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ORIGINAL RESEARCH

The transthoracic echocardiographic skills of registrars in a department of anaesthesiology

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Background: Research has shown the value of integrating point-of-care ultrasonography (POCUS) into daily practice and has highlighted the lack of competency in transthoracic echocardiographic (TTE) skill among anaesthesiology registrars. The aim of this study was to determine the level of TTE skill of anaesthesiology registrars at the University of the Witwatersrand (Wits) using an objective structured clinical examination (OSCE).

Methods: This research study employed a cross-sectional research design. Convenience sampling was used and 27 registrars were enrolled in this study. The OSCE consisted of two practical stations (Stations 1 and 2) and two clinical pathology stations (Stations 3 and 4). Adequate TTE skill was defined as competency in both the practical and clinical stations and an overall pass score of 70% was used.

Results: The overall mean (SD) score obtained for the OSCE was 45.2% (23%). In comparing the TTE skill of registrars who have completed a cardiac rotation and have completed an accredited course with those who have not, no significant differences were found in the pass scores. Registrars who had completed an accredited TTE course performed significantly better in Stations 3 and 4 ($p = 0.014$). Of the registrars, 37% obtained a pass score for practical stations and 14.8% for the clinical stations with only 11.1% achieving an overall pass score indicating TTE competency. No significant difference in pass scores was found with the different categories of registrars. There was a strong positive significant correlation between completing more TTEs and the scores obtained ($r = 0.540$, $p = 0.004$). Completing more TTEs was associated with a higher score.

Conclusion: Findings from this study suggest that the current skill level of registrars performing TTEs at our department is not sufficient to achieve clinical competency and that the training may not be initiated early enough in the registrar programme.

Keywords: point-of-care ultrasonography, echocardiography, objective structured clinical examination, transthoracic echocardiography

Introduction

Ultrasound plays an important role in improving procedural safety and diagnostic accuracy. It has become widely accepted as a diagnostic and procedural tool, but the application thereof was previously limited to specialist radiographers.[1] With the advances in technology, portable ultrasound machines have become more affordable and more widely available to other medical disciplines.[1,2] Over the last two decades, advances in technology have led to ultrasonography being incorporated more frequently into clinical practice.[1,2] The bedside application of ultrasound has since become referred to as point-of-care ultrasonography (POCUS).[1-5] Emergency medicine, cardiac anaesthesia and critical care were among the first disciplines to incorporate this skill into their daily practice.[2,6] As the applications of POCUS have expanded and new research has validated and emphasised benefits for the clinician, many other medical disciplines have begun to integrate POCUS into their daily practice, including anaesthesia with its perioperative applications.[4] This has resulted in a greater need for clinicians to be trained and accredited in the use of POCUS.[3] Consequently, a number of courses, protocols and curricula have been developed and subsequently implemented across clinical medical disciplines in registrar training and at undergraduate level.[6]

In today's practice, all anaesthetists should have a basic level of ultrasound understanding and proficiency.[7] Kathrada et al.[8] highlights that ultrasound equipment is freely available to most South African anaesthetists but that very few of them are completely comfortable in performing POCUS and desire further training. They concluded that POCUS training should be formalised in a curriculum and made more accessible.[8] The European Association of Cardiovascular Imaging (EACVI)[9] states that the level of competence in echocardiography must be the same for emergency and elective cases, as well as for cardiologists and non-cardiologists. There is limited evidence for the assessment of competency in POCUS. Poor competency in transthoracic echocardiographic (TTE) skill in anaesthesiology registrars has been shown.[2,5] The aim of this study was to determine the level of TTE skill of anaesthesiology registrars at the University of the Witwatersrand (Wits) using an objective structured clinical examination (OSCE).

Methods

Approval to conduct the study was obtained from the University of the Witwatersrand Human Research Ethics Committee (M191101) and other relevant authorities. Written informed

consent was obtained from all participants. This research study employed a cross-sectional research design.

The study population consisted of 112 registrars working in the Department of Anaesthesiology at Wits. The sample size was determined in consultation with a biostatistician using EpiInfo version 6 taking into account the mean and standard deviation (SD) values of previous studies.[5,7,10,11] A sample size of 26 participants would give a power of greater than 80% with a level of confidence of 95% and a significance of 5%. Convenience sampling was used.

A draft OSCE was compiled and reviewed by three cardiothoracic anaesthesiologists and a specialist cardiologist. Their recommendations were incorporated into the final OSCE. The OSCE consisted of two practical and two clinical stations:

- Station 1 – the parasternal long-axis TTE view
- Station 2 – the apical four-chamber TTE view
- Stations 3 and 4 – each displaying a real-time echocardiographic cine loop, a cardiac tamponade and a hypertrophic obstructive cardiomyopathy

Aspects of assessment for Stations 1 and 2 included appropriate orientation, depth and gain, overall image quality and target anatomy in each view. The overall image quality was assessed using a global rating scale (GRS).[12] Stations 3 and 4 each required the registrar to assess a TTE cine loop and identify the view used, pathology present and echocardiographic diagnosis. The two pathology stations chosen represent important clinical cases where the findings will impact the clinical decision-making and management.

The OSCE was conducted in the Faculty of Health Sciences Simulation Laboratory at Wits. Registrars signed a consent form and provided demographic data, and were allocated a time slot. The study used two ultrasound platforms (Mindray M7 Premium units; Mindray Bio-Medical Electronics Co., Ltd.; Shenzhen, Guangdong Province, China) with the necessary software and adult cardiac echocardiographic probes required to perform TTE examinations. Each platform was equipped with a phased array P4-2s transducer. The two echocardiographic cine loops were displayed on laptop screens. Two cardiothoracic anaesthesiologists from the department, who are Focused assessed transthoracic echocardiography (FATE) trained, assessed Stations 1 and 2, respectively. Two healthy male anaesthetists from the department were used as examination subjects. The anaesthetists were assessed to exclude any underlying pathology and abnormalities prior to the OSCE. Each station took 90 seconds to complete. The assessors graded the first two stations immediately and Stations 3 and 4 were graded at a later stage by a different cardiac anaesthesiologist from the department. The registrars received feedback on their results upon request.

A junior registrar in this study was defined as a registrar who had not completed the cardiac component of training and a senior registrar was defined as one who had. At Wits a cardiac rotation is considered a senior registrar rotation and denotes exposure to POCUS, specifically transoesophageal echocardiography (TOE) but also TTE. The cardiac component refers to the completion of the six-week cardiac anaesthesia component of the 12-week cardiac rotation. For this OSCE, adequate TTE skill was defined as competency in both the practical (Stations 1 and 2) and clinical (Stations 3 and 4) stations and an overall pass score of 70% was used. The pass score was determined in consultation with senior cardiothoracic anaesthesiologists and a cardiologist. Image quality was assessed using a GRS,[11] which is a standardised and validated method of assessing performance-based examinations, with a score ranging from 1 to 5.

Data were analysed in consultation with a biostatistician using the statistical program STATA version 13.1 (StataCorp, USA). Categorical variables were described using numbers and percentages. Numerical variables were described using means and SDs or medians and interquartile ranges (IQRs), depending on the distribution of the data. An independent t-test was used to compare scores between senior and junior registrars, between those who had passed an accredited ultrasound course and those who had not, and those who have performed clinical echocardiography and those who have not. A Wilcoxon rank-sum test was used for non-parametric paired data. A Pearson's correlation was done between the number of TTEs performed and the average scores for the stations. A *p*-value of less than or equal to 0.05 was considered statistically significant.

Results

All registrars in the departments were invited to take part in the study and a total of 28 registrars accepted the invitation and were enrolled in the study. One of the registrars had done over 200 clinical TTEs and was therefore an outlier and was excluded from the analysis. The participants' characteristics are shown in Table I.

Table I: Characteristics of participants

Characteristic	Number	Percentage
Year of registrar training		
• 1	3	11.1
• 2	6	22.2
• 3	8	29.6
• ≥ 4	10	37
Completed cardiac rotation		
• Yes	11	40.7
• No	16	59.3
Accredited TTE course completed		
• Yes	7	25.9
• No	20	74.1
Course completed within last 6 months		
• Yes	2	28.6
• No	5	71.4
TTE performed		
• At least once	14	51.9
• Never	13	48.1
Frequency of TTE performance		
• Weekly	1	3.7
• Monthly	5	18.5
• Less than monthly	21	77.8

Table II: Scores obtained for the OSCE

	Maximum achievable score	Pass%	Mean	SD	Min	Max
Station 1	14	33.3	7.2	4.3	2	14
Station 2	14	29.6	6.8	3.9	2	14
Stations 1 and 2 (%)	100	37	49.6	26.1	14	100
Station 3	5	14.8	1.7	1.4	0	5
Station 4	5	14.8	1.6	1.5	0	5
Stations 3 and 4 (%)	100	14.8	32.6	24.3	0	90
All stations	38	14.8	17.2	8.8	5	35
Percentage	100		45.2	23	13	92

Table III: Comparison of scores of candidates who have completed a cardiac rotation, completed an accredited TTE course and performed more than one TTE, and those who have not

	Score Mean (SD) %	*p*-value
Completed cardiac rotation		
Stations 1 and 2		
• Yes	50.1 (29.4)	
• No	49.3 (24.6)	0.941
Stations 3 and 4		
• Yes	39.1 (27.7)	
• No	28.1 (21.4)	0.257
All stations		
• Yes	47.4 (24.5)	
• No	43.8 (22.7)	0.697
Completed accredited TTE course		
Stations 1 and 2		
• Yes	55.9 (31.7)	
• No	47.5 (24.4)	0.474
Stations 3 and 4		
• Yes	53.8 (24.5)	
• No	26.0 (20.6)	0.014
All stations		
• Yes	59.5 (26)	
• No	41.8 (22.3)	0.205
Performed TTE		
• Yes	56.1 (25.4)	
• No	36.2 (18.7)	0.028

The participants had done a median (IQR) number of TTEs of 1 (0–8.3), with a range of 0–30. Of the 14 participants who had previously performed TTEs, the median (IQR) number of TTEs performed was 5 (0–9.5) with a range of 1–30.

The overall mean (SD) score obtained for the OSCE was 45.2% (23%), with five (18.5%) participants obtaining a pass score. The scores obtained for the four stations are shown in Table II.

There was a significant difference between the scores obtained for Stations 1 and 2 and Stations 3 and 4 ($p = 0.002$). The comparisons between the scores of those who have completed a cardiac rotation and those who have not, between those who have done an accredited TTE course and those who have not, and those who have performed one or more TTEs in clinical practice and those who have not, are shown in Table III. Comparing the level of TTE skill for Stations 1 and 2, Stations 3 and 4 and all stations overall between those who have completed cardiac rotation and those who have not, no significant differences were found. However, those who had completed an accredited course performed significantly better in Stations 3 and 4 ($p = 0.014$).

Table IV: Assessment of competency

	Pass	Fail	*p*-value
Completed cardiac rotation			
• Yes	2	9	
• No	3	13	1.000
Accredited TTE course done			
• Yes	2	5	
• No	3	17	0.580
Performed TTE			
• Yes	4	10	
• No	1	12	0.326

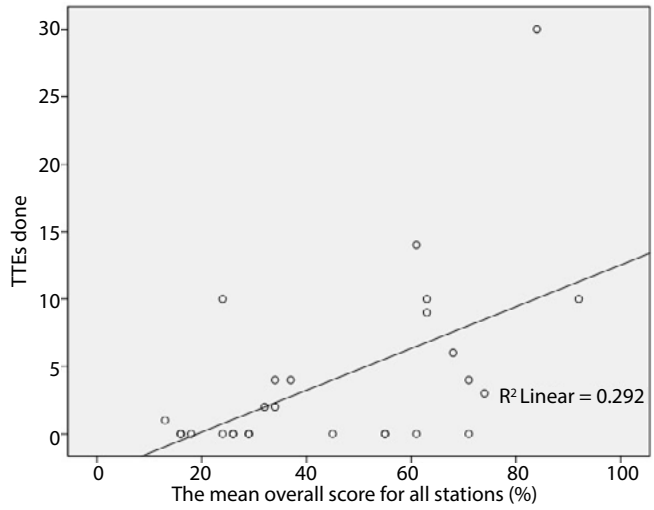
The comparisons between pass and fail of those who have completed a cardiac rotation, those who have done an accredited TTE course and those who have performed one or more TTEs in clinical practice and those who have not, are shown in Table IV. No significant differences were found.

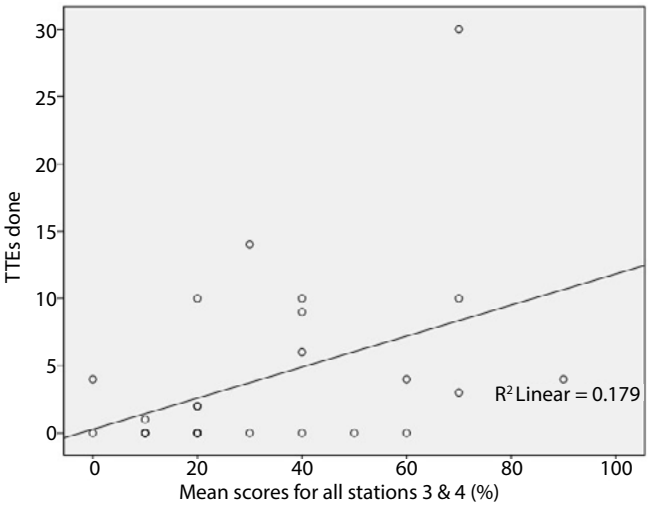
Three participants had completed a cardiac rotation, performed TTEs and completed an accredited course; however, no significant difference in their performance was found compared to the other 24 participants ($p = 0.175$). The overall mean (SD) for these three participants was 53.3 (16.7).

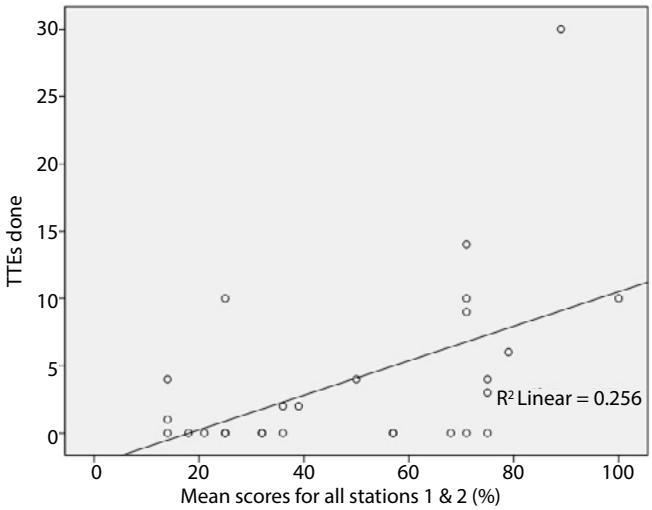
The correlations between the number of TTEs done and the scores obtained for Stations 1 and 2, Stations 3 and 4 and all stations, and the interpretation thereof are shown in the scatter plots in Figure 1. There is a strong positive correlation between the number of TTEs done and the TTE scores for Stations 1 and 2 ($r = 0.506$, $p = 0.007$), Stations 3 and 4 ($r = 0.423$, $p = 0.028$) and mean overall score ($r = 0.540$, $p = 0.004$). Completing more TTEs was associated with a higher score.

Discussion

As POCUS expands and becomes part of the clinicians' daily practice, there is an increased need for the ongoing assessment, improvement of skill and maintenance of standards in this field.[2] Therefore, there is a need for the development of curricula and training protocols as part of a registrar training programme.[6] Rebel et al.[5] found that anaesthesiology registrars' exposure to and clinical use of ultrasound was not sufficient for developing competency in POCUS. The American Society of Echocardiography (ASE)[14] recommends an ongoing training,







	Stations 1 and 2	Stations 3 and 4	Stations All
Strength	Strong	Moderate	Strong
r-value	0.506	0.423	0.540
p-value	0.007	0.028	0.004

Figure 1: Correlations between the number of TTEs performed and scores obtained

assessment and accreditation process. It is essential that all clinicians, including anaesthetists, have a basic level of ultrasound understanding and proficiency.[7] There has been a drive to incorporate ultrasound education into accredited registrar training programmes as well as at an undergraduate level.[14]

In our study, the mean score was 45.2%, with 11.1% of participants achieving an overall pass score. These results are similar to Ramsingh et al.[15] who found a baseline score of 48% among anaesthesiology registrars. Rebel et al.[5] had a 13% pass rate for the TTE practical stations and a 40% success rate for the TTE pathology station, but did not state the set pass score for the OSCE. In our study, the pass score was set at 70%; 37% of registrars passed the practical stations and 14.8% passed the clinical stations, with 11.1% achieving an overall pass score for both the clinical and practical stations indicating TTE competency.

Ongoing training and assessments are essential in maintaining basic standards of POCUS practice and patient care.[9,16] The ASE[14] recognises this and advises that POCUS training should commence at an undergraduate level and encourages the introduction of fundamental principles, indications, applications and limitations of POCUS as early on in training as possible. In our study, 25.9% of registrars had completed an accredited TTE course, and of these, 28.6% passed the OSCE. This indicates that the basic training in skill and background knowledge may not be introduced early enough in the registrar training. There was no significant difference in the overall level of TTE skill of those registrars who had completed an accredited course to those who had not. This suggests that a once-off accredited course in TTE may not suffice for the proficient acquisition of long-term practical skill and knowledge. It has been demonstrated that when echocardiographic skills are not performed regularly, the proficiency will diminish over time. Thus a process of ongoing training and reaccreditation to ensure the maintenance of TTE standards is required.[16,17]

Barber and Fletcher[4] acknowledge that the actual number of TTEs performed is less important than the overall quality of the educational experience, range of pathologies observed and the quality of supervision. The ASE guidelines[14] for TTE suggest that the number of TTEs performed or hours of training may act as surrogates for proficiency in echocardiography and recommend the performance of a minimum of 150 TTEs to ensure basic competency. In 2018, the Portuguese Society of Cardiology[18]

recommended that emergency focused cardiac ultrasound (FCU) practitioners require the completion of a minimum of 50 clinically indicated echocardiographic examinations in a period of less than a year to maintain competency. In our study we found that the registrars had performed 0–30 TTEs, which is below the recommended number. Studies with junior practitioners have found competency in performing and interpreting TTE after 20–30 examinations, if the examination was limited to the parasternal views.[17] We found that the highest scores in our practical parasternal long-axis view support this finding.

In our study, the registrars who had more practical experience obtained higher scores in the practical stations. Wiegers et al.[14] highlight the importance of exposure to a spectrum of clinical conditions and the hands-on application of TTE in the diagnosis and management of cardiac conditions. Chisolm et al.[19] found that after an initial mixed didactic and scanning training, followed by five months of independent scanning, the competency in TTE was evident. They further showed that acquiring the clinical ability to interpret echocardiographic images is learnt more quickly than the practical skill to acquire the views. They found that there were strong trends toward increased competency with increased numbers of examinations performed.[19]

At our institution, the cardiac rotation is considered a senior rotation.There was no significant difference in the level of TTE skill of registrars who had completed a cardiac rotation to those who had not. This may be a result of greater emphasis being placed on TOE during the cardiac rotation. Research has shown that competency in TOE does not translate to the equivalent in TTE, as the skills and learning goals are distinctly different.[3,4]

Study limitations

Our study was done contextually and may not be generalisable to other institutions. Owing to the small sample size, the study may have been underpowered to find differences between groups, if these exists. Convenience sampling may have contributed to sampling bias. A small number of OSCE stations was a further limitation of this study. The authors recommend a complete training programme with the early completion of an accredited training course, ongoing supervised training with simulation and adequate clinical exposure and practice, recurrent objective assessment of skill, and an accreditation and reaccreditation process. The results of our study could be used to motivate for a curriculum with the necessary simulation equipment to enhance the overall training and assessment process.

Conclusion

Findings from this study suggest that the current skill level of registrars in performing TTEs in the studied department is not sufficient to achieve clinical competency and that the training may not be initiated early enough in the registrar programme.

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Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

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