection fraction, and volume state. LV size, ventricular function, IVC size, and respiratory variation can all be used to determine the state of intravascular volume. FoCUS is furthermore utilized to direct urgent invasive operations like pericardial tap or assess the insertion of an intravenous pacemaker. On FoCUS, other pathologic diagnoses, such as endocarditis, masses in the heart, thrombus in the LV, valve pathologies, Regional Wall Motion Abnormalities (RWMA), and dissection of the aorta, might be suspected.[25]

The "5Es" protocol (Effusion, Ejection, Equality, Exit, and Entrance) for teaching and practicing FoCUS was established by M. Kennedy Hall et al. based on their more than 12 years of expertise in a high-volume, academic emergency department. Each E stands for a particular examination of clinical data that is immediately important.[26]

In a study by Schneider et al., 19 1st year medical student with no prior knowledge to expertise with ultrasonography were given patients to scan under the direction of AI to get PLAX, Apical-four-chamber, and Apical-two-chamber images. Experts compared these images to scans they had previously performed on the same patients. The results showed that the medical students were more successful in obtaining diagnostic-quality views in the AP4 (86%) compared to the AP2 (68%) and parasternal long axis (58%) views, nonetheless overall, no less than one diagnostic scan visual was produced amongst 91% of the attempts.[27]

In a retrospective observational study conducted in the Seoul University Hospital Department of EM, a total of 1,652 bedside cardiac ultrasounds were performed during the research period. The study selected a set of 46 evaluations conducted by 23 emergency medicine residents through random sampling. According to experts A and B, the performance score climbed from 39.5 to 56.1 and 45.3 to 62.9, respectively (p-values for both were 0.01). A negative correlation was observed between younger age, higher early-phase score, and better confidence, and a larger improvement in performance in multivariable linear regression analysis, although the number of exams had a positive association.[18]

Ethiopia

Through the Toronto Addis Ababa Academic Collaboration in Emergency Medicine (TAAAC-EM), a survey was conducted by Aspler, A. et al., to determine the essential and comprehensive Point of Care Ultrasound (PoCUS) scans that should be embodied in the core residency PoCUS curriculum, known as "PoCUS1", at Addis Ababa University-Emergency Medicine. The survey involved faculty and residents from AAU EM, and it revealed that Focused Assessment with Sonography for Trauma (FAST), IVC, and lung (pneumothorax, pleural effusions, and interstitial syndrome) were identified as crucial introductory topics. The survey was completed by 16 residents, while 17 residents successfully finished the PoCUS1 program. The authors of the study successfully implemented a scalable fundamental PoCUS program for ECCM residents at AAU and provided three master trainers to ensure the continuity of the curriculum.[28]

A March 2023 publication on a cross-sectional study conducted in SPHMMC and TASH, by Tadesse, A.Z., et al. utilizing a survey conducted online to gather information from senior-year students in their second and third years ECCM residents, discovered that 27 (35.5%) of 76 respondents ranked their present level of expertise required for a sterile transducer is considered to be excellent, 28 (36.8%) were rated as fair in knobology, while 27 participants (35.5%) demonstrated a very good understanding of transducer selection knowledge. 32 (42.1%) people ranked their IVC interpretation abilities as very good. 26 (34.2%) said they had a good skill for interpreting FAST/EFAST and concluded that the main obstacles to the utilization of ultrasound were identified as the absence of ultrasound machines and a lack of organized curricula. To enhance their skills in the future, residents suggest that the availability of equipment, face-to-face training, and a well-structured curriculum should be prioritized.[29]

Stachura, M., et al., conducted an observational study in TASH ED, Addis Ababa, Ethiopia which involved a sample of 118 patients with clinical criteria of PoCUS, and the most common scan being pericardial among a total of 338 examination performed for 145 indications, (n = 78; 23%). In 53 (45%) patients, ultrasonography discoveries altered management of patients by modifying the working diagnosis, leading to a new therapy approach (n = 28; 24%), and/or modifying a disposition choice (n = 9; 8%) which led them to conclude that PoCUS offered clinically pertinent data for patient care, notably for polytrauma, undifferentiated shock and dyspnea, in this town, low-resource, educational emergency care center in Ethiopia.[22]

3. Objectives of the study

General objective

To evaluate accuracy in FoCUS interpretation among ECCM residents in TASH and SPHMMC.

Specific objectives

To assess FoCUS interpretation capabilities of TASH and SPHMMC ECCM residents.

To study the factors that affect the diagnostic accuracy of FoCUS in TASH and SPHMMC of ECCM residents.

To determine sensitivity, specificity, and AUROC of FoCUS interpretation by ECCM residents of AAU and SPHMMC in identifying deadly cardiac emergencies.

4. Methods and materials

Study setting and period

The research was carried out at TASH and SPHMMC in Addis Ababa. In association with AAU, the University of Wisconsin, and the University of Toronto, the Department of Emergency Medicine was founded at TASH in 2010 G.C. After receiving approval from the AAU Senate in October 2010, the department started a two-year ECCM nursing program and a three-year residency program. Emergency services were introduced at Saint Paul University in 2011. The duration of the study was 5 months from August to December 2023 G.C.

Study design

Institutional-based observational cross-sectional study.

Population

Target population

All ECCM residents attending all 7 institutions providing EM.

Source population

All ECCM residents of TASH and SPHMMC.

Study population

ECCM senior residents of TASH and SPHMMC.

Sampling frame/unit and method

Simple convenience sampling method from 91 senior residents (44 at TASH and 47 at SPHMMC).

Sampling size determination

In this section Za/2 is measure under the normal standard table for the given 95% confidence inte rval, and n is the required minimum sample size. P represents the best measurement of prevalenc e, because no previous research has been done in our nation; we increased the sample size by 50 %; d as the margin of error (0.05) when input in to the single population formula, n = (1.96).2*0. 5(1-0.5)/ (0.05)2 = **384**.

We utilized the correction formula, where n represents the sample size we calculate (384), N is th e total population (92), corrected sample size = n*N/ n+N = **74**, and we added a 10% non-respon se rate (Sample size/1-10%). This resulted in a sample size calculation of **82**.

Eligibility criteria

Inclusion criteria

All ECCM senior residents who were completing their residency programmes at SPHMMC and TASH.

Exclusion criteria

Residents not in their third year of study, as well as year two residents who have not completed the first six months of their year.[18]

Dependent variable(s)

Accuracy in interpretation of FoCUS of ECCM residents.

Independent variables

Presence of FoCUS training, year of residency, level of confidence, and degree of satisfaction.

Operational definitions

Accuracy – prior study done on the diagnostic Evaluation of ECCM residents' accuracy in lung US understanding took an accuracy of 80%.[30, 31]

Performance – the overall score of respondents out of fifteen cardiac ultrasound videos.

Senior resident – Residents in their third year of study, as well as year two residents who have completed the first six months of their year.[18]

FoCUS training – a training taken online or face-to-face directly training on FoCUS interpretation.

Data collection tool, methods, and procedures

Cardiac US videos were picked from the official ACEP website (Sonoguide // Echocardiography for Emergency Physicians (acep.org) and The PoCUS Atlas (TPA) with permission. The questionnaire was prepared, formatted, pretested and uploaded to Google Form. This questionnaire was given to the population which included basic information about the residents, training, image acquisition, and FoCUS ultrasound videos concentrating on typical life-threatening situations that happen in the emergency room.[18] The examination included a normal subxiphoid view, normal A4C view, normal PLAX view, normal PSAX view, normal IVC views, IVC with respiratory collapse, large IVC with minimal respiratory variability, RV thrombus on A4C view, a subxiphoid video of an effusion of the pericardium with tamponade physiology, PLAX view of hyperdynamic systolic function, PLAX view of reduced ejection fraction, A4C view of RV dilation and septal bowing, RWMA of LV, McConnell's sign, cardiac standstill. The residents were sent the FoCUS ultrasound videos via online platforms.

Data quality control

The lead investigator was in charge of data collection, and the replies were verified for completeness prior to putting them into the SPSS program. 3% of the study population underwent a pretest and a pilot Cronbach alpha test was performed for internal reliability and it was at 0.765.

Data processing and analysis

For tidying and analysis by the primary investigator, the completed questionnaires were coded, manually reviewed, and entered into SPSS version 27. To summarize the sociodemographic and background characteristics of the study population, descriptive statistics such as proportion, mean, and standard deviation were generated using tables and charts. To evaluate the comparison of the accuracy of FoCUS image identification between third- and second-year residents, a chi-square test was conducted. Univariate then multivariate binomial logistic regression analysis was used to find the characteristics that influence competency in interpreting FoCUS.

The AUROC was used to describe the accuracy of identifying deadly cardiac emergencies. To assess the existence and significance of the link, an Adjusted Odds Ratio [AOR] with a 95% confidence interval [CI] was produced. The P-value cutoff for statistical significance was 0.05.

Ethical considerations

After receiving approval from AAU's IRB for the Department of ECCM, TASH, data collecting commenced.

Plan for dissemination of results

The study should be published in credible journals and presented at conferences domestically and abroad.

5. Results

Demographic characteristics

During the study duration, of 93 eligible study subjects and calculated sample size of 82, 80 replied to the Google Form. The non-response rate was 2.4%. Out of the 80 respondents 56 (70%) were males and 24 (30%) were female, and the mean and median age were 29.85 and 30 years respectively with a SD of 1.576 (symmetric [skewness, 0.493] and light-tailed [kurtosis, 0.648], but not normally distributed with Kolmogorov-Smirnov (KS) test of significance below 0.001) (Figure 2). Among the total of 80 respondents, 41 (51.2%) were from TASH whereas 39 (48.8%) were from SPHMMC and 45 (56.3%) amongst the respondents were third-year residents (Figure 3).

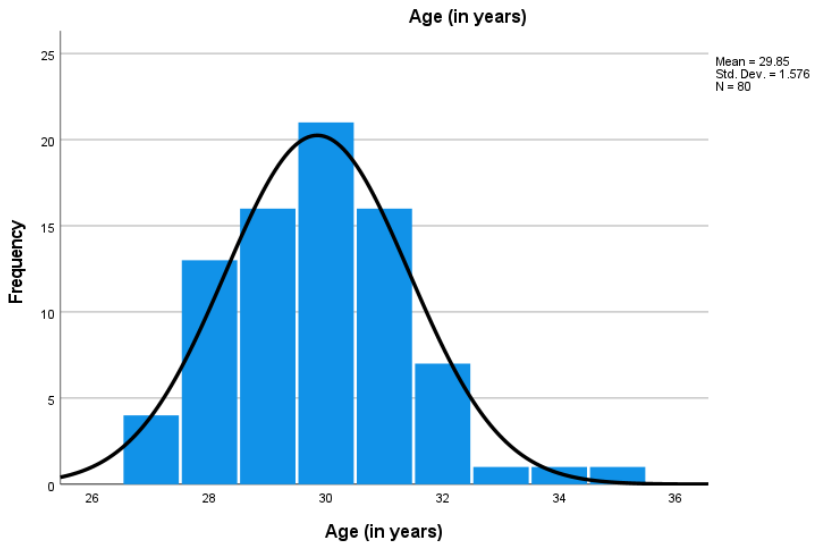

Figure 1: Age distribution, mean, and a SD in years

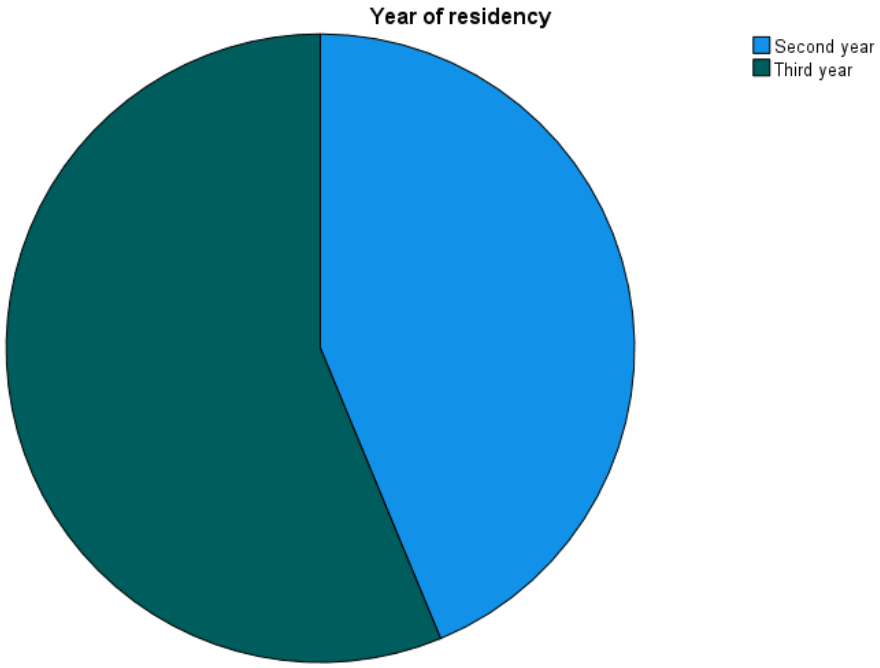

Figure 2: Year of residency

Training, skill, confidence, and satisfaction parameters

During their residency, 44 (55%) of the respondents received training on FoCUS; of those, 17 (21.3%) received the training on FoCUS during the first year of their residency, and all of them attended all of the training sessions. Furthermore, out of the 44 participants who received the training for FoCUS, 32 (72.7%) believe that the training was not enough. 41 (51.2%) of the 80 residents strongly agree that they have the skills to perform FoCUS in the ED.

The number of patients, for whom FoCUS applied for in one duty during the day, was more than four and at night time was two for 35 (43.8%) of the respondents. Nearly all 77 (96.3%) of the residents think they can properly acquire all 5 of the basic cardiac views, and the rest 3 can confidently acquire 4 of the basic views. 11 (13.8%) and 19 (23.8%) of the residents are very confident and somewhat confident in acquiring and interpreting FoCUS images respectively (Figure 4).

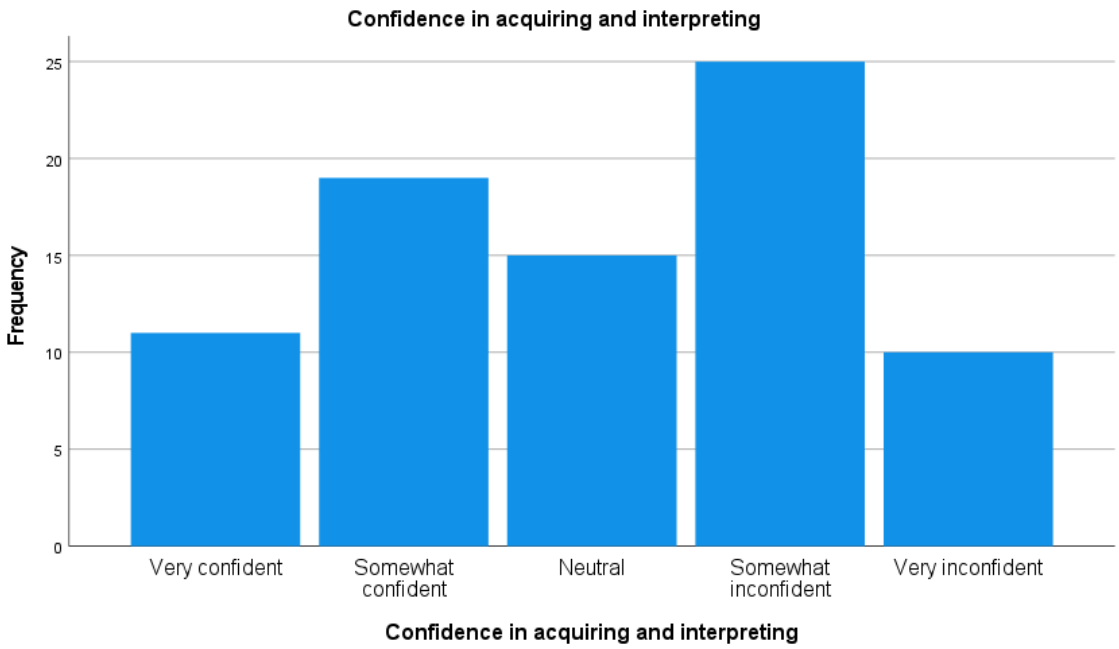

Figure 3: Confidence in acquiring and interpreting FoCUS images

When it comes to asking for help, 20 (25%) sometimes and only 8 (10%) never seek help (Figure 5). 73 (91.3%) from senior residents, 70 (87.5%) from consultants, 23 (28.7%) from radiologists, 47 (58.8%) from cardiologists, and 62 (77.5%) seek help from peers. Most of the respondents, 28 (35%), are somewhat dissatisfied with the current FoCUS training (Figure 6).

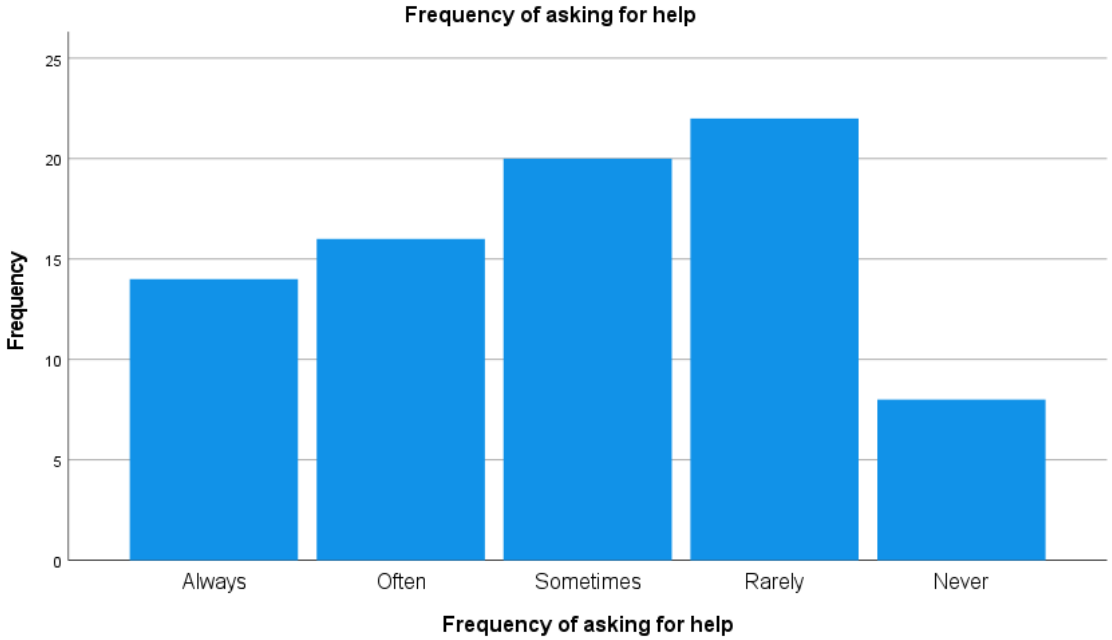

Figure 4: Frequency of asking for help

Figure 5: Level of satisfaction with FoCUS training

FoCUS findings interpretation

Out of the 80 respondents 38 (47.7%) correctly identified 12 or more of the FoCUS videos, the mean score was 11 with a SD of 2.267 (Table 1). The maximum and the minimum score were 15 and 6 respectively.

Table 1: Scores of FoCUS interpretation

Scores		Frequency	Percent
	6	3	3.8
	7	3	3.8
	8	10	12.5
	9	4	5
	10	8	10
	11	14	17.5
	12	14	17.5
	13	15	18.8
	14	7	8.8
	15	2	2.5
	Total	80	100.0

From all the provided videos 73 (91.3%) of the residents correctly identified collapsing IVC and 72 (90%) of the residents correctly identified cardiac standstill which are the most correctly identified variables, and RWMA was only correctly identified by 37 (46.3%) of the total residents (Table 2).

Table 2: Interpretation frequency and percentages

Videos	Correct	Incorrect
Collapsing IVC	73 (91.3%)	7 (8.8%)
Normal Subxiphoid view	64 (80%)	16 (20%)
Tamponade physiology	60 (75%)	20 (25%)
Normal PSAX	60 (75%)	20 (25%)
RV thrombus	55 (68%)	25 (31.3%)
RWMA	37 (46.3%)	43 (53.8%)
Plethoric IVC	66 (82.5%)	14 (17.5%)
Normal PLAX	54 (67.5%)	26 (32.5%)
Hyperdynamic function	63 (78.8%)	17 (21.3%)
Standstill	72 (90%)	8 (10%)
Reduced EF	70 (87.5%)	10 (12.5%)
D-Sign	41 (51.2%)	39 (48.8%)
Normal A4C	53 (66.3%)	27 (33.8%)
McConnell's Sign	47 (58.8%)	33 (41.3%)
Normal IVC	64 (80%)	16 (20%)

When the accuracy of correctly identifying a pathologic video was studied using AUROC it was 0.68 or 68% (acceptable or moderate level of accuracy) for tamponade physiology with statistical significance of 0.016 and 95%CI of between 0.546 and 0.815, the sensitivity and specificity was 81.7% and 40% respectively at a score of >=9.5 out of 15 questions.

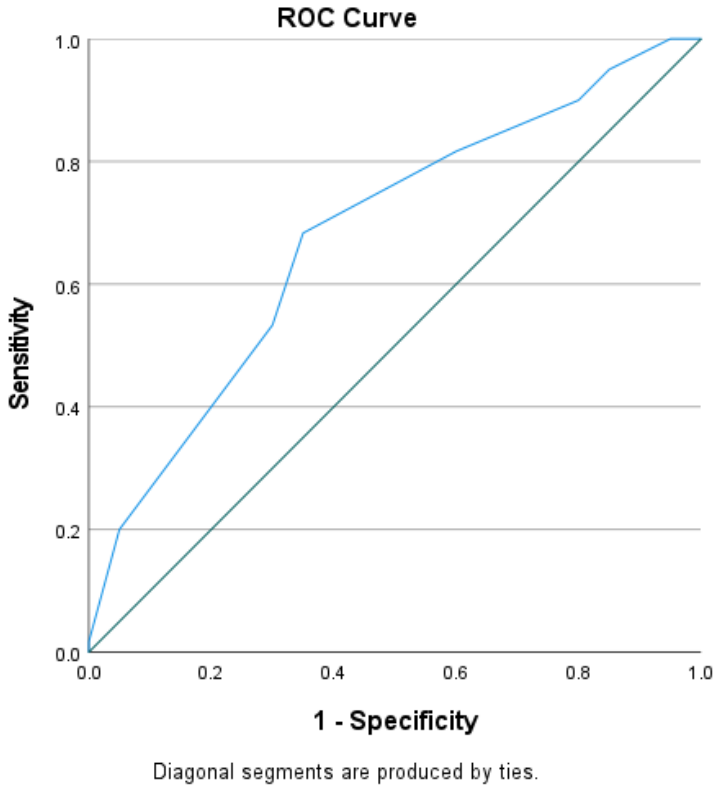

Figure 6: AUROC of 0.68 for identifying pathologic videos

When we assessed the comparison between second- and third-year residents on FoCUS interpretation using the Chi-square test, the videos with statistical significance indicated the third-year residents had better accuracy are identifying normal subxiphoid view, tamponade physiology, RV thrombus, D-sign, and McConnell's Sign at P-values of 0.010, 0.006, 0.048, 0.026, and 0.037 respectively.

In regression analysis, three independent variables were each studied using univariate then taken to multivariate binomial logistic regression model against the performance of the residents which is the dependent variable. Year of residency and frequency of asking for help are with, P-values of 0.035 and 0.012, Adjusted Odds Ratio of 12.434 and 0.577, and 95 CI of [1.189, 129.990] and [0.375, 0.888] respectively. Additional values are summarized in table 4.

Table 3: Comparison between residents in their second- and third year on FoCUS interpretation

	Second year		Third year		P-values
	Correct	Incorrect	Correct	Incorrect	
Collapsing IVC	30	5	43	2	0.230
Normal Subxiphoid view	23	12	41	4	0.010
Tamponade physiology	21	14	39	6	0.006
Normal PSAX	23	12	37	8	0.091
RV thrombus	19	16	36	19	0.014
RWMA	19	16	18	27	0.204
Plethoric IVC	28	7	38	7	0.604
Normal PLAX	22	13	32	13	0.434
Hyperdynamic function	24	11	39	6	0.059
Standstill	30	5	42	3	0.288
Reduced EF	30	5	40	5	0.741
D-Sign	13	22	28	17	0.026
Normal A4C	24	11	29	16	0.699
McConnell's Sign	16	19	31	14	0.037
Normal IVC	30	5	34	11	0.399

Table 4: Factors associated with accuracy of FoCUS interpretation

			COR [95% C.I.]				AOR [95% C.I.]	
	P-value	COR	Lower	Upper	P-value	AOR	Lower	Upper
FoCUS training during residency	0.023	2.889	1.154	7.229	0.276	0.272	0.026	2.828
Year of residency	0.003	4.118	1.594	10.638	*0.035	12.434	1.189	129.990
Frequency of asking for help	0.01	0.594	0.400	0.884	*0.012	0.577	0.375	0.888

AOR – Adjusted Odds Ratio, COR – Crude Odds Ratio, 95%CI – 95% Confidence Interval

* Statistically significant

6. Discussion

In this research project, the researchers made a discovery regarding the accuracy of FoCUS video interpretation among the respondents. Specifically, they found that 38 out of all of respondents, representing 38 (47.7%) of the total residents, were able to correctly identify the FoCUS videos that were provided to them through the Google Forms platform. This discovery gave insight on the level of proficiency exhibited by the respondents in interpreting the videos.

The study's results pointed out a greater level of accuracy in FoCUS video interpretation compared to previous studies conducted on ECCM residents, such as the study titled "Evaluation of ECCM residents' accuracy in Electrocardiogram Interpretation" conducted in 2021.[32] In that particular study, none of the ECCM residents were found to be accurate in interpreting ECGs.

The disparity in accuracy levels between the two studies can be attributed to several factors. First, despite exploring accuracy on nearly the same group of respondents, the type of study differed. The current study focused on evaluating the accuracy of FoCUS video interpretation, while the previous study concentrated on ECG interpretation. The difference in the imaging modality and the specific skills required for interpretation could account for the contrasting results.

Additionally, it is worth considering the exponential changing nature of Emergency Medicine, which may have contributed to the higher accuracy level observed in the current study. Over the past few years, there have been advancements in technology, increased access to devices, and improved training opportunities. These factors could have positively influenced the residents' ability to interpret FoCUS videos accurately.

In this study, the researchers utilized a total of 15 videos that encompassed a diverse range of pathologies and normal cases. The selection of videos was guided by the unanimous statement of the ASE and ASEP. This statement underlines the value of exposing trainees in FoCUS to a variety of studies that represent the spectrum of pathologies they are ought to recognize at their respective training levels that allows for a more robust evaluation of the trainees' proficiency in identifying abnormal findings as well as distinguishing them from normal studies.[25]

The study found that a significant proportion of senior residents demonstrated competence in identifying specific pathologies. Specifically, 73 (91.3%) of the senior residents were successful in properly identifying collapsing IVC, while 72 (90%) accurately identified cardiac standstill. These pathologies were among the most correctly identified variables in the study.

On the other hand, RWMA was the least correctly identified variable, with only 37 (46.3%) of the senior residents able to recognize it. This lower identification rate could potentially be attributed to several factors. Firstly, it is possible that the senior residents had minimal exposure RWMA during their training, which may have limited their familiarity with this specific pathology. Secondly, the lack of proper phased array probes, which are instrumental in assessing cardiac function, could have affected their ability to detect and interpret RWMA accurately. Lastly, the study suggests that a prevalent problem in many impoverished countries' emergency departments is an absence of expertise in the identification and interpretation RWMA.[20]

To evaluate the comparison of the accuracy of FoCUS image identification between third- and second-year residents, a chi-square test was conducted. The year of residency was considered an independent factor that could potentially influence the accuracy of identifying FoCUS images. The results of the test indicated that third-year residents demonstrated statistically significant improvements over second-year residents in identifying specific FoCUS images, such as the normal subxiphoid view, tamponade physiology, RV thrombus, D-sign, and McConnell's Sign.

A separate study undertaken in 2023, which examined the accuracy of PoCUS among the same group of residents, it was found that third-year residents were able to accurately identify lung consolidation and lung metastasis. The statistical analysis showed significant P-values of 0.031 and 0.042, respectively, indicating their improved proficiency compared to second-year residents in identifying these specific pathologies.[30]

Accuracy was 68% with sensitivity and specificity of identifying deadly cardiovascular pathology (cardiac tamponade) was 81.7% and 40% respectively if they can correctly identify >=9.5 of the rest of the videos provided among EM residents of AAU and SPHMMC.

Furthermore, the researchers were able to identify the factors that influenced the accuracy of the residents in identifying FoCUS videos through the utilization of binary logistic regression analysis model.

After conducting the Hosmer-Lemeshow goodness-of-fit test on the logistic regression models to ensure the validity of the results, it was determined that the year of residency was the most significant independent factor affecting accuracy. The adjusted odds ratio [OR] was calculated to be 12.434, with a 95% confidence interval [CI] of 1.189 to 129.990 and a significant P-value of 0.035. This indicates that third-year residents were at 12.434 odds or 12.434-fold more likely to correctly identify FoCUS videos compared to second-year residents. And participants with more frequency of asking for help were 42.3% less likely to be accurate. When the researchers compared these data to a prior study in a similar space, they discovered that the level of residency was likewise an independent factor influencing the residents' accuracy in identifying ECG at an Adjusted Odds Ratio [OR] level of 3.34.[32]

7. Study limitations and strengths

Some of the drawbacks were the absence of clinical data provided to the respondents that have an impact on their judgment and accuracy in interpreting the FoCUS videos.

Additionally, the study's limitation of including residents only from AAU and SPHMMC restricts the applicability of the findings to a broader population of residents.

The study involved collaboration between TASH and SPHMMC, which strengthens the credibility and validity of the research.

8. Conclusion

In conclusion, this study addresses a major gap in the scientific literature by investigating the accuracy of FoCUS among ECCM residents at TASH and SPHMMC. Through this research, 38 (47.7%) of respondents demonstrated the capability to accurately identify FoCUS videos, with the accuracy increasing with the year of residency, consistent with findings in related fields. Furthermore, a substantial percentage of respondents expressed dissatisfaction with the available training, highlighting the importance for improvements in the educational resources provided. Importantly, it was found that collapsing IVC and cardiac standstill were the most commonly identified pathologies, while regional wall motion abnormality was the least frequently identified.

9. Recommendation

Conforming to the findings of this research, the authors recommend to improve the practice of FoCUS among ECCM residents in the ED through enhanced training programs, incorporating simulated practice, promoting continuous education and skill maintenance, providing mentorship and supervision, and fostering collaborative efforts between institutions. These recommendations aim to optimize FoCUS interpretation skills and ensuring high-quality patient care in emergency care settings.

10. Work plan

Table 5: Work Plan

	Time by week (Starting from March to December 2023 G.C.)																																		
Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Prepare proposal																																				
Submission of proposal for advisor review																																				
Finalize proposal for IRB submission																																				
IRB review																																				
Commence research work																																				
Data collection																																				
Data analysis																																				
Write up a draft thesis																																				
Review by advisor																																				
Finalize thesis write-up																																				
Submission for defense																																				
Revise thesis																																				
Final submission																																				

11. References

1. Via G, Hussain A, Wells M, Reardon R, ElBarbary M, Noble VE, et al. International evidence-based recommendations for focused cardiac ultrasound. Journal of the American Society of Echocardiography : official publication of the American Society of Echocardiography. 2014;27(7):683.e1-.e33.
2. Patel AR, Patel AR, Singh S, Singh S, Khawaja IJC. Cardiac ultrasound in the intensive care unit: a review. 2019;11(5).
3. Adhikari S, Fiorello A, Stolz L, Jones T, Amini R, Gross A, et al. Ability of emergency physicians with advanced echocardiographic experience at a single center to identify complex echocardiographic abnormalities. The American Journal of Emergency Medicine. 2014;32(4):363-6.
4. Neskovic AN, Edvardsen T, Galderisi M, Garbi M, Gullace G, Jurcut R, et al. Focus cardiac ultrasound: the European Association of Cardiovascular Imaging viewpoint. European Heart Journal - Cardiovascular Imaging. 2014;15(9):956-60.
5. Farsi D, Hajsadeghi S, Hajighanbari MJ, Mofidi M, Hafezimoghadam P, Rezai M, et al. Focused cardiac ultrasound (FOCUS) by emergency medicine residents in patients with suspected cardiovascular diseases. Journal of Ultrasound. 2017;20(2):133-8.
6. T Arntfield R, J Millington SJCcr. Point of care cardiac ultrasound applications in the emergency department and intensive care unit-a review. 2012;8(2):98-108.
7. Plummer D, Brunette D, Asinger R, Ruiz E. Emergency department echocardiography improves outcome in penetrating cardiac injury. Annals of Emergency Medicine. 1992;21(6):709-12.
8. Moore CL, Rose GA, Tayal VS, Sullivan DM, Arrowood JA, Kline JA. Determination of left ventricular function by emergency physician echocardiography of hypotensive patients. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 2002;9(3):186-93.
9. Russell FM, Ehrman RR, Cosby K, Ansari A, Tseeng S, Christain E, et al. Diagnosing acute heart failure in patients with undifferentiated dyspnea: a lung and cardiac ultrasound (LuCUS) protocol. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 2015;22(2):182-91.
10. Weekes AJ, Thacker G, Troha D, Johnson AK, Chanler-Berat J, Norton HJ, et al. Diagnostic Accuracy of Right Ventricular Dysfunction Markers in Normotensive Emergency Department Patients With Acute Pulmonary Embolism. Ann Emerg Med. 2016;68(3):277-91.
11. Barbier C, Loubières Y, Schmit C, Hayon J, Ricôme JL, Jardin F, et al. Respiratory changes in inferior vena cava diameter are helpful in predicting fluid responsiveness in ventilated septic patients. Intensive care medicine. 2004;30(9):1740-6.
12. Ultrasound Guidelines: Emergency, Point-of-Care and Clinical Ultrasound Guidelines in Medicine. Ann Emerg Med. 2017;69(5):e27-e54.
13. Yamada H, Ito H, Fujiwara M. Cardiac and vascular point-of-care ultrasound: current situation, problems, and future prospects. Journal of medical ultrasonics (2001). 2022;49(4):601-8.
14. Kimura BJ, Yogo N, O'Connell CW, Phan JN, Showalter BK, Wolfson T. Cardiopulmonary limited ultrasound examination for "quick-look" bedside application. The American journal of cardiology. 2011;108(4):586-90.
15. Breitkreutz R, Price S, Steiger HV, Seeger FH, Ilper H, Ackermann H, et al. Focused echocardiographic evaluation in life support and peri-resuscitation of emergency patients: a prospective trial. Resuscitation. 2010;81(11):1527-33.
16. Kratz T, Exner M, Campo dell'Orto M, Timmesfeld N, Schüttler KF, Efe T, et al. A pocket-sized hand held ultrasound system for intraoperative transthoracic echocardiography by anaesthesiologists: A feasibility study. Technology and health care : official journal of the European Society for Engineering and Medicine. 2016;24(3):309-15.
17. ACEP. ACEP cardiology, sonoguide [Available from: https://www.acep.org/sonoguide/basic/cardiac/.
18. Kim KH, Jung JY, Park JW, Lee MS, Lee YH. Operating bedside cardiac ultrasound program in emergency medicine residency: A retrospective observation study from the perspective of performance improvement. PloS one. 2021;16(4):e0248710.
19. Stewart WJ, Douglas PS, Sagar K, Seward JB, Armstrong WF, Zoghbi W, et al. Echocardiography in Emergency Medicine: A Policy Statement by the American Society of Echocardiography and the American College of Cardiology. Journal of the American Society of Echocardiography. 1999;12(1):82-4.
20. Waweru-Siika W, Barasa A, Wachira B, Nekyon D, Karau B, Juma F, et al. Building focused cardiac ultrasound capacity in a lower middle-income country: A single centre study to assess training impact. African Journal of Emergency Medicine. 2020;10(3):136-43.

21. Becker DM, Tafoya CA, Becker SL, Kruger GH, Tafoya MJ, Becker TKJTM, et al. The use of portable ultrasound devices in low-and middle-income countries: a systematic review of the literature. 2016;21(3):294-311.
22. Stachura M, Landes M, Aklilu F, Venugopal R, Hunchak C, Berman S, et al. Evaluation of a point-of-care ultrasound scan list in a resource-limited emergency centre in Addis Ababa Ethiopia. 2017;7(3):118-23.
23. Acar Y, Tezel O, Salman N, Cevik E, Algaba-Montes M, Oviedo-García A, et al., editors. 12th WINFOCUS world congress on ultrasound in emergency and critical care. Critical ultrasound journal; 2016: SpringerOpen.
24. Spencer KT, Flachskampf FA. Focused Cardiac Ultrasonography. JACC: Cardiovascular Imaging. 2019;12(7, Part 1):1243-53.
25. Labovitz AJ, Noble VE, Bierig M, Goldstein SA, Jones R, Kort S, et al. Focused cardiac ultrasound in the emergent setting: a consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. Journal of the American Society of Echocardiography : official publication of the American Society of Echocardiography. 2010;23(12):1225-30.
26. Kennedy Hall M, Coffey EC, Herbst M, Liu R, Pare JR, Andrew Taylor R, et al. The "5Es" of emergency physician-performed focused cardiac ultrasound: a protocol for rapid identification of effusion, ejection, equality, exit, and entrance. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 2015;22(5):583-93.
27. Schneider M, Bartko P, Geller W, Dannenberg V, König A, Binder C, et al. A machine learning algorithm supports ultrasound-naïve novices in the acquisition of diagnostic echocardiography loops and provides accurate estimation of LVEF. The international journal of cardiovascular imaging. 2021;37(2):577-86.
28. Aspler A, Kegel F, Beyene T, Zewdu T, Tesfaye B, McKnight A, et al. Establishing a Self-sustaining Emergency Medicine Point-of-Care Ultrasound Curriculum in an Academic Teaching Hospital in Ethiopia. Ethiopian journal of health sciences. 2022;32(3):533-8.
29. Tadesse AZ, Abicho TB, Alemu DM, Aspler AJEMI. Point of Care Ultrasound (POCUS) Utilization and Barriers by Senior Emergency Medicine and Critical Care Residents at Two Teaching Referral Hospitals, Addis Ababa, Ethiopia. 2023;2023.
30. Beyene T. Evaluation of Emergency and Critical Care Medicine residents' diagnostic accuracy in lung ultrasound interpretation in Addis Ababa, Ethiopia: a cross-sectional study at two public teaching hospitals. 2023.
31. Arbelot C, Dexheimer Neto FL, Gao Y, Brisson H, Chunyao W, Lv J, et al. Lung ultrasound in emergency and critically ill patients: number of supervised exams to reach basic competence. Anesthesiology. 2020;132(4):899-907.
32. Dr. Meron Tesfaye DTZ, Dr. Demmelash Gezahegn. Evaluation of emergency and critical care medicine residents' accuracy in Electrocardiogram Interpretation in Addis Ababa Ethiopia. 2021.

Annexes

Annex 1: Consent form and information sheet

I am Dr. Nahom Mesfin, a third-year resident at Addis Ababa University, Tikur Anbessa Specialized Hospital, Emergency and Critical Care Medicine Department. As for the partial fulfillment of the academic year, I am doing this research on the accuracy of Focused Cardiac Ultrasound (FoCUS) perspective among Emergency and Critical Care Medicine residents in Addis Ababa, Ethiopia.

I would appreciate you taking your valuable time to fill out this online Microsoft Form as it is essential for me to comprehend my research question. This will only be used for educational purposes and your identity will be kept confidential.

People to contact for additional information: If you have any questions, you can reach the primary investigator at the address below:

Name: Dr. Nahom Mesfin

Tel: +251920935180

Email: nahom.mesfin@aau.edu.et

Contact details for the complaint : Have you any concerns that the research team is acting fraudulently or improperly, please contact Addis Abeba University, College of Health Sciences, Department of Emergency and Critical Care Medicine, at the address below:

Email: emergencymedicine.som@aau.edu.et

If you agree to engage in this study, I appreciate your honesty.

Annex 2: data collection tool questionnaire

Section 1 - Please choose your answers for the questions.

1. Your age (in years):
2. Your gender
   A. Male **B.** Female
3. Where are you doing your postgraduate training?

A. AAU **B.** SPHMMC

4. Your year of residency?

A. 2nd year **B.** 3rd year

5. Have you received FoCUS training throughout your residency program?

A. Yes, I did **B.** No, I did not

6. If you answered yes, I did for question 5, at which of residency?
7. If you answered yes, I did for question 5, have you received all the training?

A. Yes, I did **B.** No, I did not

8. If you answered yes, I did for question 5, do you think the amount of FoCUS teaching was enough?

A. Yes, it was **B.** No, it was not **C.** Maybe

9. Your level of agreement about your skills to use ultrasound in the ED? (Including selecting probe, changing gain and depth, storing image)
   (Strongly agreement through strong disagreement)
10. Number of patients you use FoCUS for in a single day shift?
A. <2 **B.** 2 **C.** 3 **D.** 4 **E.** >4
11. Number of patients you use FoCUS for in a single night shift?
A. <2 **B.** 2 **C.** 3 **D.** 4 **E.** >4
12. How many fundamental views in adult cardiac ultrasonography can be correctly acquired? (PLAX, PSAX, A4C, Sub-xxiphiod-4C, IVC)
    (None and 1 through 5).
13. What is your level of confidence in your ability to acquire and understand proper FoCUS images?
    (Very confident through lack of confidence and extremely unconfident)
14. How frequently do you ask for help in interpreting those FoCUS scans?
    (All the time, often, sometimes, rarely, never)
15. Who do you turn to for assistance?
A. Senior resident **B.** ECCM consultant **C.** Radiologists/cardiologists **D.** Peers
16. How would you describe your satisfaction with present FoCUS training in the emergency department? (Very or somewhat satisfied through neutral, somewhat and very dissatisfied)

Section 2 - Please see the FoCUS videos below and write the cardiac view you see and the clinical findings in the space provided below each video.

1. Cardiac Video 1 Inferior Vena Cava with -50- Respiratory Collapse
2. Cardiac Video 2 Normal Subxiphoid View
3. Cardiac Video 3 Subxiphoid View of Pericardial Effusion with Cardiac Tamponade Physiology
4. Cardiac Video 4 Normal Parasternal Short Axis View
5. Cardiac Video 5 RV thrombus
6. Cardiac Video 6 Regional Wall Motion Abnormality
7. Cardiac Video 7 Large Inferior Vena Cava with Minimal Respiratory Collapse
8. Cardiac Video 8 Normal Parasternal Long Axis View
9. Cardiac Video 9 Parasternal Long Axis View of Hyperdynamic Systolic Function
10. Cardiac Video 10 Cardiac Standstill
11. Cardiac Video 11 Parasternal Long Axis View of Severely Reduced Systolic Function
12. Cardiac Video 12 Parasternal Short Axis View with D Sign
13. Cardiac Video 13 Normal Apical Four Chamber View
14. Cardiac Video 14 McConnell's Sign
15. Cardiac Video 15 Normal Inferior Cava with Mild Respiratory Collapse