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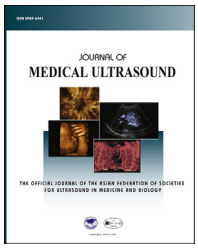

ORIGINAL ARTICLE

Toward an Appropriate Point-of-Care Ultrasound Curriculum: A Reflection of the Clinical Practice in South Africa

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Abstract *Background:* Point-of-care ultrasound has become an essential skill in the armory of modern physicians. The South African point-of-care ultrasound curriculum reflects that of the United Kingdom by including five module applications, namely, extended focused assessment of sonography in trauma (eFAST), abdominal aorta aneurysm, central and peripheral venous access, focused emergency echocardiography in resuscitation (FEER), and deep venous thrombosis (DVT). A recent descriptive study demonstrated marked discrepancies between the current five point-of-care ultrasound curriculum application modules trained and the disease burden faced by doctors within Cape Town Emergency Centers during their daily clinical practice. The motivation for conducting this study is to extend the study location beyond Cape Town. The objective was to establish whether the clinical practice exposure of South African certified point-of-care ultrasound providers reflects the current curriculum content.
Methods: An online survey was conducted. All South African certified emergency medicine point-of-care ultrasound providers were eligible for inclusion. Cases with incomplete data and providers practicing outside South Africa were excluded. Summary statistics were used to describe all variables.
Results: Forty-four providers completed the survey (52.4% response rate), but only 37 responses were analyzed [currently working outside South Africa ($n = 5$); incomplete responses ($n = 2$)]. Most respondents were female ($n = 20$, 54.1%); aged > 35 years ($n = 22$, 59.5%); working in the Western Cape Province ($n = 29$, 78.4%); and emergency medicine specialists ($n = 22$, 59.5%). The eFAST (35.9%), DVT (24.4%), and FEER (14.3%) application modules were the most frequently used. The top five modules selected that best match the participants' perceived burden of disease were eFAST (89.2%), DVT (86.5%), FEER (64.9%), first-trimester pregnancy (56.8%), and focused assessment with sonography for human immunodeficiency virus/tuberculosis (43.2%). Most respondents ($n = 27$, 73%) indicated that the curriculum should be expanded to include more than five application modules.

Conflicts of interest: All contributing authors declare no conflicts of interest.

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Conclusions: This study indicates a mismatch between the current point-of-care ultrasound curriculum and the clinical burden of disease experienced. Disease burden, disease impact, technical difficulty of ultrasound applications, and logistical barriers need to be incorporated when considering a change in the curriculum to make it more appropriate for the South African setting.

Introduction

Point of care ultrasound (POCUS) benefits both patients and doctors. It provides additional clinical data for doctors for both expediting diagnoses and reducing diagnostic errors [1,2], while patients are subjected to less procedural complications [3]. Competency is vital for any POCUS provider to assure they practice safely and benefit from all the advantages [4,5]. Many formal international POCUS training programs currently exist that train doctors to become competent in its use [5].

South Africa has a POCUS curriculum that is very similar to the United Kingdom's with regard to both curriculum content and method of delivery. Trainees enter the training program by attending a 1-day introductory course, followed by completion of an online assessment. Trainees then need to complete a proctored scan list of five module applications, namely, extended focused assessment of sonography in trauma (eFAST), abdominal aorta aneurysm (AAA), central and peripheral venous access, focused emergency echocardiography in resuscitation (FEER), and deep venous thrombosis (DVT). Upon completion of the scan list they qualify to challenge the exit competency assessment, which is an objective simulated clinical examination using real patient models. Successful candidates subsequently receive competency certification and POCUS provider status. POCUS providers who excel in their newly acquired skill can be invited to become POCUS trainers. The training program is accredited by the Emergency Medicine Society of South Africa and the College of Emergency Medicine of South Africa which, in combination, fulfils a similar governance role as the Royal College of Emergency Medicine in the United Kingdom [6].

All five application modules used in training were adopted directly from peer curricula without much oversight and not considering whether the content is applicable to the vastly different disease burden exposure. A recent study described discrepancies between the South African POCUS curriculum content and Cape Town emergency departments' disease burden [7]. The application modules required by the patient burden were very different from the current curriculum content. The study was only limited to Cape Town and was not representative of the South African population with varied disease burdens in different parts of the country. This study aimed to establish whether the perceived burden of disease as experienced by South African certified point-of-care ultrasound providers in their day-to-day practice reflects the current POCUS curriculum content.

Methods

Study design

An online survey was conducted from February 2, 2015, to March 3, 2015.

Study setting and population

There are three regional POCUS training centers in South Africa (Gauteng, KwaZulu/Natal, and Western Cape) through which candidates can obtain certification by completing the credentialing process. Each of these centers keeps a database of successful candidates.

All South African certified emergency medicine POCUS providers were eligible for inclusion in the study. Cases with incomplete data and providers practicing outside South Africa were excluded.

Data collection and management

All potential participants were contacted via e-mail with an explanation and invitation to complete an online questionnaire (Appendix 1). Participants had 4 weeks to complete the survey; all nonresponders were reminded weekly by e-mail until they responded or the deadline expired.

The data were collected in such a way as to protect participants' confidentiality. No personal or identifying information was collected. The online survey platform deidentified all responses before converting the data into a password-protected electronic spreadsheet (Microsoft Excel; Microsoft Corporation, Redmond, WA, USA).

Statistical analysis

Summary statistics were used to describe all variables.

Results

Eighty-four invitations were sent to POCUS providers who trained at either the KwaZulu/Natal or the Western Cape training sites (the Gauteng trainees were excluded as their facilitator failed to respond). Overall, 44 providers completed the survey (52.4% response rate); however, only 37 responses were analyzed (total excluded = 7; responders currently working outside South Africa = 5, incomplete responses = 2).

Table 1 Demographics of point-of-care ultrasound providers participating in the study.

	n (%)
Sex	
Male	17 (45.9)
Age (y)	
< 30	2 (5.4)
30–34	13 (35.1)
35–49	22 (59.5)
Province working in	
Western Cape	29 (78.4)
KwaZulu/Natal	6 (16.2)
Northern Cape	2 (5.4)
Qualification	
Emergency medicine specialist	22 (59.5)
Emergency medicine registrar	8 (21.6)
Medical officer	4 (10.8)
Nonclinical position	1 (2.7)
Other	2 (5.4)
Point-of-care ultrasound qualification	
Provider only	20 (54.1)
Provider and trainer	17 (45.9)

The demographics of the responders are presented in Table 1. The majority of Level 1 POCUS trainers ($n = 10$, 58.8%) and provider-only respondents ($n = 13$, 65%) have been qualified as POCUS providers and/or trainers for >1 year. Most respondents used POCUS on a daily basis ($n = 27$, 73%); however, 87.3% of trainers used POCUS at least three times a week compared with 80% of provider-only physicians. The eFAST, DVT, and FEER application modules were the most frequently used (Table 2).

Participants were provided a list of all point-of-care ultrasound application modules, and asked to select any five modules that best match their perception of the disease burden in their setting. The eFAST, DVT, FEER, and focused assessment with sonography for human immunodeficiency virus/tuberculosis, and first-trimester pregnancy modules were the most frequently selected (Tables 3 and 4).

Ten respondents (27%) felt that the POCUS curriculum should not be expanded to include more than five application modules, whereas 27 (73%) indicated that the curriculum should include more than five application modules [expand to 6 ($n = 7$), 18.9%; expand to 7 ($n = 11$), 29.7%; and expand to >7 ($n = 9$), 24.3%].

Discussion

Our results indicate a mismatch between the current South African POCUS curriculum and the clinical burden of disease experienced.

Three modules (eFAST, DVT, and FEER) were most frequently indicated, both overall and when divided into trainer and provider groups (Tables 3 and 4). eFAST and DVT applications were the most regularly used due to the following reasons: trauma is part of the quadruple burden of disease in South Africa [8], while human immunodeficiency virus (HIV)/AIDS and tuberculosis (TB) are associated with an increased risk of the development of DVT [9], both of which are highly prevalent in South Africa [10,11]. The frequent use of the FEER application is not entirely understood, however, we expect it is used much broader than the module's intended aim of assisting decision making when managing nonshockable cardiac arrest rhythms.

The need for ultrasound evaluation in first-trimester pregnancy patients manifested clearly, and is similarly applicable in other African and low-to-middle income countries [12]. However, the use of this module in the South African emergency department setting needs to be limited to abdominal evaluation for several reasons, including the lack of availability of intracavity probes, overcrowding with possible lack of patient privacy, and lack of trained facilitators (Personal communication Dr H Lamprecht).

The discrepancy between the perceived need to include the vascular module was surprising (50% in providers vs. 24% in trainers). This variation could be explained by most providers being in their earlier career phase, and therefore, they are more directly involved in hands-on management of patients, with subsequent need to perform ultrasound-guided vascular access more regularly.

The high prevalence of HIV and TB in South Africa explains the need to use the focused assessment with sonography for HIV/TB (FASH) application module [10,11,13]. The objective of the FASH application is to detect disseminated TB in severely immunocompromised patients [14]. Although ranked fifth in the overall group, this ranking is skewed by the trainer group, possibly indicating that the more experienced trainer group applied POCUS more broadly in clinical practice.

Table 2 Average use of point-of-care ultrasound application modules in the current curriculum.

Module	All	Trainer			Provider only		
		< 3 y ($n = 9$)	≥ 3 y ($n = 8$)	All	< 3 y ($n = 16$)	≥ 3 y ($n = 21$)	All
eFAST	35.90%	34.4%	31.3%	36.6%	38.1%	34.3%	38.5%
DVT	24.40%	25.6%	19.0%	19.4%	22.6%	25.8%	26.0%
FEER	14.30%	20.0%	13.5%	15.6%	16.3%	12.8%	12.1%
Vascular	8.60%	9.4%	6.1%	7.5%	9.4%	8.0%	7.3%
AAA	6.90%	6.2%	7.8%	6.9%	8.3%	5.8%	6.8%
Other	9.90%	4.4%	22.3%	14.0%	5.3%	13.3%	9.3%

AAA = abdominal aorta aneurism assessment; DVT = deep venous thrombosis assessment; eFAST = extended focused assessment with sonography in trauma; FEER = focused emergency echocardiography in resuscitation.

Table 3 Most useful point-of-care ultrasound applications according to the perceived local burden of disease for all respondents and trainers only.

All			Trainer								
			< 3 y experience (n = 9)			≥ 3 y experience (n = 8)			All		
	Module	n (%)		Module	n (%)		Module	n (%)		Module	n (%)
1	eFAST	33 (89.2)	1	DVT	9 (20.0)	1	eFAST	7 (17.5)	1	eFAST	15 (88.2)
2	DVT	32 (86.5)	2	eFAST	8 (17.8)	2	DVT	5 (12.5)	2	DVT	14 (82.4)
3	FEER	24 (64.9)	3	First trimester	7 (15.6)	2	FEER	5 (12.5)	3	FEER	10 (58.8)
4	First trimester	21 (56.8)	4	FEER	5 (11.1)	2	Shock	5 (12.5)	3	First trimester	10 (58.8)
5	FASH	16 (43.2)	5	FASH	4 (8.9)	3	First trimester	3 (7.5)	5	FASH	9 (52.9)
6	Vascular	14 (37.8)	5	Vascular	4 (8.9)	3	Lung	3 (7.5)	6	Shock	7 (41.2)
6	Shock	14 (37.8)									

AAA = abdominal aorta aneurism assessment; DVT = deep venous thrombosis assessment; eFAST = extended focused assessment with sonography in trauma; FASH = focused assessment with sonography for human immunodeficiency virus/tuberculosis; FEER = focused emergency echocardiography in resuscitation.

The AAA application module, part of the current POCUS curriculum, might be unsuitable for the South African setting. The prevalence of AAA in South Africa is low due to the relatively young population (<9% over 60 years) [11]. Training individuals in the AAA ultrasound module also proved challenging as many POCUS trainees had limited access to patients with pathology reports (i.e., positive scans) (Personal communication Dr H Lamprecht).

Should the curriculum change?

The South Africa POCUS curriculum requires a reassessment in relation to the environment it trains for. However, the process of curriculum change is not as simple as just substituting a few application modules with alternatives. A previous Cape Town study showed contrasting results; the top five ranked modules were (1) "pulmonary," (2) "musculoskeletal," (3) "cardiac," (4) "FASH," and (5) "renal" [7]. Although the same curriculum was evaluated, it was matched against actual patients and only in Cape Town emergency departments. The current study broadened the study population to emergency medicine POCUS providers practicing in South Africa, and the burden of disease they perceived in their own clinical setting.

The disease prevalence, however, should not be the only factor to consider whether the module application should be included in the national curriculum. The impact of the disease and the technical difficulty of acquiring quality ultrasound images should also be considered. A proposed solution to incorporate all three variables in such an assessment is to use a weighted ranking matrix (Tables 5 and 6) [7]. However, the variable ranges of the proposed matrix still need to be clarified. The next step to establish such ranges would be a consensus agreement among POCUS providers in South Africa.

Rationalizing which application modules should substitute the current curriculum content by only analyzing the disease burden, disease impact, and POCUS difficulty also remains inappropriate. South Africa is a middle-income country with limited resources available for clinical ultrasound training. Access barriers, for example, limited access to certified trainers and ultrasound machines, are more prevalent in under-resourced countries and could explain why the Cape Town clinical ultrasound training center had a low credentialing success rate (19.7%)

Table 4 Most useful point-of-care ultrasound applications according to the perceived local burden of disease for all respondents and providers only.

All			Provider								
			< 3 y experience (n = 16)			≥ 3 y experience (n = 21)			All		
	Module	n (%)		Module	n (%)		Module	n (%)		Module	n (%)
1	eFAST	33 (89.2)	1	eFAST	15 (18.8)	1	eFAST	18 (17.1)	1	eFAST	18 (90.0)
2	DVT	32 (86.5)	2	DVT	15 (18.8)	2	DVT	17 (16.2)	2	DVT	18 (90.0)
3	FEER	24 (64.9)	3	FEER	12 (15.0)	3	FASH	15 (14.3)	3	FEER	14 (70.0)
4	First trimester	21 (56.8)	4	Vascular	12 (15.0)	4	FEER	12 (11.4)	4	First trimester	11 (55.0)
5	FASH	16 (43.2)	5	First trimester	11 (13.8)	5	First trimester	10 (9.5)	5	Vascular	10 (50.0)
6	Vascular	14 (37.8)				6	Shock	9 (8.6)	6	Shock	7 (35.0)
6	Shock	14 (37.8)							6	FASH	7 (35.0)

DVT = deep venous thrombosis assessment; eFAST = extended focused assessment with sonography in trauma; FASH = focused assessment with sonography for human immunodeficiency virus/tuberculosis; FEER = focused emergency echocardiography in resuscitation.

Table 5 Weighting for disease prevalence, disease impact, and POCUS difficulty of POCUS application modules.

Weight	Disease prevalence	Disease impact	POCUS difficulty
1	Rare	Nonurgent	Advanced
2	Relatively common	Serious (but not life-threatening)	Moderate
3	Very common	Life-threatening	Easy

Note. Reproduced from "Adequacy of the emergency point-of-care ultrasound core curriculum for the local burden of disease in South Africa," by D.J. van Hoving, H.H. Lamprecht, M. Stander, K. Vallabh, D. Fredericks, P. Louw, M. Müller, and J.J. Malan, 2013, *Emerg Med J, 30*, p. 312–5. Copyright 2013, *BMJ Publishing Group*. Reproduced with permission from BMJ Publishing Group Ltd.
POCUS = point-of-care ultrasound.

Table 6 Example of weighted ranking matrix to determine the South African POCUS curriculum.

POCUS module	Disease prevalence (P)	Disease impact (I)	POCUS difficulty (D)	P × I × D	Relative weight	Rank
Pulmonary	3	2	1	6	0.13	4
FASH	3	2	2	12	0.27	2
eFAST	3	2	3	18	0.4	1
Aorta	1	3	3	9	0.2	3
Total				45	1	

Note. Reproduced from "Adequacy of the emergency point-of-care ultrasound core curriculum for the local burden of disease in South Africa," by D.J. van Hoving, H.H. Lamprecht, M. Stander, K. Vallabh, D. Fredericks, P. Louw, M. Müller, and J.J. Malan, 2013, *Emerg Med J, 30*, p. 312–5. Copyright 2013, *BMJ Publishing Group*. Reproduced with permission from BMJ Publishing Group Ltd.
eFAST = extended focused assessment with sonography in trauma; FASH = focused assessment with sonography for human immunodeficiency virus/tuberculosis; POCUS = point-of-care ultrasound.

compared with other international training programs (range 40–78%) (Personal communication Dr H Lamprecht) [15–17]. Furthermore, time constraints had proved to be an important training barrier, and therefore, time considerations of training the POCUS curriculum should also be taken into account (Personal communication Dr H Lamprecht). The FASH application, as an example, was ranked in the top five (Tables 3 and 4) and although not technically difficult, it has six different views to perform [14]. Therefore, more training time will need to be allocated for trainees to learn to perform the scan. The overall time burden will increase if the vascular access (2 views) is replaced by the FASH module. Any possible substitute application module should therefore also be weighed against the logistical burdens they may pose.

Web-based education shows promise to alleviate the impact of some of the access barriers in low- and middle-income countries. The addition of web-based education to the more traditional methods of hands-on and simulation training may lead to improved proficiency of certain ultrasound-guided procedures [18,19]. Adapting current web-based education platforms, where offsite trainers can review images of real patients and provide feedback to their trainees, will extend their reach to smaller peripheral hospitals.

Another possibility to ensure that the acquired skills match the local burden of disease is to allow for a more flexible curriculum. Instead of populating the curriculum with five compulsory module applications for all, trainees may select elective module applications. For example, a curriculum may consist of three core modules (eFAST, DVT, and FEER) and two elective modules that trainees can select to match their local burden of disease or personal interest. The flexibility arrangement may save on wasted training (e.g., doctors who never see obstetrics and gynecology patients are not unnecessarily exposed to first-trimester pregnancy ultrasound training).

The study has certain limitations that might affect the external validity of the survey: (1) only POCUS providers and trainers from the Cape Town and KwaZulu/Natal training programs were included; (2) only half of invitees responded, and (3) most responders were based within the Western Cape Province. Furthermore, the survey measured the objective opinion of respondents and not necessarily the actual burden of disease. Lastly, there is very limited access to training for application modules beyond the current curriculum and those interested in alternative modules are mainly dependent on self-learning. This could explain the difference in selected modules between trainers and providers.

Conclusion

This study highlights the malalignment of the current POCUS curriculum by adding the perceived disease burden POCUS providers experienced in their own practices within a larger study setting. The next step to ensure appropriate curriculum content is to establish whether the utility of POCUS in a hospital setting reflects the current South African clinical ultrasound curriculum. Thereafter, stakeholders should be able to revise the curriculum taking into account a weighted ranking matrix and logistical barriers unique to the local training environment.

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Appendix 1. Questionnaire.

1. Please indicate your **gender**:
   - M
   - F
2. Please indicate your **age**:
   - _____years
3. Please indicate your **current position**:
   - Medical officer
   - Emergency medicine registrar
   - Nonemergency medicine registrar
   - Emergency medicine specialist
   - Nonemergency medicine specialist
   - Nonclinical position
   - Other:_____
4. Please indicate the **province** in which you practice most of the time
   - Eastern Cape
   - Free State
   - Gauteng
   - KwaZulu/Natal
   - Limpopo
   - Mpumalanga
   - North West
   - Northern Cape
   - Western Cape
   - Outside Republic of South Africa
5. For how long have you been qualified as a Level 1 point-of-care ultrasound provider (in years)?
   - <1
   - 1
   - 2
   - 3
   - 4
   - 5
   - >5
6. For how long have you been qualified as a Level 1 point-of-care ultrasound **trainer** (in years)?
   - Not applicable
   - <1
   - 1
   - 2
   - 3
   - 4
   - 5
   - >5
7. On average, how **often** do you use point-of-care ultrasound in your clinical practice?
   - Every day
   - 2/3 times per week
   - Weekly
   - 2/3 times per month
   - Monthly
   - Less than once a month

8. Of all the point-of-care ultrasounds you perform, please indicate the percentage for each applications (max total = 100%)
   - eFAST (Extended focused assessment with sonography in trauma)
   - Abdominal aorta aneurysm
   - Deep venous thrombosis
   - Basic cardiac ultrasound/FEER (focused emergency echocardiography in resuscitation)
   - Vascular access (central and peripheral)
   - Other point-of-care ultrasound applications
9. Below is a list of all the point-of-care ultrasound applications, please select **any 5 applications** that best match the burden of disease in your setting
   - Abdominal aorta aneurysm
   - Basic cardiac ultrasound/FEER (focused emergency echocardiography in resuscitation)
   - Deep venous thrombosis
   - eFAST (extended focused assessment with sonography in trauma)
   - FASH (focused assessment with sonography in human immunodeficiency virus/tuberculosis)
   - First-trimester pregnancy/pelvic
   - Gastrointestinal
   - Head and neck
   - Liver (including gallbladder and cystic ducts)
   - Musculoskeletal
   - Peripheral nerve blocks
   - Pulmonary
   - Renal (including ureter and bladder)
   - Shock protocols
   - Testicular
   - Vascular access (central and peripheral)
10. Do you think it is achievable to expand the current point-of-care ultrasound curriculum by adding extra applications?
    - No, keep at 5 applications
    - Yes, expand to 6 applications (i.e., add 1 extra application)
    - Yes, expand to 7 applications (i.e., add 2 extra applications)
    - Yes, expand to more than 7 applications (i.e., add more than 2 applications)