Short report

A descriptive study of the use of cardiac point of care ultrasound (PoCUS) in public emergency centres in Cape Town

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A R T I C L E   I N F O

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A B S T R A C T

Introduction: The indications for cardiac point of care ultrasound (PoCUS) vary somewhat in different parts of the world, and training programs may also differ. We set out to describe the self-reported cardiac PoCUS indications and imaging windows used at a selection of secondary-level, public hospital emergency centres in Cape Town.

Methods: A descriptive study with prospective data collected from emergency centres of Mitchells Plain District, Victoria and New Somerset Hospitals in Cape Town were used. Data were collected over a three-month period by providers who have completed a basic emergency ultrasound course, using a purpose-designed data collection tool for all cardiac PoCUS scans.

Results: Fifteen PoCUS providers recorded 267 data entries over the three-month study period; there were 17 exclusions, leaving 250 entries for analysis. The most common indication for performing cardiac PoCUS was electrocardiogram abnormalities, 27% (n = 112); dyspnoea, 25% (n = 102); chest pain, 16% (n = 65); cardiomegaly on chest x-ray, 12% (n = 51); new murmur, 6% (n = 23); and chest trauma, 5% (n = 22). Other indications made up the remaining 10% (n = 40). Parasternal long and short axis were the predominantly used views.

Conclusion: Cardiac PoCUS is used for a wide range of indications beyond the recommended training guidelines. Some indications may be more useful in low- to middle-income settings. Further research needs to be done to ascertain the extent of the use of cardiac PoCUS, and possibly the need for a more comprehensive training program with adequate training in these clinical conditions, to ensure safe practice.

African relevance

• Cardiac PoCUS is a useful tool in the diagnostic evaluation and management of shock and cardiac arrest.
• Cardiac PoCUS training should be tailored to reflect the local burden of disease.
• It is possible that cardiac PoCUS indications can be improved, specifically in low resource settings.

Introduction

The International Federation of Emergency Medicine (IFEM) describes point of care ultrasound (PoCUS), as a “diagnostic or procedural guidance ultrasound that is performed by a clinician during a patient encounter to help guide the evaluation and management of the patient” [1]. Cardiac PoCUS specifically, has progressed to become a useful tool in the diagnostic evaluation, emergent management, and guidance of ongoing management of shock, chest pain, cardiac arrest and acute dyspnoea [2–4]. Rapid assessment by cardiac PoCUS has shown a mortality benefit in these populations [3]. The use of PoCUS in these patient groups targets cardiac chamber sizes, aortic root assessment, inferior vena cava assessment, pericardium and pleura assessment, and left ventricular function to guide acute management [5]. Cardiac PoCUS is intended to guide emergency care practitioners in emergent management and serve a complementary role in comprehensive echocardiography [2].

In South Africa, the College of Emergency Medicine (CEMSA) requires the completion of a Basic Emergency Ultrasound (EUS) course to become an accredited PoCUS provider [6]. This EUS course entails attendance of an accredited training course which teaches ultrasound logistics, and proficiency in five clinical components. The CEMSA policy document describes cardiac PoCUS as limited echocardiography.
used in the setting of non-shockable cardiac arrest rhythms; that is pulseless electrical activity (PEA), and asystole. Cardiac PoCUS is performed during the rhythm check phase of cardiopulmonary resuscitation (CPR). It is used to assess wall motion abnormalities and treatable causes of PEA such as hypovolemia, pulmonary embolism, cardiac tamponade and pneumothorax. The subxiphoid, parasternal long axis, short axis and apical four chamber views are the main windows used [6]. A log book of supervised scans must be completed, followed by a credentialing examination.

Anecdotally, in clinical practice, emergency physicians, registrars (specialist trainees) and medical officers (non-training grade doctors) at times use cardiac PoCUS beyond the scope of cardiac arrest. The aim of this study was to describe the self-reported indications for, and specific use (sites and windows applied) during bedside cardiac PoCUS as used at a selection of secondary-level, public hospital Emergency Centres (ECs) in Cape Town.

Methods

We conducted a prospective, descriptive study to address the study aim. We collected the data from a convenience sample of available clinicians from three regional and district level public hospital emergency centres (ECs) in the Western Substructure of Cape Town. These were Mitchells Plain District Hospital, Victoria Hospital and New Somerset Hospital. The decision to use a convenience sample was foremost practical: given the lack of resources; and second the lack of existing data on this topic, that restricted the use of a power calculation. The decision to use the study sites were practical as these sites employed a number of level 2 (advanced) accredited PoCUS users. Data were collected from October 2017 to January 2018. This duration was based on an estimate of four PoCUS providers at each facility performing at least one cardiovascular PoCUS per shift or every other shift per provider. In other words, between 240 and 480 data entries if each provider worked 20 days a month.

A two-step approach was planned for data collection. Step one, consent was obtained from the emergency care providers who were to participate in the study. Inclusion criteria included providers that have been credentialed or were in the credentialing process for PoCUS (as defined by the CEMSA). As such, providers included emergency physicians, emergency medicine specialist trainees and emergency centre medical officers. At the same time demographic data were collected and included information on medical qualifications, and additional ultrasound qualifications. We also collected a self-reported evaluation of competency for each bedside cardiac PoCUS windows using a Likert scale: 1, not competent at all; 2, somewhat competent; 3, competent; and 4, very competent (0 was used to describe where a window was not used).

Step two, study data were collected using the e-survey client SurveyMonkey (San Mateo, California). These were: indication for bedside cardiac PoCUS, windows used, self-reported image quality and whether the ultrasound was performed under supervision or not. The survey also included a self-reported competency scale for the various windows. The URL link to the survey was converted to a quick response (QR) code which were in turn applied to the ultrasound device(s) in each of the study sites. Consented participants were encouraged to record as many data entries as convenient using their smart phones and the QR code link. Both the survey content and QR code function were tested in a short pilot (17 entries). No changes to the survey format were required following the pilot study.

The data sample were downloaded from SurveyMonkey to excel for analysis. Demographics are presented using descriptive statistics. Indications for, and windows used during bedside cardiac PoCUS are ranked in terms of usage and presented in tables and as proportions. Self-reported competency in bedside cardiac PoCUS, the indications for, and frequency of specific windows used for the bedside cardiac PoCUS were also described. Inferential statistics were not part of the analysis given the lack of a power calculation.

The study protocol was approved by the Human Research Ethics Committee of the University of Cape Town (reference 581/2017).

Results

We recruited 15 PoCUS providers from the three study sites. Participants recorded 267 data entries; the 17 pilot entries were excluded leaving 250 entries for analysis. There were no further exclusions. Table 1 provides the qualifications of participants. Regarding participants’ highest qualifications, 8 (53%) had MBChB (or equivalent) and 7 (47%) had a specialist degree in emergency medicine. Advanced bedside cardiovascular ultrasound refers to courses that teach views, measurements and their interpretation not covered in the basic EUS course.

There were 150 (60%) entries that listed only one indication, whilst the rest listed multiple indications for cardiac PoCUS. The other indications group included syncope 6 (1.4%), pulmonary embolus 2 (0.5%), and transient ischaemic attack, palpitations, unexplained high pulse pressure, aortic aneurysm with possible thoracic extension, general fatigue, troponin leak and possible infective endocarditis 1 (0.2%) each.

Indications for, and the specific windows used for each cardiac PoCUS, ranked by frequency is provided in Table 2.

Self-reported image quality was described as adequate 219 (88%); not adequate, but able to interpret 27 (11%); and not adequate, unable to interpret 4 (2%). The self-reported competency of providers for various bedside cardiac PoCUS windows is described in Table 3.

Discussion

Although this study found that cardiac PoCUS were largely applied for its recommended use [1,2,6,7], there were some outliers: the most commonly used indication for cardiac PoCUS provided was an ECG abnormality. Other odd (but uncommonly applied) indications provided by participants included transient ischaemic attack, general fatigue and troponin leak. These are not described in the CEMSA cardiac PoCUS guidelines. The study was not designed to explore these. It is possible that these unusual indications were included in the clinical work-up due to the lack of accessible diagnostic testing available in the relatively lower resourced study settings, or that the indications were valid, but lacked sufficient context within the confines of the study methods to validate its inclusion.

Clinical training should ideally be tailored to the local burden of disease [8]. South Africa’s burden of disease for example include Human Immunodeficiency Virus and tuberculosis, in addition to many

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### Table 1: Highest qualification versus job title of PoCUS providers.

| Participants | Consultants | Emergency medicine specialist trainees | Medical officers |
|--------------|-------------|----------------------------------------|-----------------|
| All participants | 7 (47%) | 4 (27%) | 4 (27%) |
| CEMSA ultrasound – trainee | 0 | 0 | 3 (75%) |
| CEMSA ultrasound - credentialed | 3 (43%) | 3 (75%) | 1 (25%) |
| Advanced bedside cardiovascular ultrasound – trainee | 0 | 0 | 0 |
| Advanced bedside cardiovascular ultrasound - credentialed | 4 (57%) | 1 (25%) | 0 |
chronic lifestyle diseases also present in high-income countries, and trauma. As the CEMSA policy was adapted from high-income setting guidance, it is possible that some of these unusual indications may be required within the local setting. But this will require further exploration.

Unsurprisingly, self-reported competency in all views was highest for better qualified emergency ultrasound providers. This may simply represent confidence as the study methodology did not allow for verification of competency. The most frequently used cardiac windows were very similar for all indications, except cardiac arrest and chest trauma, where subxiphoid four chamber view was preferred. It is reassuring to see that providers adhered to the standard cardiac PoCUS windows as per the CEMSA policy when the situation dictated. Cardiac PoCUS can be a useful adjunct, however, use outside of formal guidelines should be supported by an appropriate evidence base to ensure safe practice (especially within vulnerable communities).

Regarding limitations: as an unpowered, limited centre study, the study may not represent the full spectrum of the indications and windows applied for cardiac PoCUS in the Western Cape. We do believe it provides a reasonable representation of indications and use to guide future study design. The data collected is likely to be biased given the convenience selection of study sites with known advanced PoCUS providers. This was intentional as we believed the bias would exaggerate findings in a small sample. Despite this, we do believe it provides a reasonable representation of how cardiac PoCUS is used in practice in other similar settings. Indications were not connected with specific diagnoses. In hindsight, the addition of a working diagnosis may have provided more context on some of the indications provided. We were not able to link data captured to specific consented providers, we did not have access to the resources required to effectively do so. This did not influence the objectives of the study.

**Conclusion**

Cardiac PoCUS is an important tool that has been integrated into emergency medicine practice. The results of this study suggest that

| Indications                  | Number of PoCUS events per indication (n) | % Views used | Number of times views utilised (n) | % |
|-----------------------------|------------------------------------------|--------------|-----------------------------------|---|
| Overall                     | 415                                      | n/a          | Parasternal long axis             | 236 | 32% |
|                             |                                          |              | Parasternal short axis            | 160 | 22% |
|                             |                                          |              | Apical five chamber               | 153 | 21% |
|                             |                                          |              | Subxiphoid four chamber           | 102 | 14% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 80  | 11% |
| ECG abnormality             | 112                                      | 27%          | Parasternal long axis             | 108 | 96% |
|                             |                                          |              | Apical five chamber               | 96  | 86% |
|                             |                                          |              | Parasternal short axis            | 92  | 82% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 45  | 40% |
|                             |                                          |              | Subxiphoid four chamber           | 23  | 21% |
| Dyspnoea                    | 102                                      | 25%          | Parasternal long axis             | 100 | 98% |
|                             |                                          |              | Parasternal short axis            | 72  | 71% |
|                             |                                          |              | Apical five chamber               | 72  | 71% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 50  | 49% |
|                             |                                          |              | Subxiphoid four chamber           | 34  | 33% |
| Chest pain                  | 65                                       | 16%          | Parasternal long axis             | 62  | 95% |
|                             |                                          |              | Parasternal short axis            | 49  | 75% |
|                             |                                          |              | Apical five chamber               | 44  | 68% |
|                             |                                          |              | Subxiphoid four chamber           | 18  | 28% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 13  | 20% |
| Cardiomegaly on chest x-ray | 51                                       | 12%          | Parasternal long axis             | 51  | 100%|
|                             |                                          |              | Apical five chamber               | 41  | 80% |
|                             |                                          |              | Parasternal short axis            | 40  | 78% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 26  | 51% |
|                             |                                          |              | Subxiphoid four chamber           | 11  | 22% |
| New murmur                  | 23                                       | 6%           | Parasternal long axis             | 23  | 100%|
|                             |                                          |              | Parasternal short axis            | 17  | 74% |
|                             |                                          |              | Apical five chamber               | 14  | 61% |
|                             |                                          |              | Subxiphoid four chamber           | 10  | 43% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 10  | 43% |
| Chest trauma                | 22                                       | 5%           | Parasternal long axis             | 16  | 73% |
|                             |                                          |              | Parasternal short axis            | 7   | 32% |
|                             |                                          |              | Apical five chamber               | 7   | 32% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 4   | 18% |
| Haemodynamic instability    | 16                                       | 4%           | Parasternal long axis             | 16  | 100%|
|                             |                                          |              | Parasternal short axis            | 14  | 88% |
|                             |                                          |              | Apical five chamber               | 11  | 69% |
|                             |                                          |              | Subxiphoid four chamber           | 10  | 63% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 10  | 63% |
| Other indications           | 15                                       | 4%           | Parasternal long axis             | 15  | 100%|
|                             |                                          |              | Apical five chamber               | 9   | 60% |
|                             |                                          |              | Subxiphoid four chamber           | 8   | 53% |
|                             |                                          |              | Parasternal short axis            | 5   | 33% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 4   | 27% |
| Cardiac arrest              | 9                                        | 2%           | Subxiphoid four chamber           | 6   | 67% |
|                             |                                          |              | Parasternal long axis             | 6   | 67% |
|                             |                                          |              | Subxiphoid inferior vena cava     | 2   | 22% |
|                             |                                          |              | Parasternal short axis            | 2   | 22% |
|                             |                                          |              | Apical five chamber               | 1   | 11% |

PoCUS, point of care ultrasound; ECG, electrocardiogram.
cardiac PoCUS is used for a wide spectrum of clinical scenarios at the various study sites, including indications and windows outside local guidance. Further research is required to explore the narratives behind these indications. This may possibly uncover indications which is relevant and appropriate within the local setting.

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Dissemination of results

Results were disseminated to the heads of the ECs where data were collected.

Authorship contributions

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: UG contributed 80%; JM and SB contributed 10% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

Prof Stevan Brujins is an editor of the African Journal of Emergency Medicine. Prof Brujins was not involved in the editorial workflow for this manuscript. The African Journal of Emergency Medicine applies a double blinded process for all manuscript peer reviews. The authors declared no further conflict of interest.

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Table 3
Self-reported competency of providers for various bedside cardiac PoCUS windows (median and interquartile range, IQR).

| Window                  | Medical officers | Registrars | Emergency physicians |
|-------------------------|------------------|------------|----------------------|
| Parasternal long axis   | 2.5 (2–3)        | 3 (3–3.25) | 4 (3–4)              |
| Parasternal short axis  | 2.5 (2–3)        | 3 (2.75–3.25) | 3 (3–4)              |
| Apical five chamber     | 2 (1.75–2.25)    | 2 (2–2.5)  | 3 (2–4)              |
| Subxiphoid four chamber | 2.5 (2–3)        | 3.5 (3–4)  | 4 (3–4)              |
| Apical four chamber     | 2 (1.75–2.25)    | 2.5 (2–3.25) | 4 (2.5–4)           |
| Subxiphoid inferior vena cava | 2 (1.75–2.25) | 3.5 (3–4)  | 4 (3–4)              |
| Suprasternal             | 1 (1–1)          | 1 (0–2)    | 1 (1–3)              |

Competency Scale: 1, not competent at all; 2, somewhat competent; 3, competent; 4, very competent; EUS, emergency ultrasound.