

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

by

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Abbreviations

AAA	Abdominal aortic aneurysm
ACEM	Australasian College for Emergency Medicine
ACEP	American College of Emergency Physicians
ASE	American Society of Echocardiography
BLEEP	Bedside-limited echocardiography by the emergency physician
CEMSA	College of Emergency Medicine of South Africa
CVC	Central venous catheter
DVT	Deep vein thrombosis
EACVI	European Association of Cardiovascular Imaging
eFAST	Extended focused assessment by sonography in trauma
EC	Emergency Centre
ECG	Electrocardiograph
EUS	Emergency ultrasound

FATE	Focus assessed transthoracic echocardiography
FEEL	Focused echocardiography entry level
FEER	Focused emergency echocardiography in resuscitation
FOCUS	Focused cardiac ultrasound
HEART	Haemodynamic echocardiography assessment in real time
HIC	High income country
IFEM	International Federation of Emergency Medicine
IP	Internet protocol
IQR	Interquartile range
IVC	Inferior vena cava
LMIC	Low- and middle-income country
LV	Left ventricle
MBCbB	Bachelor of Medicine and Bachelor of Surgery

MMed Master of Medicine

OSCE Objective Structured Clinical Examination

PEA Pulseless electrical activity

PoCUS Point of Care Ultrasound

QR Quick response

RUSH Rapid Ultrasound in Shock

RV Right Ventricle

Part A: Literature review

Introduction

The use of cardiac ultrasound in the emergency setting was described by Mayron et al in the Annals of Emergency Medicine, as early as 1988(1). Even at this early stage, the benefit of emergency physician-performed cardiac ultrasound, as a time sensitive investigation, was recognised. The initial goal of cardiac ultrasound in the emergency setting was to recognise pericardial effusion. Mayron conducted a study over a one-year period and found cardiac ultrasound in the emergency setting to be helpful for diagnostic and time-sensitive management in the setting of: penetrating chest trauma, unexplained hypotension and non-perfusing dysrhythmias. The concept of cardiac imaging through ultrasound in the emergency centre (EC) has endured since.

Objectives of literature review

- to briefly describe the context of PoCUS in emergency centres
- to describe the use of cardiac PoCUS in emergency centres in high-income settings
- to describe the use of cardiac PoCUS in emergency centres in low- and middle-income settings
- to broadly describe existing training guidelines for cardiac PoCUS in emergency centres in high-income settings
- to broadly describe existing training guidelines for cardiac PoCUS in low- and middle-income settings

Literature search strategy, including inclusion and exclusion criteria

There were various sources used for the literature search in order to maximise the yield of results. These included PubMed, Mendeley, Google Scholar and Scopus. MESH terms included 'point of care cardiac ultrasound', 'emergency echocardiography', 'focused cardiac ultrasound', 'LMIC', 'emergency centre ultrasound', and 'cardiac ultrasound training'. The search yielded approximately 80 articles which may possibly be relevant. Inclusion criteria were mainly relevant articles published in English in peer reviewed journals. The reference section of articles was then further explored for further relevant literature, and so on and

so forth. Excluded articles included those in languages other than English. Full text articles that required to be purchased and were not available on the library portal, were also excluded. As per MMed guidance, included literature did not require a formal assessment of the quality of the articles used.

Summary of the relevant literature

The context of PoCUS in emergency centres

Cardiac Point of Care ultrasound (PoCUS), is the concept of a focused cardiac ultrasound performed in the emergent setting. It is performed and interpreted by treating physicians who are immediately responsible for the emergency management of an acute patient. As such, PoCUS is used as an adjunct to the history and physical examination of a patient (1). This concept is known by many different terms, such as: emergency echocardiography, bedside cardiac ultrasound, goal-directed cardiac ultrasound, focused cardiac ultrasound (FoCUS), or bedside echo.

PoCUS has become an integral part of emergency medicine (2). It differs from comprehensive echocardiography in that it is a bedside investigation used to answer very specific clinical questions when working through acute cardiac-related differential diagnoses. PoCUS uses minimal but the most efficient views to answer these specific questions (3). The benefits of cardiac PoCUS are many, and include acquisition of real-time dynamic images which correlate with symptoms or suspected diagnoses, rapid identification and intervention of life-threatening conditions – it is easily repeated, non-invasive and does not expose patients to ionising radiation (2).

The scope of practice of PoCUS can be broadly categorised as resuscitative, symptom or sign based, diagnostic, therapeutic and monitoring , and procedural guidance(4). The increasing use of cardiac PoCUS by non-cardiologists have also been acknowledged by a few cardiology and cardiovascular imaging associations. In 2014, the European Association of Cardiovascular Imaging (EACVI) published an opinion statement (2). The statement emphasises the need for PoCUS, the importance of provider competence, and the acknowledgement of providers of their limitations and the limitations of PoCUS. The EACVI has stated that the targets, scenarios and conditions for which PoCUS is used should be specific, and not include more complex structural and functional defects. Their

Target recommendations are:

- the assessment of global left ventricle (LV) and right ventricle(RV) systolic function and size,
- pericardial effusion,
- and intravascular volume assessment;

Scenarios:

- chest pain,
- circulatory compromise/shock,
- chest/cardiac trauma,
- cardiac arrest,
- and respiratory compromise;

Conditions:

- pulmonary embolism,
- myocarditis,
- cardiac tamponade,
- ischaemic LV/RV dysfunction,
- cardiomyopathies (i.e. Dilated, Hypertrophic, Takotsubo),
- and hypovolaemia.

They have also stressed the importance of the relevant specialities implementing systematic educational and training requirements to provide accurate and high-quality PoCUS assessments.

In 2010, a consensus statement was published by the American Society of Echocardiography(ASE) and American College of Emergency Physicians(ACEP) (6). The statement acknowledges the value of cardiac PoCUS and its integration into the curriculums and clinical practice of specialities such as emergency medicine. The recommended clinical applications are outlined, as are the recommendations for training guidelines for cardiac PoCUS.

The statement by the ASE/ACEP also highlights that cardiac PoCUS is different from comprehensive echocardiography. In certain clinical scenarios, cardiac PoCUS serves a

complementary role, but cannot replace echocardiography. The primary uses of cardiac PoCUS are described as assessment of intravascular volume status, relative chamber size, global cardiac function, and assessment for pericardial effusion

The use of cardiac PoCUS in emergency centres in high-income settings

In light of the various advantages of cardiac PoCUS various protocols have largely been developed for use in high-income settings (6). There are many protocols and the more common ones include: the focus assessed transthoracic echocardiography (FATE) protocol, focused echocardiography entry level (FEEL), bedside-limited echocardiography by the emergency physician (BLEEP), haemodynamic echocardiography assessment in real time (HEART) and Rapid Ultrasound in SHock (RUSH).

All these protocols encompass similar goals. They assess ventricular wall thickness, cardiac contractility, chamber size and compliance, and exclude obvious cardiac pathology (6). The time sensitive nature of the treatment of shock was acknowledged by Perera et al. In 2010, Perera published the RUSH protocol, a 3-step protocol which can be integrated in the early assessment of a patient in shock (7). The steps involve the bedside ultrasound assessment of the heart, lungs, aorta; size and collapsibility of the inferior vena cava and jugular veins; venous thromboembolism; and free fluid in the peritoneal cavity. Typical of emergency setting cardiac PoCUS protocols, the RUSH protocol was mainly designed for the evaluation of shock and hypotension, but can also be used in the assessment of dyspnoea and chest pain(8).

The aetiology of hypotension can be many, and not all causes of hypotension can be found sonographically. However, cardiac PoCUS remains an invaluable tool in narrowing down the causes of hypotension. Some of the causes of hypotension found on cardiac PoCUS are LV dysfunction, pericardial effusion with or without features of tamponade, intravascular volume depletion, sepsis and pulmonary embolus(3). The heart is assessed using four views, the subxiphoid view; parasternal long- and short-axis views; and the apical 4-chamber view. The efficiency of being able to perform all these views is emphasised, as the cardiac PoCUS provider may not get optimal information with just one view(7). Multiple views are also recommended to prevent misinterpretations, such as mistaking epicardial fat for a pericardial effusion(9).

The initial assessment for hypotension is for pericardial effusion and signs of tamponade such as decreased RV size with early diastolic collapse, minimal or absent respiratory variation in the inferior vena cava(IVC), and/or diastolic right atrial collapse(2). Cardiac PoCUS can then be used for ultrasound guided pericardiocentesis. Pericardiocentesis performed blindly, carries multiple risks, including pneumothorax; laceration of cardiac chambers; liver lacerations and pneumopericardium. Under ultrasound guidance, these risks are decreased(9). In 2004, Mandavia et al, conducted a study to assess the accuracy of emergency physicians in diagnosing pericardial effusion on bedside cardiac ultrasound. There were 515 cardiac bedside scans that were performed by emergency physicians who were trained and examined on bedside cardiac ultrasound. The scans were performed for varying indications. The findings were then reviewed by an echocardiographer. The study found that emergency physicians detected pericardial effusions with a 96% sensitivity and 98% specificity, and an overall accuracy of 97.5%. They therefore concluded that bedside echocardiography performed by emergency physicians is reliable in evaluating for pericardial effusion(10).

Left ventricular contractility is assessed in cardiac PoCUS as an estimate of pump strength. The motion of the endocardial walls of the left ventricle are visually assessed for the percentage change from systole to diastole(7). Exact ejection fraction is not calculated, but contractility is assessed as poor, moderately depressed or normal(2). Assessment of cardiac contractility helps the clinician to distinguish cardiogenic from non-cardiogenic shock, and tailor treatment accordingly(3). A study by Randazo et al, conducted over a five month period in the year 2000, found that the visually estimated ejection fraction by emergency physicians, is able to estimate left ventricular function with reasonable accuracy(11). The emergency physicians were trained in bedside cardiac and non-cardiac ultrasound. Their ability to accurately obtain five views (apical four chamber, subcostal, parasternal long axis, parasternal short axis and apical two chamber) were tested. The study included bedside cardiac ultrasound in 51 patients and cardiologists provided the reference standard.

An acute dilatation of the right ventricle size, raises the concern of a pulmonary embolus (7). The normal ratio of the left ventricle size to the right ventricle, is 1:0.6. A patient in extremis, with massive pulmonary embolus may require thrombolysis. In order to support the diagnosis, further views and findings for massive pulmonary embolus need to be present. Some other PoCUS findings include; right ventricular hypo- kinesis, septal flattening, septal paradoxical motion, or a hyperdynamic LV with a full IVC. Adequacy of views are important in determining the correct sizes and comparison of the chambers. The

parasternal long axis view needs to be well aligned to ensure subsequent views are done at the correct level of the heart. The parasternal short axis view at the level of the ventricles visualise the comparison of the size and morphology of the left and right ventricles. The subxiphoid view may show a dilated IVC. The apical four chamber view helps visualise and compare all four chambers and McConnell's sign, which is hypokinesis of the RV wall, with apical preservation (8). It must be noted that cardiac PoCUS in pulmonary embolism, is used only to evaluate patients who may benefit from immediate intervention. It is not used to exclude pulmonary embolism (3).

Finally, cardiac PoCUS during cardiac arrest may be helpful during the pulse check-phase of cardiopulmonary resuscitation. It has been found to be especially useful in pulseless electrical activity (PEA) and asystolic cardiac arrest. This is because there may be reversible causes of PEA or asystole seen on cardiac PoCUS that can potentially be reversed. These include cardiac tamponade, findings suggestive of PE and severe hypovolaemia which have already been described (2).

Use of cardiac PoCUS in emergency centres in low- and middle-income settings

Low- and middle-income countries (LMICs) have a shortage of imaging modalities and availability due to lack of resources. Despite this, hand-held bedside ultrasound devices have become a useful tool for diagnostic imaging in resource-limited settings. In 2011, Sippel et al published a review article on the uses of bedside ultrasound in LMICs across the world. In Africa, studies published from Egypt, Tanzania, Rwanda and Liberia, reported obstetrics and gynaecology as the most useful component of ultrasound for diagnosing or changing patient management(12–15). A study from Congo/ Zambia reported abdominal ultrasound to be useful in diagnosing gastrointestinal pathology in patients with human-immunodeficiency virus(HIV)(16) (17). PoCUS has been found to be a useful bedside tool in these studies. However, access, maintenance, and skills amongst other challenges remain barriers to its availability. A survey was conducted across 44 LMICs in Asia, Africa and South America to identify the perceived barriers to bedside ultrasound. The most commonly perceived barrier was 'lack of training, followed by:

- cost of maintaining/ obtaining/ updating machines,
- lack of reliable maintenance to fix machine, lack of equipment, lack of internet to tele-communicate for support,

- no support personnel to answer questions,
- machine breaking,
- lack of gel,
- trained personnel in ultrasound leaving the site,
- lack of electricity or power, lack of support of point of care ultrasound from the hospital administration,
- discomfort in image interpretation,
- lack of support of point of care ultrasound from the radiology department,
- discomfort in using ultrasound to make images,
- too much time to get ultrasound and perform exam,
- liability concerns,
- adequate coverage by radiology – eliminating the need to perform own exam'(18).

Despite the challenges, the use of POCUS has been explored in some LMICs. In 2006, a medical delegation went to Gambia in Africa to conduct a study on the use of handheld cardiac ultrasound in patients with hypertension(19). The purpose of cardiac PoCUS was to assess for left ventricular hypertrophy (LVH), in patients who are borderline hypertensive. The diagnosis of hypertension with borderline high blood pressures requires repeat measurements and adequate personnel. Due to lack of resources in LMICs, this is not always possible. LVH is a risk factor for life-threatening cardiac conditions and is a complication of hypertension. Cardiologists used cardiac PoCUS to determine LVH using a parasternal long axis view and started antihypertensive treatment if LVH was found. This was identified as a beneficial use for cardiac PoCUS in a LMIC setting(19).

In 2012, a study conducted by Stachura et al, at a tertiary level hospital in Addis Ababa, Ethiopia, aimed to identify the high impact POCUS studies most relevant to an Ethiopian EC(20). Patients in the EC who received POCUS scans specified by the study during a fixed period were enrolled. There were fifteen POCUS scans of possible relevance identified. Of these there were three POCUS studies relevant to cardiac POCUS; pericardial effusion or tamponade, cardiac function, inferior vena cava for volume status. These three scans ranked amongst the top six POCUS studies that were requested, and evaluation for undifferentiated medical shock/hypotension and dyspnoea ranked in the top three clinical indications.

Overall, POCUS was found to change the management plan in 45% of the patients and provided clinically useful information in 95% of patients.

Shah et al conducted a study in two rural Rwanda district hospitals(14). They aimed to assess POCUS applications most used and the possible change in management plans. Cardiac POCUS was the third most commonly used study. Cardiac POCUS in this region was tailored to local burden of disease. Pericardial effusion, global LV function, and mitral stenosis was assessed based on previous demographics including rheumatic heart disease, viral and HIV cardiomyopathy, and tuberculous pericardial effusions. Cardiac POCUS changed management in patients found to have decreased global LV function, by adding diuretics to their management. The above studies have proved the utility of cardiac POCUS, but further literature focussing on the use of cardiac PoCUS in LMICs remain elusive.

Training guidance for cardiac PoCUS in emergency centres in high-income settings

Multiple academic bodies in emergency medicine and imaging have outlined recommended guidelines for emergency ultrasound training and accreditation. The international federation of emergency medicine (IFEM), has developed a document to assist and guide emergency medicine leaders to structure PoCUS training programs(21). The document does not dictate what should be done but recommends common steps that can be tailored to any training venue. IFEM recommends that the applications chosen to be taught in a training program, should be adapted to the local emergency practice. For each chosen application, candidates should be taught an introduction, gain experience, competency should be confirmed, and skills maintained. An example of a basic core application given is basic cardiac PoCUS: is the heart beating normally? Is there pericardial fluid? Is there an enlarged right ventricle? And is the left ventricle enlarged? Demonstration of how to generate and optimize an ultrasound image and apply it clinically should also be taught. They recommend that competency be assessed by a task specific checklist, and global rating scale.

The American College of Emergency physicians (ACEP) has also published a policy guideline on PoCUS by emergency physicians(22). They have identified twelve core applications. Like IFEM, they also state that candidates should be able to acquire adequate images. Basic ultrasound physics, knobology, application of exam protocols is also to be taught. They also recommend individualised assessment methods be used before and after the training period to assess areas of increased needs per candidate. In order to attain credentialing, candidates should have obtained 25-30 scans per application, and be assessed in objective structured clinical examinations (OSCEs)/simulations/question and answer sessions.

The American Society of Echocardiography (ASE) recommends that all PoCUS training programs be structured and assess competence(23). Three core components are emphasised: didactic education, hands-on image acquisition, and image interpretation experience. The ASE also strongly recommends that some of the hands-on training be done in real-time, as immediate feedback by an experience sonographer is crucial to learning. They also recommend that candidates perform a significant number of PoCUS scans on the specific ultrasound machine that is used in their practice.

The Australasian Society for Ultrasound in Emergency Medicine (ASUM), has also acknowledged the role of PoCUS across various disciplines, including emergency medicine. Similar to the other academic imaging bodies, PoCUS has been identified to be a point of care tool which assists in further assessment of physical examination findings, improve safety of certain emergent interventional procedures by providing image guidance (24). The Australasian College for Emergency Medicine (ACEM) have included PoCUS as a core skill in their emergency medicine training curriculum and includes basic echocardiography, e-FAST, AAA and procedural guidance(25). ACEM has produced a policy document on the credentialing process for focused echocardiography/basic echocardiography in patients with cardiac arrest or haemodynamic compromise(26). Recommended views are subcostal, parasternal long axis, parasternal short axis, apical 4 chamber when technically possible. They are to assess for LV and RV size and function, pericardial effusion and tamponade, and volume status. There are workshops to teach these views and clinical scenarios, with hands-on experience, and an assessment process for competency. The process also includes direct observation when scanning and a targeted number of specific scenarios to be scanned.

The Royal College of emergency medicine, United Kingdom, has developed a level one ultrasound curriculum for residents. The components include theory of ultrasound physics, relevant anatomy; a practical component with hands-on observation and teaching by experienced personnel; logbook records; and competency assessments during training(27).

There is an echocardiography in life support aspect of the level one course. The highlighted indications for use are cardiac arrest and the causes of pulseless electrical activity, that is hypovolemia, cardiac tamponade, and pulmonary embolism. The primarily used view is subxiphoid, but the parasternal long axis and short axis, and apical four chamber are also taught to maximise the chances of optimal views.

There are minor variations in the training recommendations by the various organisations. However, the principles of training: online and didactic teaching, hands-on practical on live models, and a structured competency assessment, remain the common goal.

Training guidelines for cardiac PoCUS in low- and middle-income settings

In 2017, Salmon et al authored an article on the current post graduate emergency medicine training programs in Africa. It was also acknowledged that LMICs have unique burdens of disease, resource limitations and challenges which resource-rich curricula do not take into account(28). They documented that Africa has eight emergency medicine residency programs. The most well organised PoCUS curriculum that is standardised for all emergency medicine programs within a country, exists in South Africa.

The College of Emergency Medicine South Africa (CEMSA) has a common credentialing process for basic emergency ultrasound across all five emergency medicine residency programs in the country. All emergency medicine residents are required to go through the process, but it is also available to other doctors. The course includes basic physics applicable to ultrasound scanning, operation (knobology) of ultrasound machines, generating an image, optimising visualisation of structures and identifying common artefacts, and normal and abnormal anatomy relevant to the scan. The components taught and tested are lower limb deep vein thrombosis (DVT), FEER (focused emergency echocardiography in resuscitation), abdominal aortic aneurysm (AAA), extended focused assessment and sonography in trauma (eFAST), and CVC (central venous catheter) insertion. The course is based on and adapted from guidelines by American College of Emergency Physicians (ACEP), the Australasian College for Emergency Medicine (ACEM) and the Royal College of Emergency Medicine (RCEM) in the United Kingdom. Candidates must complete an online test, attend a hands-on course with instructors, log a specified number of scans and submit a portfolio. The final step to accreditation is a practical and oral examination in an (OSCE)(29).

In a descriptive study conducted in multiple ECs by van Hoving et al in the western Cape, it was found that PoCUS in the EC is used for a multitude of indications other than those taught in the basic emergency ultrasound course. Cardiac PoCUS ranked as the third most common of the fourteen indications(30).

Conclusion

Cardiac PoCUS is well documented to be an important diagnostic tool in the EC internationally. There are many guidelines and proposed curricula by cardiology and imaging bodies in high-income country (HIC) settings. However, due to resource constraints and paucity of expertise, the guidelines of HICs may not always be relevant or adequate for the disease burden in LMICs. Training programs need to be developed and/or refined to meet the local disease patterns regionally for cardiac PoCUS to bridge the gap of patient diagnostics, and lack of advanced imaging modalities.

Further research is needed to identify the clinical indications and symptomology for which cardiac POCUS is used. This may help identify local patterns of disease that cardiac POCUS can assist in diagnosing or managing. This information may also help tailor local cardiac POCUS training programs to patient demographics in LMICs. It is highlighted in the training guidance of HICs, that multiple views and windows are the recommendation for adequate image acquisition. Understanding which the most commonly used views in LMICS are, can help identify the unique sequences for which cardiac PoCUS is used in LMICs. This may have training implications as well. Finally, resources and skill seem to be barrier to ultrasound availability in LMIC emergency centres. Further data is needed to identify the gaps in skills of ultrasound providers.

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Part B: Manuscript in article format

Title page

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

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Abstract

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

Background

Cardiac point of care ultrasound (PoCUS) has evolved into an important diagnostic tool in the daily practice of emergency medicine. Its use has been advocated internationally, but its limitations have also been emphasised. The indications for cardiac PoCUS vary somewhat in different parts of the world, and training programs may also differ. We set out to describe the self-reported 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 collection from the emergency centres of Mitchells Plain District, Victoria and New Somerset Hospitals was used. Data were collected over a three-month period, by all formally consented providers who have completed a basic emergency ultrasound course, using a purpose-designed data collection tool for all cardiac PoCUS scans. The study was approved the University of Cape Town's Human Research Ethics Committee (581/2017).

Results

We recruited 15 PoCUS providers who recorded 267 data entries over the 3-month study period. Seventeen surveys were excluded leaving 250 for analysis. The most common indication for cardiac PoCUS was electrocardiogram abnormalities, 27% (n=112); dyspnoea, 25% (n=102); chest pain, 16% (n=65); cardiomegaly on chest xray, 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

The results of the study suggest that cardiac PoCUS is used for a wide range of indications which are recommended in training guidelines. However, some indications are outliers but may be useful in low-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.

Main text of article

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

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) Cardiovascular PoCUS in particular has progressed to become a useful tool in the diagnostic evaluation, emergent management and guidance in ongoing management of shock, chest pain, cardiac arrest and acute dyspnoea(2)(3)(4). Rapid assessment by cardiovascular 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). The American College of Emergency Physicians and American Society of Echocardiography views PoCUS to be an indispensable first line test for cardiac assessment in an acutely symptomatic patient. They have stated that cardiac PoCUS is not intended to replace comprehensive echocardiography, but to guide Emergency Care practitioners on emergent management and serve a complementary role in comprehensive echocardiography (2). The IFEM recommends that all emergency medicine trainees are trained, assessed and credentialed in PoCUS before graduating as emergency physicians.

The American Society of Echocardiography and the American College of Emergency Physicians have developed a consensus statement outlining the utility of Focused cardiac ultrasound (FOCUS) in the emergent setting. They have defined the principle role of focused cardiac ultrasound as a time sensitive assessment of a symptomatic patient. Clinical indications for FoCUS, other than cardiac arrest; included cardiac trauma, hypotension and shock, dyspnoea and chest pain. (2)

The College of Emergency Medicine of South Africa's (CEMSA's) policy statement outlines the process of becoming an accredited PoCUS provider.(6) This Basic Emergency Ultrasound Course (EUS) includes attending an accredited training course which teaches basic ultrasound physics, use of the ultrasound machine, optimising images and proficiency in five clinical components: extended focused assessment by sonography in trauma (eFAST), assessment of lower limb deep vein thrombosis, using ultrasound to guide central venous catheter placement, assessment for an abdominal aortic aneurysm, and focused emergency echocardiography in resuscitation (FEER). The candidate is then required to complete a log book with a specified number of scans observed and signed off by accredited ultrasound trainers, followed by a credentialing examination. The CEMSA policy document describes FEER as limited echocardiography used in the setting of non-shockable cardiac arrest rhythms; that is PEA (pulseless electrical activity), and asystole. FEER 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 view is primarily used, but parasternal long axis, short axis and apical four chamber views can also potentially be used (6). Clinicians are trained in these views and ultrasound signs of these pathological processes. FEER is the only cardiac assessment in the CEMSA basic EUS course. Anecdotally, in clinical practice, emergency physicians, registrars (specialist trainees) and medical officers (non-training grade doctors) use cardiac PoCUS for indications beyond cardiac arrest.

The aim of this study was to describe the self-reported indications for, and specific use (sites and windows applied) during bedside cardiovascular 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 a

combination of three regional and district level public hospitals 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 lack of resources, and second the lack of existing data on this topic restricted the use of a power calculation. Data collection occurred over a fixed period of three consecutive months. 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 registrars and emergency centre medical officers. At the same time demographic data were collected and included information on medical qualifications, additional ultrasound qualifications and a self-reported evaluation of competency in performing various bedside cardiovascular PoCUS windows.

Step two, study data were then 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 URL link to the survey were converted to a quick response (QR) code which were in turn applied to the ultrasound device(s) in each of the study sites. It also contained a reminder to record study data and a study telephone number in case of a query or QR code link error. Consented participants were encouraged to record as many data entries as convenient. We estimated that a single data entry would take less than two minutes to complete. Where consented providers did not have access to a QR scanner, a logbook was provided to collect the same set of data. Weekly check-ins with all providers were done to encourage data capture and to pick up and deal with bugs in the process.

Following data capture, the data sample were downloaded from SurveyMonkey to excel for analysis. All data were collected using the electronic survey. There was no data collected using a logbook.

A self-reported competency scale for the various windows, was used as follows:

- 1- Not used
- 2- Not competent at all
- 3- Somewhat competent
- 4- Competent
- 5- Very competent

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 over the 3-month period. Seventeen surveys were excluded leaving 250 for analysis. The excluded surveys were the initial surveys submitted by participants to pilot test the QR code from their smart device. All entries were complete and 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.

Table 1: Highest qualification versus job title of PoCUS providers

Participants	Consultants	Registrars	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

There were 150 (60%) completed entries that listed only one indication for ultrasound. There were 100 (40%) completed entries that listed multiple indications for ultrasound. Other indications 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%) per indication.

The most commonly used view for cardiac PoCUS was parasternal long axis 236 (32%), followed by parasternal short axis 160 (22%), apical five chamber 153 (21%), subxiphoid four chamber 102 (14%) and subxiphoid inferior vena cava 80 (11%).

Table 2: Indication for and specific windows used for cardiac PoCUS

Indications	Number of PoCUS events per indication (n)	%	Views Used	Number of times views utilised (n)	%
Overall	415	n/a	parasternal long axis	236	
			parasternal short axis	160	
			apical five chamber	153	
			subxiphoid four chamber	102	
			subxiphoid inferior vena cava	80	
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%	subxiphoid four chamber	21	95%
			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%

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.

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

Window	Medical Officer	Registrar	Emergency Physician
All windows	3 (4-2.75)	3 (5-3)	4 (5-4)
Parasternal Long Axis	3,5 (4-3)	4 (4.25-4)	5 (5-4)
Parasternal Short Axis	3,5 (4-3)	4 (4.25-3.75)	4 (5-4)
Apical Five Chamber	3 (3.25-2.75)	3 (3.5-3)	4 (5-3)
Subxiphoid Four Chamber	3,5 (4-3)	4,5 (5-4)	5 (5-4)
Apical Four Chamber	3 (3.25-2.75)	3,5 (4.25-3)	5 (5-3.5)
Subxiphoid Inferior Vena Cava	3 (3.25-2.75)	4,5 (5-4)	5 (5-4)
Suprasternal	2 (2-2)	2 (3-1)	2 (4-2)
Window	EUS Trainee	Accredited in EUS	Advanced Course
All windows	3 (4-3)	4 (4-3)	3,5 (5-4)
Parasternal Long Axis	4 (4-3,5)	4 (4,5-4)	4,5 (5-4)
Parasternal Short Axis	3,5 (4-3,5)	4 (4-3.5)	4,5 (5-4)
Apical Five Chamber	3,5 (3.5-3)	3,5 (3.5-3)	3,5 (5-2)
Subxiphoid Four Chamber	3,5 (4-3,5)	4 (5-4)	4,5 (5-4)
Apical Four Chamber	3,5 (3.5-3)	3,5 (4.5-3)	4 (5-4)
Subxiphoid Inferior Vena Cava	3,5 (3.5-3)	3,5 (4.5-4)	4,5 (5-4)
Suprasternal	2 (2-2)	2 (5-1)	3,5 (3-2)

Discussion

This study found that most of the PoCUS indications were largely applied for its recommended use by various emergency medicine bodies(2,6-10). That said, the most commonly used indication for cardiac PoCUS described in this study was for

ECG abnormality – not listed as an indication for cardiac PoCUS by either the European Association of Cardiovascular Imaging (EACVI) or the American Society of Echocardiography/ American College of Emergency Physicians (ASE/ ACEP) guidelines. Various pathologies may be suspected from ECG abnormalities. Further diagnostic testing, including radiology and laboratory may not immediately be available in LMIC settings. This is possibly the reason for the increased use of cardiac POCUS as a quick, accessible adjunct in diagnosing and treating EC patients. Other indications for cardiac PoCUS, that are also not listed as recommendations included transient ischaemic attack, general fatigue and troponin leak. However, these were less commonly applied. This may simply reflect the variability in use of cardiac PoCUS between differently resourced settings. It is worth exploring these indications further, specifically from a training perspective, as training programs should ideally be tailored to local burdens of disease (11). In the absence of other advanced imaging (computed tomography and magnetic resonance imaging) in resource limited settings, PoCUS can be a useful tool. However, if it is to be used for indications outside of published western guidelines this should be backed by an appropriate evidence base. This will ensure safe practice within vulnerable communities.

As expected, the use of multiple views was required to make cardiac PoCUS assessments. Parasternal long and short axis, apical four and five chamber, and subxiphoid views are the most commonly mentioned views in the literature for adequate image acquisition (12–15). Self-reported competency in all views is the highest in providers with the highest qualifications and in those who have completed advance cardiac PoCUS courses.

Regarding limitations, the study does not represent the full spectrum of indications for PoCUS and windows used in the Western Cape, as it is not a powered study. The data collected from each of the three ECs may not have been equally contributory to the complete data set. This could possibly result in specific EC POCUS protocols influencing the captured indications for POCUS. We do believe it provides a reasonable guide of what PoCUS is used for within these low resourced settings. It was initially proposed that all electronic surveys will be linked to the ultrasound

providers who performed them. This was to be done by collecting the internet protocol (IP) addresses of each providers smart device being used to complete the electronic surveys and matching it to the data collected from each survey (including the IP address of the device on which the survey was completed). Also, the linking of IP addresses to each provider and the surveys, was meant to be a security measure to ensure that PoCUS scans done by only consented providers were captured on the database. However, the IP addresses were found to not be unique to the devices. The data collected could therefore not be linked to the providers. It is considered safe to assume that data was collected by only the consented participants, as PoCUS scans in each of the emergency centres are only allowed to be performed by doctors who have completed the basic emergency ultrasound course or under the supervision of an accredited provider. The inability to link surveys to providers did not influence the objectives of the study.

Self-reported competency and self-reported image quality was not confirmed by an external reviewer. However, competency of providers and their ability to obtain adequate images was not an objective of the study.

Conclusion

Cardiac point of care ultrasound is an important tool that has been integrated into emergency medicine practice. The results of this study suggest that cardiac PoCUS is used for a wide spectrum of clinical scenarios even in LMIC settings. The self-reported competency of cardiac PoCUS providers improves with higher levels of qualification and experience. Given the low resource environment it is understandable that there were some out-of-scope use by some providers. It may be worth exploring this further. Although enhancing the current local cardiac PoCUS curriculum may benefit patients, it may also complicate what is meant to be a simple bedside investigation. The feasibility of such a step will need to be properly explored in order to reduce potential harm.

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Nora-Ann for assistance with data management.

Competing interests and funding

The authors declare no competing interests. The study was self-funded by the investigators.

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Part C: Addenda

A. Relevant journal *Instructions to Authors*

The article presented in Part B has been formatted for publication in the following journal: African Journal of Emergency Medicine

The guidance for authors can be found at the following URL:

<https://www.elsevier.com/journals/african-journal-of-emergency-medicine/2211-419x/guide-for-authors>

B. Questionnaire/ data capture instrument

Provider Demographics

1. Name of Provider: _____

2. Highest medical qualification (circle):

Undergraduate (MBChB or equivalent) Masters or equivalent (MMed, FCEM
etc) PhD

3. Are you a specialist trainee? (circle)

Yes/ No

4. Highest ultrasound qualification (circle):

Basic Emergency Ultrasound (CEMSA) Basic Emergency Ultrasound (CEMSA) -
trainee Advanced bedside cardiovascular ultrasound Advanced bedside
cardiovascular ultrasound - trainee

Mobile Phone Check

5. QR code scanner provided on device? (circle)

Yes/ No

6. If yes, please provide IP number: _____

7. Please scan the code below to check functionality



8. If no, have you been provided with a logbook? (circle)

Yes/ No

Self-reported cardiac ultrasound competency

Please indicate how competent you are in using the described windows

<u>Window</u>	<u>Not used</u>	<u>Not competent at all</u>	<u>Somewhat competent</u>	<u>Competent</u>	<u>Very competent</u>
Parasternal Long Axis					
Parasternal Short Axis					
Apical 5 chamber					
Subxiphoid 4 chamber					
Apical 4 chamber					
Subxiphoid inferior vena cava					
Suprasternal					

Please select only the applicable options (You make select more than one):

1. Indication for Bedside cardiovascular PoCUS

- Chest pain
- Haemodynamic instability
- New murmur

- Chest trauma
- Dyspnoea
- Cardiac Arrest
- ECG abnormality
- Cardiomegaly on chest x-ray
- Other. Please Specify: _____

2. Windows used

- Subxiphoid four chamber
- Subxiphoid inferior vena cava
- Parasternal Long Axis
- Parasternal Short Axis
- Apical 5 Chamber

3. Self-reported image quality

- Adequate
- Not adequate, but able to interpret
- Not adequate, unable to interpret

4. Training

- I performed this ultrasound under supervision

- I performed this ultrasound without supervision
- I supervised this ultrasound

Comments:

C. Consent forms and any related participant information sheets

Information Sheet and consent

I am conducting a study to describe the indications for, and windows used for bedside cardiovascular point of care ultrasound (PoCUS) performed on patients in the Emergency Centre.

You are invited to participate as a data collector if you are credentialed in or in the credentialing process of the Basic Emergency Ultrasound course outlined by the College of Emergency Medicine South Africa. Participation is entirely voluntary, and you may withdraw from the study at any point, should you wish to.

You will be requested to fill in a provider form with your qualifications. The information you provide is confidential and will only be accessed by the research team. Your name will not be used in or published in data analysis.

There are no additional risks to you or your patient other than those in routine daily practice.

Data collection requires you to have a Quick Response (QR) scanner installed on your smartphone. For every bedside cardiac PoCUS, you perform in the EC, you will be required to scan the QR code attached to the ultrasound machine. This will open a survey for you to fill and submit electronically. There will be a number to contact in the event of failure in the ability to do this.

You will also be required to provide your phone Internet Protocol (IP) address, to ensure that the data submitted is only collected by consented providers. This information will be kept confidential and deleted after data collection.

Should you be unwilling or unable to perform data collection electronically, a logbook will be provided to your EC to record information.

The outcome of the study will be compared to international bedside cardiovascular PoCUS curricula, with the possibility of modifying our current South African curriculum.

Please tick the following box:

- I agree to participate in the study outlined in the information sheet and understand the information provided by the researcher

Signature of participant: _____ Date: _____

Thank you for your participation.

Kind Regards

Dr U. Ganas

Registrar

Division of Emergency Medicine

Cape Town

ushiraganas@gmail.com

Ethics number: HREC 581/2017

D. Acknowledgements

Thank you to my parents Mr and Mrs Ganas for their unwavering support, and to SG for his faith and encouragement.

E. Research Protocol

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

Student: Dr Ushira Ganas

Supervisors: 1. Dr JJ Malan

2. A/Prof SR Bruijns

Division of Emergency Medicine

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1. Introduction

1.1 Background

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) PoCUS is a useful bedside imaging technique in Emergency Medicine. (2)

Point of care cardiovascular ultrasound by Emergency Practitioners in acute care settings, has been described as early as the 1990s for penetrating cardiac injuries. The rapid assessment by cardiovascular PoCUS showed a mortality benefit in this population (3). Since then, cardiovascular PoCUS has progressed to become a useful tool in diagnostic evaluation, emergent management and guidance in ongoing management (4) of shock, chest pain, cardiac arrest (3), acute dyspnoea (5). Its use in patients with these symptoms looks primarily at chamber sizes, inferior vena cava in fluid assessment, aortic root for dissection, pericardial and pleural effusions, left ventricular function. (6)

Cardiac PoCUS in particular, has been noted by the American College of Emergency Physicians and American Society of Echocardiography, to be an indispensable first line test for cardiac assessment in a symptomatic patient. They have devised a consensus statement outlining the clinical applications of cardiac PoCUS and its limitations. They have stated that cardiac PoCUS is not intended to replace comprehensive echocardiography, but to guide Emergency Care practitioners on emergent management and serve a complementary role in comprehensive echocardiography. (4)

IFEM recommends all Emergency Medicine trainees be adequately trained in, assessed and credentialed in PoCUS before the end of their training period. South Africa is amongst the countries that have an established PoCUS curriculum.(1) In South Africa, PoCUS credentialing is mandatory for, but not limited to Emergency Medicine trainees.(7)

Countries that have established PoCUS curricula (Canada, Australasia, South Africa, United Kingdom) have differences in the content and training process(1).

The College of Emergency Medicine South Africa (CEMSA), has published a policy statement, outlining the process of becoming an accredited PoCUS (referred to as *Basic Emergency Ultrasound* in the policy document) provider.(7) The process entails attending an accredited training course which teaches basic ultrasound physics, use of the machine, optimising images and proficiency in five clinical components. These components are: extended focused assessment by sonography in trauma (eFAST), assessment of an abdominal aortic aneurysm, assessment of lower limb deep vein thrombosis, using ultrasound to guide central venous catheter placement and focused emergency echocardiography in resuscitation (FEER). The candidate is then required to produce a log book with a specified number of scans observed and signed by accredited ultrasound trainers or copies of the images. The final step is a credentialing examination with a theoretical and practical component.

Accredited basic emergency ultrasound providers may then proceed to train in PoCUS with a larger scope at their choosing.

1.2 Motivation

Cardiovascular PoCUS provides a wealth of information. It is not incorporated into the CEMSA Basic emergency ultrasound course. Anecdotally, a more enhanced scope of cardiovascular practice is being practiced by some doctors locally.

Understanding what aspects of cardiovascular ultrasound is used, may help to shape the curriculum for advanced training. This study provides the opportunity to describe the use of cardiovascular PoCUS.

1.3 Research question

What is cardiovascular PoCUS used for in emergency centres at a selection of secondary-level public hospitals in Cape Town?

1.4 Aim

The aim of this study is to describe the self-reported indications for, and specific use (sites and windows applied) during bedside cardiovascular PoCUS as used at a selection of secondary-level, public hospital Emergency Centres (ECs) in Cape Town.

1.5 Objectives

- I. To describe the self-reported indications for bedside cardiovascular PoCUS as used at a selection of secondary-level public hospital ECs at secondary level public hospitals in Cape Town
- II. To describe the specific windows used during bedside cardiovascular PoCUS as used at ECs at selected secondary-level public hospitals in Cape Town
- III. To describe the self-reported competency of providers for various bedside cardiovascular PoCUS windows

2. Methodology

2.1 Study Design

A descriptive study will be conducted using prospective data collection.

2.2 Study setting and population

Data will be collected from a combination of three regional and district level public hospitals in the Western Substructure of Cape Town: Mitchells Plain District Hospital, Victoria Hospital and New Somerset Hospital. These EC's are included in the academic training program for Emergency Medicine in the Western Cape. As a formal study will require more resources to adequately answer all aspects of cardiovascular PoCUS use in the EC, we have decided to rather collect a convenience sample initially for this study to first test the feasibility of a larger study. The study sample will therefore be limited by the time over which the study will be conducted.

Data collection will occur over a fixed period of two consecutive months. Given an estimate of four providers at each facility performing at least one cardiovascular PoCUS per shift or every other shift, per provider, we estimate an eventual sample size of between 240 and 480 data entries if each provider works 20 days a month.

2.3 Data Collection

A two-step approach will be used for data collection. Firstly, consent (appendix A) will be obtained from the emergency care providers who will be performing cardiovascular PoCUS. It is imperative that they have been credentialed, or are in the credentialing process for at least basic PoCUS or Basic Emergency Ultrasound (as defined in the CEMSA policy document). As such, providers will include emergency physicians, emergency medicine trainees and emergency centre medical officers. Demographic data will be collected from the participating providers employed in the EC at each of the three facilities, using the data collection sheet presented in Appendix B. This will include information on medical qualifications, additional ultrasound qualifications and a self-reported evaluation of competency in performing various bedside cardiovascular PoCUS windows. A check of the providers smartphone (when available) will be performed at the same time to allow streamlined data

collection. This will include checking the device to ensure it has a Quick Response(QR) code scanner installed and the provider knows how to operate this. If the device has a QR scanner, the providers Internet Protocol (IP) address of their smartphone will be collected. This is important to ensure that only the consented providers data will be collected for analysis. The e-survey client that will be used for data collection has the capability to restrict access to the pre specified IP addresses only.

Secondly (for providers with QR scanner), study data will be collected using the e-survey client SurveyMonkey (San Mateo, California). A short survey will be created to capture information regarding individual cardiovascular PoCUS assessments(Appendix C). The URL link to the survey will be converted to a QR code which will in turn be applied to the ultrasound device(s) in each of the study sites with a reminder to record data on cardiac ultrasounds as well as a number to contact in case of a query or QR code link error. Consented providers then simply have to scan the code and enter the data requested in the survey when they have completed a cardiovascular PoCUS. We estimate it will take less than two minutes to complete a single data entry. If the survey is used by other users this will be identified by the lack of inclusion of their smart device's IP address in the list captured as part of the demographic data and the e-survey client will not allow a data entry. The e-survey client will not store any data onto the device, but merely uses the device as a collection conduit.

Alternatively (where providers do not have a device with a QR code scanner), a logbook will be provided that will collect the same set of information.

Weekly check-ins with providers will be done to encourage data capture and to pick up and deal with bugs in the process (i.e. change of smartphone, broken smartphone, broken QR code link, etc.).

2.4 Data safety and monitoring

The Division of Emergency Medicine's secure SurveyMonkey account will be used for data collection. Access to the account is controlled by the division's junior research

fellow. Although we have no interest in the identities of individual providers, these will at least initially be captured along with their smartphone's IP addresses in order to link their IP addresses with e-client. This will be required for trouble-shooting during data collection. Names of providers and references to individual facilities will be removed from any data set prior to data analysis. These will be captured into Excel (Microsoft Office, Redmond, Washington).

Once the survey has closed, the data sample will be downloaded from SurveyMonkey to Excel. Any data captured in a logbook will be transcribed into the spreadsheet. After merging the two databases, names and IP addresses will be removed and replaced with unique study numbers to identify individual providers.

Data capture tools (electronic or logbook) will not capture any patient data at any point in the study. Electronic files related to the project will be password protected and stored on an access controlled desktop computer in the division's offices. Following completion of the study, paper documents will be stored in a dedicated, lockable study cupboard at the division's offices, as per HREC guidance. Only the study team and the division secretary will have access to study material.

2.5 Data analysis

Demographics will be presented using descriptive statistics. Indications for, and windows used during bedside cardiovascular PoCUS will be ranked in terms of usage and presented in tables and as proportions. We do not plan any inferential statistics on this part of the analysis. Associations between self-reported competency in bedside cardiovascular PoCUS with the indications for and frequency of specific windows used for the bedside cardiovascular PoCUS will also be descriptively expressed. Depending on the sample size, categorical data may be compared using the Chi Square or Fishers Exact Test. The latter will be done in consultation with the Clinical Research Centres statistical services. It has to be stressed that this study has not been powered and it was planned primarily as a descriptive study. The focus will therefore be on presenting findings descriptively.

3. Time Schedule

<u>Task</u>	<u>Time Frame</u>
EMDRC	3 months
HREC	3 months
Facility approval	2 months
Data Collection	3 months
Data Management	2 months
Analysis and Reporting of Results	2 months
Writing	2 months
Prepare and submit for publication	2 months

4. Ethical Considerations

The Health Sciences Research Ethics Committee of the University of Cape Town will be approached for ethics approval. Facility approval will be obtained via the National Health Research Database.

4.1 Description of risks and benefits

As mentioned previously, data will be collected electronically or in a logbook, There is risk of loss of data which is intended to be minimised by weekly export of electronic surveys to excel and storage by the junior research fellow. Logbooks, if used, will be collected and stored by the junior research fellow on a weekly basis.

The probability and magnitude of risk and discomfort to the patients in the study, are not anticipated to be greater than those routinely experienced.

Risk to the providers are not anticipated to be greater than their daily work routine as they are being requested to now collect data of the bedside cardiovascular PoCUS that they are performing as daily practice. Confidentiality of the providers will be maintained as only the research team have access to data collected. Personal identifiers will be removed prior to data analysis.

The outcomes of the study may potentially benefit the future of the cardiovascular PoCUS curriculum in South Africa. The data collected will be compared the use of cardiac PoCUS in Emergency Centres in countries with established PoCUS curricula. This comparison will potentially assist in the revision and improvement of the current basic cardiac ultrasound training of South African Emergency Medicine trainees.

This may in turn broaden the scope of cardiovascular PoCUS by providers and benefit patients that use the healthcare system by allowing accurate and more efficient decision making and management plans at first contact in the EC.

4.2 Informed Consent process

Providers will be provided with an information sheet (Appendix A) to read and have the process explained. Written consent will then be obtained from providers (Appendix B).

As no patient identifiable information will be captured, we request a waiver of consent from the HREC for individual data entries.

4.3 Privacy and Confidentiality

Data security and management has already been discussed. The study does not report on outcomes, only on the use and indications of cardiovascular PoCUS. Although every attempt will be made to anonymise providers, it is possible that a provider can be identified given their known ultrasound practices within a small community of providers. We believe that given the low risk nature of this study that identification by this manner is firstly unlikely, and secondly unlikely to result in harm to the providers or their reputation. Please refer to the description of benefits and risks above.

4.4 Reimbursement for participation

Providers will not be reimbursed

4.5 Emergency Care and insurance for research-related injuries

Research-related injuries are not anticipated for this low risk study

5. Limitations

- I. The number of data collectors are limited, as only providers whom are credentialed or in the credentialing process of basic emergency ultrasound, at the very least, are eligible to collect data. Data collection is also therefore dependent on the number of shifts they work and the number of bedside cardiovascular PoCUS scans they perform per shift.
- II. Data collection relies on ultrasound machines within the Emergency Centres which need to be in working order. Most of the facilities which data will be collected at, have one ultrasound machine in the EC. This machine is shared by all providers in the EC.
- III. The study only reports on the indications and findings, not on outcome. Knowing the outcome is an important variable in understanding if the test added value. The purpose of this study is to describe how ultrasound is used and is therefore not directed at outcome. It is for this reason that we are also not collecting the findings. We anticipate that this study will be followed by another that will consider the findings and the outcome.

6. Reporting and Implementation of results

The study results will be reported to the heads of the institutions involved. We are hoping to also present these findings at a local conference and perhaps consider publication. The CEMSA Ultrasound committee will also be informed of the findings.

7. Resources

7.1 Available resources

The data collectors are emergency care practitioners employed by the Western Cape Government. Ultrasound machines are the property of the institutions.

7.2 Budget

Expense	Cost (ZAR)
Telephone and data	400.00
Statistical Service	0.00
Stationery and Printing	500.00
Survey Monkey	0.00
Total Cost	900.00

Motivation for expenses:

- 1) Telephone and data – To maintain contact with the data collectors and internet for data capture
- 2) Stationery and Printing – Consent forms and information sheets need to be printed

8. References

1. International Federation of Emergency Medicine. Point-of-care emergency ultrasound guidelines.
2. Micah R. Whitson, Paul H. Mayo. Ultrasonography in the emergency department. *Critical Care* 2016;20:227
3. Robert T Arntfield, Scott J Millington. Point of Care cardiac Ultrasound Applications in the Emergency Department and Intensive Care Unit – A Review. *Current Cardiology Reviews* 2012;8:98-108
4. Arthur J Labovitz, Vicki E Noble 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* 2010;23(12):1225-1230
5. Sachita P. Shah, Sachin P. Shah et al. Focused cardiopulmonary ultrasound for assessment of dyspnoea in a resource-limited setting. *Critical Ultrasound Journal* 2016,8:7
6. Ka Leung Mok. Make it SIMPLE: enhanced shock management by focused cardiac ultrasound. *Journal of Intensive Care* 2016;4:51
7. Wells M, Bruijns S. College of Emergency Medicine of South Africa Policy Document. A provisional policy statement by the Emergency Ultrasound Subcommittee of the College of Emergency Medicine South Africa.

F. HREC approval letter



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



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31 August 2017

HREC REF: 581/2017

Dr J Malan
Emergency Medicine
c/o Eileen Maas
F51, OMB

Dear Dr J Malan

PROJECT TITLE: A DESCRIPTIVE STUDY OF THE USE OF CARDIOVASCULAR POINT OF CARE ULTRASOUND (PoCUS) IN PUBLIC EMERGENCY CENTRES IN CAPE TOWN (MMed-candidate- Dr U Ganas)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 31 August 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal Investigator.

Please note that for all studies approved by the HREC, the principal Investigator **must** obtain appropriate Institutional approval, where necessary, before the research may occur.

The HREC acknowledge that the student, Dr Ushira Ganas will also be involved in this study.

Yours sincerely

Signature Removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

HREC 581/2017