Utilization of Emergency Point of Care Ultrasound in an Emergency Department in Johannesburg

Tamsyn Beth Baillie Stanton

Student number: 9700493K

Master of Medicine in Emergency Medicine

University of the Witwatersrand

Supervisor: Prof Mike Wells

DECLARATION

I, Tamsyn Beth Baillie Stanton, student number 9700493K, declare that this research report

is my own original work and that I contributed adequately towards the research findings.
I am aware that plagiarism (the use of someone else's work without their permission and / or without acknowledging the original source) is wrong.
I confirm that ALL the work submitted is my own unaided work except where I have explicitly indicated otherwise. I have followed the required conventions in referencing the thoughts and ideas of others.

Signed:

Tamsyn Baillie Stanton

Date: 7/12/2017

Utilization of Emergency Point of Care Ultrasound in an Emergency Department in Johannesburg

Baillie Stanton T, Wells M

ABSTRACT

Introduction

Point-of-care ultrasound (PoCUS) is a widely utilized tool in Emergency Medicine (EM). The core PoCUS curriculum in South Africa (SA) does not currently include lung ultrasound or basic bedside echocardiography, although the burden of disease in a typical South African Emergency Department (ED) is skewed towards respiratory and cardiac pathologies. This study was undertaken to determine the profile of PoCUS examinations actually performed and potentially indicated in this ED, and whether current training in PoCUS is meeting the need in clinical practice.

Methods

This was a prospective observational audit of bedside PoCUS examinations actually performed, and potentially indicated, over a two-week period in the Helen Joseph Hospital ED in Johannesburg.

Results

The study included 372 patients. Ultrasound aided in the diagnosis and management of 107 (28,8%) of the patients. A total of 137 PoCUS investigations were performed. A total of 38,9% of the patients had positive ultrasound findings.

The most frequently performed PoCUS applications were e-FAST (extended focused assessment by sonography in trauma) (32,8%), DVT assessment (13,9%) and procedural guidance (10,9%).

A total of 758 PoCUS examinations were indicated in 307 (82,5%) of the patients.

Overall, 18,1% of the potentially indicated PoCUS investigations were performed.

The most frequently potentially indicated PoCUS applications were lung ultrasound (28,2%), basic cardiac (28%) and haemodynamic assessments (20,4%).

Conclusions

These findings reflect the high number of respiratory and cardiac cases seen in South African EDs. This highlights the consequent need for additional ultrasound skills to assist in the emergency management of such cases. Training of future South African EM specialist consultants should include both lung ultrasound and basic bedside echocardiography. It is time to update to the South African core PoCUS curriculum.

INTRODUCTION

Emergency medicine (EM) is a clinical field synonymous with innovation. EM has embraced ultrasound technology since the 1990s, much like the medical profession adopted the stethoscope in the 1800s. The current generation of medical providers are being trained to use this technology as an integral extension of their clinical examination[1].

Emergency point-of-care ultrasound (PoCUS) differs from formal ultrasound in that the clinician simultaneously performs and interprets the ultrasound[2]. The medical provider immediately uses the information acquired for rapid decision-making[3]. PoCUS is generally used to answer questions of a binary nature[4], to rule-in or rule-out life-threatening conditions or treatment pathways[5]. An example of this would be to confirm the presence or absence of pericardial fluid in a patient with penetrating chest trauma.

There are many applications of PoCUS. Ultrasound investigation can be driven by symptoms[6] for example, breathlessness or chest pain. Sonography can also be directed by clinical signs[6], for example hypoxia or low blood pressure. Used at the bedside, sonography aids the clinician in diagnosis and further patient management[3]. Ultrasound can be used to guide medical interventions and procedures[6][7]. Another benefit to ultrasound is that it is easily repeatable[7], thus making it a dynamic monitoring tool to assess responsiveness to a specific therapy[6]. Ultrasound has now become widely adopted as part of the assessment of virtually every unstable and undifferentiated patient in EM[8]. PoCUS is also a valuable tool in resuscitation, and has been incorporated into international and Southern African 2015 cardiac arrest guidelines[9][10].

There are many advantages to utilizing PoCUS. The non-invasive nature of this investigation increases its safety profile[5], as well as patient satisfaction[11]. Unlike many other radiological investigations, ultrasound is without the risk of exposure to ionizing radiation. In the resource-limited setting, PoCUS is a cost-effective alternative to other potentially inaccessible, advanced radiographic imaging modalities[7]. The benefit of this is to decrease diagnostic and treatment delays[7].

PoCUS training is now formally included in post-graduate EM academic programs world-wide. Emergency ultrasonography has been recognized as such a vital skill that it has been incorporated into early undergraduate training in several medical schools in the United States[1][12], including Harvard Medical School, and the Universities of California and Carolina. Training in PoCUS has not yet extended to the undergraduate level in South Africa (SA). Undergraduate medical training world-wide, including in SA, will eventually follow suit.

The content of an emergency ultrasound course may differ slightly from region to region, depending on the prevalence of pathology and requirements for that area. In SA the basic PoCUS course comprises the modules detailed in Table 1 (Section A). This curriculum was devised by the Emergency Ultrasound Subcommittee of the

College of Emergency Medicine of SA (CEMSA)[8]. The basic course is accessible to doctors, nurses and paramedics. Certification in the basic PoCUS course requires passing a theoretical and practical test, where the medical provider must demonstrate proficiency in sonar skills. The current specialist Fellowship of College of Emergency Medicine (FCEM) of SA requires registrars to obtain a basic PoCUS certification as an entry criterion for the final qualification examination. The details of this current curriculum is included in Table 1 (Section A).

Many advances have been made in the realm of PoCUS as used by Emergency Physicians. Examples of this are ultrasound measurement of optic nerve sheath to assess raised intracranial pressure[13], and ultrasound confirmation of endotracheal tube placement[14]. A number of these advanced sonar applications are included in Table 1. Despite these developments in PoCUS, the current PoCUS curriculum in SA has not mirrored this progress. Nor does it reflect the range of pathologies seen in SA Emergency Departments (EDs).

There is a dearth of literature available on the PoCUS applications that are actually being performed country-wide in SA. There are currently no studies which reveal the most common clinical uses, or potential uses, of PoCUS in Johannesburg.

EM education will benefit from evidence to guide further refinement of the core curriculum skill-set for post-graduate ultrasound training in SA. The objective of this study was therefore to describe the range of PoCUS examinations performed in an Emergency Department (ED) in Johannesburg, as well as the group of patients in whom the sonars were performed. It also aimed to identify the ultrasound exams that potentially could have been performed to aid diagnosis and management, based on the medical profile of the patients, their presenting complaints and working diagnoses. The study aimed to determine if the local burden of disease necessitates a change in the PoCUS curriculum in SA.

METHODS

Study design

The study was a prospective, observational audit.

Study setting and population

This was a single-centre study based at Helen Joseph Hospital (HJH), a secondary-level state facility in Johannesburg, Gauteng SA. HJH is part of the academic training circuit for EM registrars, with a patient population that is a mixture of medical and surgical cases, including trauma and orthopaedics. Few paediatric, obstetric and gynaecology (O&G) patients are seen at HJH, due to the close proximity of a specialised mother-and-child hospital.

Any patient presenting to the ED during a two-week period, from the 23rd January until 8th February 2017, was eligible for inclusion. Patients under the age of 18 years were excluded. Lack of consent, missing data collection sheets and patient records were additional criteria for exclusion from the study. Participating patients and staff signed consent to be involved in the study.

Sampling method

Non-probability sampling was used, with a combination of convenience and quota sampling. The researchers aimed to get equal numbers of patients that underwent PoCUS examination and those that didn't, with a total target of approximately 300 patients. The target number of 300 was set by the Division of Emergency Medicine research committee, and was not a statistically calculated target. More patients than this were invited to volunteer to allow for exclusion criteria and to allow for study drop-out. Patients were recruited non-consecutively.

Data collection

Log-sheets were completed by the regular ED staff for each patient seen who underwent ultrasound examination. The data for the patients in whom PoCUS examinations were not performed was retrieved from patient registers in the ED. In cases of missing relevant information, patient records were accessed for clarification purposes.

In the HJH ED, doctors are not permitted to provide a formal report on their PoCUS findings unless they are Level 1 basic PoCUS credentialed, or unless the PoCUS is proctored by a trained provider. This formal reporting of findings will be hand-written documentation into the clinical bedside notes of the patient. Informal, uncredentialed PoCUS examinations may be undertaken, but not documented in the bedside notes (for medico-legal reasons). The implication of this is that potentially more sonars were done than were captured in the study.

The data collected included information about the patients, the doctors attending to patients, and the PoCUS examinations performed:

- patient demographics: age, sex

- time of day the patient presented to the ED
- South African Triage Scale (SATS) category of the patient: red, orange, yellow or green
- patient disposition: where the patient went to after their ED consultation
- qualification of the doctor attending to the patient
- Level 1 basic PoCUS certification of doctor
- presenting complaint of the patient: the main symptoms or reason given by the patient for attending the ED
- working diagnosis: the ED diagnosis for the patient
- whether or not a PoCUS was performed for each patient in the study
- type of PoCUS performed
- PoCUS findings: negative or positive

Both the main presenting complaints and working diagnoses were obtained from the ultrasound data collection sheets, ED patient registers or patient clinical notes. Presenting complaints and working diagnoses were grouped into major pathophysiological clinical systems.

A negative PoCUS finding was where the PoCUS examination was recorded as normal. A positive finding was where the PoCUS identified clinically relevant abnormal findings.

A predetermined set of criteria was used to determine if a PoCUS was potentially indicated for each patient in the study, according to the medical profile of that patient (Table 1).

These criteria are pre-existing indications for ultrasound, as guided by SA[8] / Internation Federation for Emergency Medicine (IFEM)[15] and other international guidelines[6]. The process of allocation of potential PoCUS examinations for study subjects was subjective, consensus between both investigators. This was based on presenting complaint, working diagnosis, triage category or clinical grounds.

A strong indication for potential PoCUS examination was considered to be present in situations where an ultrasound examination would probably benefit clinical patient care. A weak indication for potential PoCUS was considered to be present in situations where an ultrasound examination could possibly benefit clinical patient care.

Data analysis

Data analysis was carried out using SAS version 9.4 for Windows. Categorical data were described by frequency and percentage, while continuous data were described by mean, median, standard deviation, interquartile range and histograms.

The Chi-squared test was used to assess the relationships between categorical variables. Fisher's exact test was used for 2 x 2 tables or where the requirements for the Chi-squared test could not be met. The strength of the significant associations was measured using Cramer's V and the phi coefficient respectively. The following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little if any association

The relationship between continuous (age) and categorical variables was assessed by the t-test. Where the data did not meet the assumptions of these tests, a non-parametric alternative, the Wilcoxon rank sum test was used. The strength of the associations was measured by the Cohen's d for parametric tests and the r-value for the non-parametric tests. The following scale of interpretation was used:

0.80 and above	large effect
0.50 to 0.79	moderate effect
0.20 to 0.49	small effect
below 0.20	near zero effect.

The 5% significance level was used throughout.

Ethics

Approval was obtained from the Human Research Ethics Committee (Medical) at the University of the Witwatersrand, Johannesburg (protocol M140658).

RESULTS

A total of 390 (21%) of the 1853 patients seen in the HJH ED during the two week's data collection period consented to participate in the study. The number of patients who declined to participate were not recorded. Of the 390 patients who consented to participate, 372 (95,4%) were included in the study. Seven patients were excluded, as they were younger than 18 years of age. Eleven patients were excluded as there was insufficient data for analysis. Please refer to Figure 1, the PRISMA flow-chart of patient selection.

There were 158 (42,5%) female patients and 212 (57%) male patients in the study. Only 2 (0,5%) of the patients in the study were reported as gender unknown (Table 2). There was no significant association between patient's gender and whether or not the patient had a PoCUS. The median age of the patients (35y IQR 28-43y) who underwent a PoCUS examination was significantly lower than the median age (39y IQR 22-55y) of patients who did not. There was a significant, weak, association between time of presentation and whether or not a patient had EPCUS ($p=0.011$; Cramer's $V=0.26$) (Table 2). More PoCUS examinations were done during daylight hours.

The majority (52,2%) of the study patients were triaged as SATS "yellow" (Table 2). There was a significant, moderate, association between triage category and whether or not a PoCUS examination was performed ($p<0.0001$; Cramer's $V=0.38$). Patients triaged as SATS "red" were more likely to get a PoCUS, whereas those triaged SATS "yellow" were less likely to get a PoCUS.

Of the 372 patients included in the study, 152 (40,9%) were admitted (Table 2). There was a significant, weak, association between disposition and whether or not a PoCUS investigation was undertaken (p=0.0003; phi coefficient=0.28). The patients who had a PoCUS were more likely to be admitted.

Of the 372 patients included in the study, 107 (28,8%) had sonars performed during the study period (Table 3). A total of 137 sonars were performed on those 107 patients. Some patients had more than one ultrasound examination, depending on their presenting complaint or clinical indication for investigation. Of the patients investigated by PoCUS, 37 (38,9%) had positive sonar findings.

The majority of the patients, 47,8% (178/372), in the study were evaluated and treated by medical officers; and a further 12,4% (46/372) were evaluated and treated by EM registrars (Table 3). There was a significant, moderate association between doctor qualification and whether or not a PoCUS was performed (p<0.0001; Cramer's V=0.49). Of the 107 patients who did have a PoCUS exam, 91,6% (98/107) were evaluated and treated by medical officers and EM registrars.

A total of 37/57 (64.9%) of the patients that had a PoCUS were treated by Level 1 PoCUS trained doctors. None of the clinicians in the study were Level 2 PoCUS credentialed.

There was a significant, moderate, association between whether or not the doctor had attended a basic PoCUS course and whether or not a sonar was performed ($p<0.0001$; phi coefficient=0.40).

A total of 85% (91/107) of the patients that had a PoCUS examination were treated by doctors who had attended a basic Level 1 ultrasound course.

There was a significant, moderate association between whether or not the doctor had a basic Level 1 PoCUS accredention and whether or not a PoCUS was performed ($p<0.0001$; phi coefficient=0.26). Only 26,2% (28/107) of the patients that had a PoCUS exam were treated by doctors who were basic Level 1 ultrasound course accredited. None of the doctors in this study were accredited in the more advanced Level 2 PoCUS modules.

Figure 2 illustrates the profile of the presenting complaints of the study population, grouped into major systems. There were a total of 615 presenting complaints, as some patients had more than one main complaint. The primary presenting complaints were related to the respiratory, cardiovascular, gastrointestinal and musculoskeletal (MSK) systems.

Figure 3 shows the working diagnoses of the patients, grouped into major systems. There were a total of 464 working diagnoses, as some patients had more than one diagnosis. The primary diagnoses were respiratory, cardiovascular, soft tissue and neurological in nature. Soft tissue injuries were defined as injuries to muscles, tendons, ligaments and connective tissues[16].

The most commonly performed PoCUS applications, are shown in Table 4. e-FAST (33,6%), DVT assessments (13,9%) and procedural guidance (10,9%) were the most frequent sonar investigations performed. A smaller proportion of other sonars were done, including basic cardiac (8,8%), ocular (8,8%), GIT/Abdomen (6,6%).

The basic Level 1 ultrasound modules of e-FAST, DVT, basic cardiac, AAA and vascular access accounted for 65,7% (89/137) of the PoCUS applications performed in this ED. The remaining 34,3% (47/137) of the PoCUS exams performed in this ED fell within categories that are not yet included in the basic ultrasound curriculum. Some patients had more than one PoCUS module performed.

A PoCUS was potentially indicated in 82,5% (307/372) of the patients (Table 3).

Table 5 Identifies the PoCUS applications that were potentially indicated in the study population, based on the medical profile, triage category, presenting complaints and working diagnoses of the patients.

The total number of strongly indicated PoCUS examinations was 665, with an additional 93 weakly indicated sonars. Out of the total 758 potential PoCUS investigations that could have been undertaken, 137 (18,1%) actual PoCUS examinations were performed. Some patients had more than one potentially indicated PoCUS application. The breakdown of the indicated PoCUS applications, as well as the percentage of the strongly indicated PoCUS exams which were performed are detailed in Table 5.

The most frequently potentially indicated PoCUS applications were lung (28.2%), basic cardiac (28%) and haemodynamic (20,4%). A lesser number of e-FAST, procedural guidance, GIT/Abdominal and FASH sonars were potentially indicated. The gap between potentially indicated PoCUS components and those actually performed was highest, and most clinically relevant, between FASH and haemodynamic ultrasound.

DISCUSSION

During the study period of two weeks in the HJH ED a total of 107 patients had a PoCUS, and 137 PoCUS examinations were performed. The primary medical disorders were respiratory, cardiovascular and musculoskeletal, including soft tissue conditions.

The main PoCUS investigations performed were e-FAST, DVT assessment and procedural guidance. The main PoCUS applications potentially indicated were lung, echocardiography and haemodynamic. PoCUS examinations were more likely to be performed by medical officers and registrars, and by doctors who had completed Level 1 basic PoCUS training. Fewer than 20% of potentially indicated sonars were performed. The gap between performed and potentially indicated PoCUS exams was highest for FASH and haemodynamic components. There were significant gaps between the PoCUS applications that were actually performed and potentially indicated, and the core PoCUS curriculum.

PoCUS is an important diagnostic tool in EM, as is evidenced by 28,8% of all patients in this ED study undergoing some form of PoCUS.

This figure is higher than the 2012 Western Cape (WC) study, where 13% of the ED patients underwent PoCUS[17]. It is also higher than the use of ultrasound in 15.91% of acute medical admissions in a 2011 Cape Town (CT) study[18]. Those study figures are much higher than in another 2011 study in WC where only 4.5% of the population had an ultrasound as part of their workup[19] on admission. This is likely a reflection of the increased use of PoCUS in EM.

Putting it into perspective

When designing a national PoCUS curriculum, it is important to take into consideration the burden of disease and clinical need for specific PoCUS components in that country. This makes a syllabus relevant for the patients and gives clinicians appropriate ultrasound skills to manage typical conditions seen in the EDs[17]. In SA in 2013 the leading causes of mortality were TB, pneumonia, HIV and cardiac disease[20]. These are the patients that potentially present to EDs seeking acute medical care, who may benefit from PoCUS.

The primary medical conditions in this study population were respiratory, cardiovascular and musculoskeletal, including soft tissue injuries. This study population was similar to that of a recent CT study, where the most frequent clinical indications for ultrasound in the study population were respiratory (26.1%), musculoskeletal (15.6%) and cardiovascular (11.3%)[17] complaints. This is in contrast to another WC study that identified respiratory conditions (10.1%), blunt injury resulting from trauma (5.9%), and abdominal pain (4.9%) as the primary clinical complaints [19]. All three studies highlight the prevalence of respiratory complaints in SA.

The main PoCUS applications that were utilised in this current Johannesburg study were e-FAST, DVT assessment and procedural guidance. A smaller proportion of cardiac and ocular sonars were performed. The main PoCUS applications that were potentially indicated in this study were lung, basic cardiac and haemodynamic scans. A smaller proportion of potentially indicated sonars included e-FAST, procedural guidance, GIT/Abdominal and FASH.

The following sonar applications were the identified in a recent CT study[17] as most frequently performed: respiratory, MSK, cardiac, FASH and renal. Of note is that none of these components are currently included in the core PoCUS curriculum. A reason for the frequency of these additional PoCUS applications in the CT setting may be that the providers performing the PoCUS examinations were consultants. Specialist EPs frequently undergo further training in PoCUS, acquiring intermediate and advanced skills. Moreover, this study was conducted approximately five years ago when the use of PoCUS was incipient, and not as prevalent. Another, more significant reason for the frequency of these PoCUS modules could be the high clinical need for these particular elements of PoCUS in the study population, given the findings of the current study. To the knowledge of the authors, there are no other studies in Gauteng, or SA, detailing the extent of PoCUS use in EM.

Respiratory illness was the most prevalent medical condition in this study. Few lung ultrasound examinations were conducted in this study, but it was the leading potentially indicated PoCUS application. This is in contrast to the van Hoving study, where lung ultrasound was the most frequently performed PoCUS[17]. Both studies were performed in winter, increasing the prevalence of respiratory conditions[17]. This is a significant finding, as lung ultrasound is currently not yet included in the formal post-graduate PoCUS training. Lung ultrasound is technically easy to learn and to perform. These findings support the suggestion that lung ultrasound be included in the core curriculum.

Basic cardiac ultrasound was one of the leading ultrasound modules indicated in both this current study and the van Hoving study[17]. This is significant as basic cardiac peri-arrest ultrasound, the FEEL, is currently included in the core curriculum, but basic and advanced echocardiography are not. This study highlights the relevance and requirement for basic focused echocardiography in early patient management in the ED. Advanced echocardiography is a more difficult application of sonar and requires much more time to become proficient in the skill[21]. For this reason, advanced echocardiography is currently beyond the scope of the EM registrar PoCUS training.

The high number of e-FAST investigations performed in this ED reflected the high prevalence of trauma in Johannesburg and in South Africa[20][22][23][24]. Between 2002 to 2004 in a Johannesburg trauma unit, mainly clinical features were used to diagnose cardiac tamponade in patients with penetrating trauma[25]. Occasionally formal echocardiography was utilized. e-FAST did not feature prominently in patient management in the trauma unit at that time. Subsequently, e-FAST has become widely incorporated into trauma resuscitation within SA, following the worldwide trend[26]. Over a 12-month period in 2008, 72 e-FAST scans were performed at in patients with both blunt and penetrating trauma[27] at Ngwelezane Hospital ED in Northern KwaZulu Natal. The Ngwelezane study found that 28% of the e-FAST scans were positive. The e-FAST examination was found to be highly specific in that study, with a specificity of 100%. This figure is comparable with other studies [28][29] and reiterates the value of the e-FAST in management of trauma patients. Due to the high burden of trauma in SA[22], the e-FAST examination is currently and should remain a vital component of PoCUS training.

Assessement of haemodynamics was a frequent potential indication for PoCUS in this ED study. This module was infrequently performed both in this study and the CT ED study[17]. Haemodynamic PoCUS is a component that is relatively easy to learn and perform. It involves visualising the Inferior Vena Cava (IVC) to assess of intravascular status and provide an estimation of central venous pressure (Table 1, section B). In hypotensive patients, the assessment of IVC can be used to guide fluid or inotropic management of a patient [30]. It is a relevant additional module for an updated curriculum, that should be taught in conjunction with the basic cardiac examination.

The FASH scan was one of the most frequent PoCUS investigations undertaken by EM consultants in CT[17]. Only one FASH exam was undertaken in this study ED, even though it was frequently potentially indicated. This reason for this could be the lack of training or knowledge about the FASH exam. Due to the high burden of

HIV/AIDS and TB[21] the FASH is a PoCUS application that is of particular relevance in SA[32]. This is because the FASH exam aids in rapid identification of extra-pulmonary TB in settings with a high prevalence of TB[31]. FASH is a component that could be included in an updated curriculum, as most components of the FASH scan are already covered in the e-FAST and AAA modules.

Even though musculoskeletal and soft tissue conditions had a high prevalence in this study, no musculoskeletal ultrasounds were performed. This is in direct contrast to the Van Hoving study, where musculoskeletal sonars were ranked second[17]. The authors propose that musculoskeletal PoCUS may require a significant amount of time and skill to perform. This module is not currently part of the basic PoCUS course. The authors agree with Van Hoving et al, in that musculoskeletal PoCUS is not likely to be considered part of the core curriculum at this point in time.

The most common clinical uses of PoCUS in the United States 10 years ago were: trauma; cardiac arrest; pericardial effusion[33]; AAA; pelvic; biliary; procedural guidance; renal and DVT scans[5]. An 2010 Australian study found that PoCUS is mainly used in trauma, vascular access, AAA, ruling out cardiac tamponade, and confirmation of asystole[34]. A recent Canadian study described their main PoCUS applications as follows: AAA, free fluid in abdomen following trauma, pericardial fluid, and confirmation of intra-uterine pregnancy[35]. In Colombia PoCUS was used for trauma, obstetrics, procedures including vascular access, basic echo and volume status[36]. Although there appears to be significant overlap in sonar skills globally, of note, none of these countries featured lung ultrasound or FASH.

In this study PoCUS was more likely to be performed by medical officers, EM registrars and doctors who had attended training and certification in Level 1 basic PoCUS. This is a logical finding, as providers who have the opportunity to practice their PoCUS skills develop confidence in their abilities. Of concern in general EM practice, and in this study, is non-credentialed sonar investigations. It is important to note that ultrasound is an operator-dependent investigation. One of the major causes for error in PoCUS is the sonographer[37]. Providers should be aware of the risk missing important findings if they have not completed the necessary PoCUS training[36]. Providers should also be wary of over-estimating their skill and misinterpreting results. None of the clinicians in this study were credentialed in the current Level 2 PoCUS components of lung ultrasound or basic echocardiography.

Fewer than 20% of potentially indicated sonars were actually performed in this study. There are a few possible explanations for this. Providers will perform investigations that they have been trained to do[39] and feel most comfortable doing. The most common barrier to using PoCUS is lack of training[35]. Another barrier to PoCUS is technical difficulty in obtaining images[39], which is particularly relevant in echocardiography. Time pressure on doctors working in a busy provincial academic unit may have been another deterrent to doing extra ultrasound examinations. Another barrier to PoCUS is lack of senior supervision[39]. In a US study, providers felt less confident doing basic echocardiography, hepatobiliary, lung and intravascular volume assessment by ultrasound[39]. It should be noted that these components are not currently included in the basic PoCUS training in SA. Despite the advancement of PoCUS in EM, it is still not as widely accepted by other disciplines. For this reason, doctors may not spend the time doing a lung PoCUS when a CXR is still indicated in a patient with pneumonia for admission. Medicolegal reasons could be another factor contributing to the gap between actual and potential PoCUS examinations[39]. Doctors in this academic unit were not permitted to document their sonar findings in the clinical notes if they were not Level 1 PoCUS certified or proctored.

Another significant reason for the discrepancy between actual and potential PoCUS examinations is that the total number of potential PoCUS investigations was likely overestimated by the authors.

The gap between the PoCUS components actually performed and potentially indicated in this study was highest, and most clinically relevant, for FASH and haemodynamic ultrasound. Neither component is formally taught as part of the core PoCUS curriculum. This may explain why haemodynamic PoCUS and FASH exams were performed so infrequently. The gap was the lowest for e-FAST. This is likely because e-FAST is the most widely accepted, and possibly the easiest, PoCUS application to perform.

This study highlights discrepancies between the PoCUS practice in this ED and the current core PoCUS training in SA. The SA curriculum has not been formally updated since it was first drafted in 2009[8]. The American College of Emergency Physicians (ACEP) PoCUS guidelines that were drafted in 2001 were updated later in 2008[6][40]. Eight years after the initial SA guideline publication, it is reasonable to initiate a similar process for the PoCUS curriculum in SA.

When updating a PoCUS curriculum, PoCUS programme directors should balance the need for a specific PoCUS module against feasibility of each component. Factors to consider include the time and skill required to acquire and then competently perform the chosen sonar module; as well as the level of difficulty of each PoCUS application. Other important considerations are the prevalence and impact of the condition.

Recommendations for the PoCUS core curriculum

Both this study and the Van Hoving study reflect the high prevalence of respiratory and cardiac pathologies in SA. They both support the inclusion of lung ultrasound and basic focused echocardiography in the specialist FCEM curriculum. Van Hoving et al suggested a blue-print for determining the core PoCUS curriculum. Table 6 shows an adaption of this method that was used to recommend the focus of the future PoCUS core curriculum. The investigators took the following items into consideration when drawing up this table: prevalence of clinical disease; impact of disease; and difficulty of the PoCUS application. The most common clinical conditions in the study population were used to guide this recommendation.

LIMITATIONS

This was a single-centre study with a small number of patients preventing the generalization of the findings. The single week chosen to conduct the study might not be representative of the monthly patient profile.

The prospective sampling method may have introduced a degree of selection bias, as only patients able to consent could be enrolled in the study. As most consenting patients were SATS "yellow", this study doesn't reflect many of the critically ill or injured SATS "red" or "orange" patients presenting to the ED. This means that the actual number of total sonars performed was almost certainly underestimated.

Reporting bias is a potential problem with this study. Ultrasounds were probably under-reported, as filling out data collection sheets was not mandatory. Skills and approach to patient management can differ greatly between doctors. Where one practitioner may have felt an ultrasound was indicated, another may have believed otherwise. This is the reality of professional practice. Each independent practitioner is expected to follow the benchmark evidence and guidelines, but implements the guidelines based on individual interpretation and judgement. Certain applications of PoCUS are widely recognised, whilst newer developing modalities might not be widely accepted as the standard of care.

Matching patient's presenting complaints with potential indications for sonar was practically difficult to achieve. Despite having the literature-based set of criteria for PoCUS (Table 1), this process proved challenging. As this section of data analysis required subjective interpretation by the authors, the findings for this section may be biased. The authors acknowledge that for the purposes of this study, the number of potentially indicated ultrasounds may have been overestimated.

Since there was no intention to gather evidence to demonstrate if the PoCUS examinations performed altered management or outcomes, this aspect was not studied. Another limitation to the generalizability of the findings in this study might be the strong focus on PoCUS in the ED practice in this study. The expectation and academic emphasis on the use of sonar in this particular unit is not necessarily common to all other SA EDs. The ED in this study is an accredited academic teaching facility and it would thus be expected that this best-practice diagnostic modality would feature prominently. Despite this possible bias, it cannot be denied that PoCUS is gaining in momentum in EM.

CONCLUSION

PoCUS is a vital tool in expediting appropriate patient care in resource-limited hospitals and EDs around SA. PoCUS training should be relevant and locally congruent with prevalent emergency medical conditions encountered in the ED.

It is time to revise and update the SA PoCUS guidelines. This study highlights that local burden of disease in this urban study setting differs from the current basic EM PoCUS curriculum in SA. The study supports the addition of further PoCUS applications to the current specialist FCEM curriculum to match current evidence and best practice.

Due to the high number of cardiac and respiratory cases seen, lung ultrasound and basic cardiac sonar were the most frequently indicated studies. This study confirms that with regards to emergency cardiac ultrasound, the FEEL is not sufficient for the South African population. Both lung and basic focused echocardiography should be added to the post-graduate PoCUS curriculum. FASH, another module that is of particular relevance for the population in SA, should be included.

Additional ultrasound applications will benefit patient diagnosis and management. Further studies are required to identify those modules to ensure that the South African PoCUS curriculum reflects the broader South African burden of disease

REFERENCES

1. Solomon SD, Saldana F. *Point-of-Care Ultrasound in Medical Education — Stop Listening and Look.* New England Journal of Medicine, 2014. 370(12): 1083-1085.
2. Rozycki GS. *Abdominal ultrasonography in trauma.* Surgical Clinics of North America, 1995. 75(2): 175-191.
3. Sankoff J, Keyes LE. *Emergency medicine resident education: making a case for training residents to perform and interpret bedside sonographic examinations.* Annals of Emergency Medicine, 1999. 34(1): 105-108.
4. Bruijns SR, Engelbrecht D, Lubinga W, Wallis LW. *Penetrating the acoustic shadows: emergency ultrasound in South African emergency departments.* South African Medical Journal, 2008. 98(12): 932-934.
5. Tayal VS. *Emergency Ultrasound*, in *Rosen's Emergency Medicine - Concepts and Clinical Practice*, J.A. Marx, R.S. Hockberger, and R.M. Walls, Editors. 2014, Elsevier: Philadelphia. 2492-2504.
6. American College of Emergency Physicians. *Emergency Ultrasound Guidelines*, 2008. 1-38. [Accessed 2015 31 December]; Available from: www.acep.org/workarea/downloadasset.aspx?id=32878
7. Lamprecht H, Stander M, Van Hoving N. *Emergency point-of-care ultrasound applications.* Continuing Medical Education, 2012. 30(11): 416-420.
8. Wells M, Bruijns S. *Emergency Ultrasound Policy.* Policy document. Part 1 - Credentialing for Emergency Ultrasound, 2009. [Accessed 2012 19 October]; Available from: http:// emssa.org.za/documents/CEM(SA)-Emergency-Ultrasound-POLICY.pdf.

9. Callaway CW, Soar J, Aibiki M et al. *Part 4: Advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations.* Resuscitation, 2015. 132(suppl 1): S84-S145.

10. Resuscitation Council of Southern Africa. *Advanced Cardiac Arrest Algorithm-Adult and Paediatric*. 2015 [Accessed 2015 12 November]; Available from: http://www.resuscitationcouncil.co.za/advanced-cardiac-arrest-adult-paediatric.

11 Howard ZD, Noble VE, Marill KA, et al. *Bedside ultrasound maximizes patient satisfaction.* Journal of Emergency Medicine, 2014. 46(1): 46-53.

12. Hoppmann RA, Rao VV, Bell F et al. *The evolution of an integrated ultrasound curriculum (iUSC) for medical students: 9-year experience.* Critical Ultrasound Journal, 2015. 7(1): 18.

13. Blaivas M, Theodoro D, Sierzenski PR. *Elevated intracranial pressure detected by bedside emergency ultrasonography of the optic nerve sheath.* Academic Emergency Medicine, 2003. 10(4): 376-381.

14. Chou HC, Tseng WP, Wang CH, et al. *Tracheal rapid ultrasound exam (T.R.U.E.) for confirming endotracheal tube placement during emergency intubation.* Resuscitation, 2011. 82(10): 1279-1284.

15. Atkinson P , Bowra J, Jarman B et al. Internation Federation for Emergency Medicine: *Point-of-Care Ultrasound Curriculum Guidelines 2014.* Canadian Journal of Emergency Medicine, 2015. 17(2): 161-170 .

16. Sports Medicine Australia. Injury Fact Sheets. *Soft Tissue Injuries.* Website [Accessed 2016 10 April] Available from http://sma.org.au/resources-advice/injury-fact-sheets/soft-tissue-injuries/.

17. van Hoving DJ, Lamprecht HH, Stander M, et al. *Adequacy of the emergency point-of-care ultrasound core curriculum for the local burden of disease in South Africa.* Emergency Medicine Journal, 2012. 30(4): 312-315.

18. de Vries E, Raubenheimer P, Kies B, et al. *Acute hospitalisation needs of adults admitted to public facilities in the Cape Town Metro district.* South African Medical Journal, 2011. 101(10): 760-764.

19. Cohen KL, Wallis LA. *Is the current South African emergency medicine curriculum fit for purpose? An emergency medicine practice analysis.* Emergency Medicine Journal, 2011. 28(11): 955-958.

20. Statistics South Africa. *Mortality and causes of death in South Africa, 2013: Findings from death notification*, 2014. Statistics South Africa. 1-135.

21. Via G, Hussain A, Wells M et al. *International evidence-based recommendations for focused cardiac ultrasound.* J Am Soc Echocardiogr, 2014 vol. 27(7) pp. 683.e1-683.e33

22. Lewis C, Wood D. *Interpersonal violence as a major contributor towards the skewed burden of trauma in KwaZulu-Natal, South Africa.* SAMJ. 2015. 105(10): 827-830

23. Goosen J , Plani F, Moeng MS. *Overview of trauma in South Africa.* Occupational Health Southern Africa. 2007. July/August: 1-8 [Accessed 2017 5 November]; Available from: http://www.occhealth.co.za/?/download/articles_171_878/Overview+of+trauma+in+South+Africa.pdf

24. WHO. Bulletin of WHO. Norman R, Matzopoulos R, Groenewald P, Bradshaw D. *The high burden of injuries in South Africa.* 2007. 85 (9): 649-732. [Accessed on 10/11/2016] Avail from: http://www.who.int/bulletin/volumes/85/9/06-037184/en

25. Degiannis E, Loogna P, Doll D, et al. *Penetrating cardiac injuries: recent experience in South Africa.* World Journal of Surgery, 2006. 30(7): 1258-1264.

26. ATLS and The ATLS Subcommittee, and the International ATLS working group. *Advanced trauma life support (ATLS): The ninth edition. (Special Report).* Journal of Trauma and Acute Care Surgery, 2013. 74(5): 1363-1366.

27. Smith ZA, Wood D. *Emergency focussed assessment with sonography in trauma (FAST) and haemodynamic stability.* Emergency Medicine Journal, 2014. 31(4): 273-277.

28. Ghafouri HB, Zare M, Bazrafshan A et al. *Diagnostic accuracy of emergency-performed focused assessment with sonography for trauma (FAST) in blunt abdominal trauma.* Electronic Physician. 2016. 8(9): 2950-2953. [Accessed 2017 November 30]; Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5074755/

29. Richards JR, McGahan JP. *Focused Assessment with Sonography in Trauma (FAST) in 2017: What Radiologists can Learn.* Radiology. 2017. 283(1) : 30-48. [Accessed 2017 16 November]; Available from: https://doi.org/10.1148/radiol.2017160107

30. American College of Emergency Physicians. Goldflam K, Saul T, Lewiss R. *Focus on: Inferior Vena Cava Ultrasound.* June 2011. ACEP Website. [Accessed 2017 30 November]; Available from: https://www.acep.org/Content.aspx?id=80791#sm.0001s44utpisodu3u5h1se3biybyg

31. Heller T, Wallrauch C, Lessells RJ et al. *Short Report: Short Course for Focused Assessment with Sonographt for Human Immunodeficiency Virus/ Tuberculosis: Preliminary Results in a Rural Setting in South Africa with High Prevalence of Human Immunodeficiency Virus and Tuberculosis.* Am J Trop Med Hgy. 2010. 82(3): 512-515

32. Heller T, Wallrauch C, Goblirsch S et al. *Focused assessment with sonagraphy for HIV-associated tuberculosis (FASH): a short protocol and pictorial review.* Critical Ultrasound Journal. 2012. 4(21): 1-9

33. Moore CL, Molina AA, Lin H. *Ultrasonography in community emergency departments in the United States: access to ultrasonography performed by consultants and status of emergency physician-performed ultrasonography.* Annals of Emergency Medicine, 2006. 47(2): 147-153.

34. Nagaraj G, Chu M, Dinh M. *Emergency clinician performed ultrasound: availability, uses and credentialing in Australian emergency departments.* Emergency Medicine Australasia, 2010. 22(4): 296-300.

35. Leger P, Fleet R, Maltaid-Giguere J, et al. *A majority of rural emergency departments in the province of Quebec use point-of-care ultrasound: a cross-sectional survey.* BMC Emergency Medicine, 2015. 15(1): 36.

36. Henwood, PC, Beversluis D, Genthon A, et al. *Characterizing the limited use of point-of-care ultrasound in Colombian emergency medicine residencies.* International Journal of Emergency Medicine, 2014. 7(1): 7.

37. Pinto A, Pinto F, Faggian A, et al. *Sources of error in emergency ultrasonography.* Critical Ultrasound Journal, 2013. 5 Suppl 1: S1.

38. Russell J. *Ultrasound is revolutionising emergency medicine, but is UK training up to speed?* 2015. [Accessed 2016 8 January]; Available from: http://careers.bmj.com/careers/advice/Ultrasound_is_revolutionising_emergency_medicine,_but_is_UK_training_up_to_speed%3F.

39. Bellows B, Totten J, Shah S, et al. *Perceived Barriers in the Use of Point of Care Ultrasound in the WWAMI Region.* Journal of Emergency Medicine and Critical Care, 2015. 1(1): 1-4.

40. American College of Emergency Physicians. *Emergency Ultrasound Guidelines.* Annals of Emergency Medicine, 2001. 38(4): 470-481.

TABLE 1: PoCUS APPLICATIONS AND INDICATIONS			
APPLICATION	ABBREVIATION	DESCRIPTION	INDICATION
SECTION A	**BASIC ULTRASOUND APPLICATIONS (Formerly Level One) (Wells 2009[8])**		
Trauma	e-FAST - Extended focused assessment by sonography in trauma	Peritoneal fluid	Blunt abdominal trauma
		Pelvic fluid	Hypotension in trauma
		Pleural fluid	Penetrating chest injury
		Pneumothorax	Polytrauma
		Pericardial effusion	Decreased level of consciousness
Cardiac	FEEL -Focused emergency echocardiography in life support	Pericardial fluid	Cardiac arrest
		Cardiac stand-still	Suspected pericardial effusion
Venous	LCUS for DVT -Limited compression ultrasonography for deep vein thrombosis	Lower extremity – limited compression (3 point compression) of femoral + popliteal veins	Suspected DVT (deep vein thrombosis)
			Suspected PE (pulmonary embolus)
			Leg swelling
Vascular access	VA	Central line placement	Peripheral or central venous access
		Peripheral line placement	
Aorta	AAA - Assessment for abdominal aortic aneurysm	Abdominal aortic aneurysm	Vasculopath
			Elderly
			Hypotension
			Back-ache
SECTION B	**CORE / ADJUNCT ULTRASOUND APPLICATIONS (IFEM 2014[15] ACEP 2008[6])**		
Abdominal		Peritoneal fluid	Ascites
Lung / thoracic		Pleural fluid	Respiratory distress
		Pneumothorax	Hypoxia
Cardiac	Basic cardiac	Global LV function	Hypotensive patient
Fluid status / haemodynamic	IVC inferior vena cava assessment		Hypotensive patient
			IVC evaluation for volume / pressure status
Obstetric & gynaecology	O&G	Intra-uterine pregnancy	Abdominal/ pelvic pain
		Free fluid in pelvis / POD	PV bleeding in pregnancy
			Suspected ectopic pregnancy
Ocular		Optic nerve sheath diameter	Suspected raised intracranial pressure
		EOM movement + pupillary reactivity	Severely swollen peri-orbital haematoma
Soft tissue	ST	Abscess versus cellulitis	Soft tissue infections
Renal & U-G	Renal & urogenital	Gross assessment of bladder volume	Urinary retention
		Hydronephrosis	Renal colic
			Suspected renal calculi
Hepatobiliary	HPB	Gallstones	Abdominal pain
		Cholecystitis	Suspected cholecystitis
SECTION C	**EXTENDED / INTERMEDIATE APPLICATIONS (FORMERLY LEVEL 2) (IFEM 2014[15], ACEP 2008[6])**		
Trauma		Solid organ injuries	
Abdominal / **gastrointestinal**	GIT	Appendicitis	
		Diverticulitis	
Lung / thoracic		Interstitial fluid	Respiratory distress
		Consolidation	Hypoxia
		Pleural thickening	
		Ventilator management	
Cardiac	Basic bedside echocardiography	RV size and function	Hypoxia
		Systolic + diastolic function	Respiratory distress
		Tamponade	Suspected massive PE
Vascular	Vasc	DVT – complete lower limb assessment	
		DVT – upper limb assessment	
43	VA	Arterial line placement	
		Subclavian venous access	
Obstetrics & gynaecology	O&G	Adnexal assessment for cysts or masses	
		Ovarian torsion	
		Uterine masses	

Ocular		Lens dislocation	Posterior chamber and orbital pathology
		Retinal detachment	
		Vitreous haemorrhage	
Soft tissue	ST	Foreign bodies	
		Masses, Myositis	
Musculoskeletal	MSK	Fractures	
		Joint effusions	
Renal		Renal parenchymal assessment	
		Complex vs simple renal cysts	
		Renal doppler	
Hepatobiliary	HPB	Liver – assessment for masses, portal venous thrombosis	
		Pancreas – assessment for masses, inflammation, cysts	
		Spleen – assessment for size, haematoma, parenchymal changes	
Testicular		Testicular torsion, epididymitis, cysts, fracture	Testicular pain
			Testicular trauma
Paediatric		Appendicitis	
		Pyloric stenosis	
		Intussusception	
		Hip evaluation	
		Lumbar punctures	
Nerve blocks	NB	Femoral	Analgesia for fractures, dislocations, massive tissue trauma
		Forearm	
		Intercostal	
Scrotum	Testes & scrotum	Assessment of testicular blood flow in suspected testicular torsion	
Infective	FASH - Focused assessment of sonography in HIV & TB	Pericardial fluid	Assessment for extrapulmonary TB
		Pleural fluid	
		Peritoneal fluid	
		Hypoechoic splenic lesions	
		Echogenic kidneys	
		Lymphadenopathy	
		Thickened bowel wall	
Head & neck	H&N	Evaluation of neck for airway masses	
		Airway compromise	
		Vocal cord assessment	
Procedural guidance	PG	Thoracocentesis	Invasive procedures
		Paracentesis	
		Abscess drainage	
		Pericardiocentesis	
		Foreign body removal	
		Joint aspiration	
		Lumbar punture	
Confirmation of placement / procedure		Fracture reduction	
		Joint reduction	
		ETT placement confirmation	
		Evaluation of tubes eg OGT	
SECTION D	**ADVANCED ULTRASOUND APPLICATIONS (IFEM 2014[15], ACEP 2008[6])**		
Gastrointestinal	GIT	Hernia assessment	
		Colitis, ileus	
		Diverticulitis	
		Pneumoperitoneum	
Cardiac	Advanced bedside echocardiography	Regional wall motion abnormalities	
		Quantitative valve assessment	
Vascular	Vasc	Arterial insufficiency	
		Carotid stenosis	
		Transcranial Doppler	
Ocular		Retrobular haematoma	
		Orbital emphysema	
		Foreign body	
Musculoskeletal	MSK	Tendon, ligament and muscular injuries	

FIGURE 1. PRIMSA FLOW-CHART OF PATIENT SELECTION.

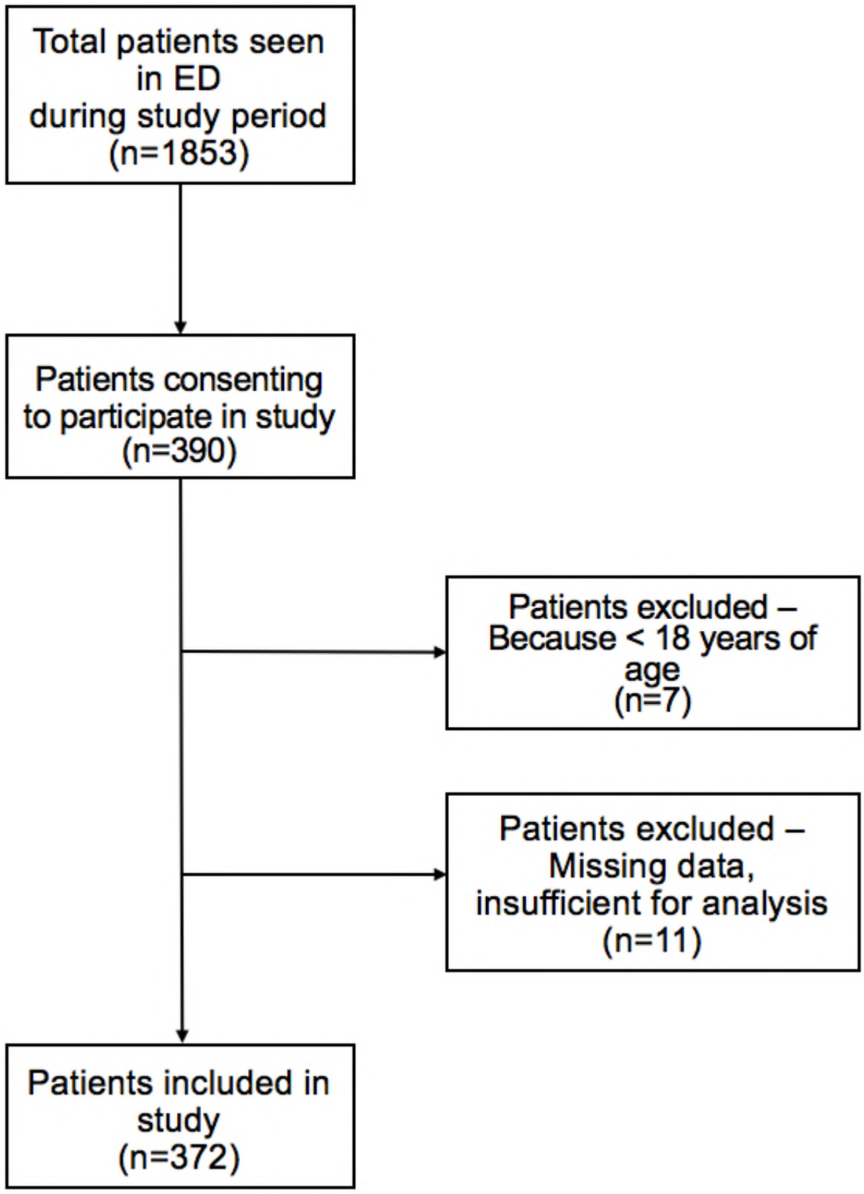

TABLE 2. PATIENT PROFILE AND DEMOGRAPHICS								
Variable	Category	Overall		Had POCUS		Did not have POCUS		p-value for between-group test
n		372		107		265		
		n	%	n	%	n	%	
Patient Sex	Female	158	42,5%	38	35,5%	120	45,3%	0,083
	Male	212	57,0%	69	64,5%	143	54,0%	
	Unknown	2	0,5%	0	0,0%	2	0,8%	-
Patient Age (years)	mean/sd	41,3	16,4	38,3	14,6	42,5	16,9	-
	median/IQR	38	29-52	35	28-43	39	29-55	0.047 (r=0.10)
	range	18-90		18-90		18-89		-
Time of presentation (hour of the day)	unknown	12	3,2%	1	0,9%	11	4,2%	-
	00h00-01h59	5	1,3%	5	4,7%	0	0,0%	0.011 (V=0.26)
	02h00-03h59	3	0,8%	1	0,9%	2	0,8%	
	04h00-05h59	10	2,7%	5	4,7%	5	1,9%	
	06h00-07h59	11	3,0%	3	2,8%	8	3,0%	
	08h00-09h59	43	11,6%	14	13,1%	29	10,9%	
	10h00-11h59	67	18,0%	15	14,0%	52	19,6%	
	12h00-13h59	55	14,8%	14	13,1%	41	15,5%	
	14h00-15h59	46	12,4%	13	12,1%	33	12,5%	
	16h00-17h59	43	11,6%	7	6,5%	36	13,6%	
	18h00-19h59	31	8,3%	14	13,1%	17	6,4%	
	20h00-21h59	31	8,3%	9	8,4%	22	8,3%	
	22h00-23h50	15	4,0%	6	5,6%	9	3,4%	
SATS Triage category	Red	32	8,6%	27	25,2%	5	1,9%	<0.0001 (V=0.38)
	Orange	95	25,5%	25	23,4%	70	26,4%	
	Yellow	194	52,2%	46	43,0%	148	55,8%	
	Green	40	10,8%	8	7,5%	32	12,1%	
	Unknown	11	3,0%	1	0,9%	10	3,8%	
Disposition	Unknown	25	6,7%	6	5,6%	19	7,2%	-
	Admit	152	40,9%	56	52,3%	96	36,2%	0.0003 (V=0.28)
	Discharge	142	38,2%	28	26,2%	114	43,0%	
	RHT	1	0,3%	0	0,0%	1	0,4%	
	Died	5	1,3%	5	4,7%	0	0,0%	
	Referral	45	12,1%	11	10,3%	34	12,8%	
	Transferred	2	0,5%	1	0,9%	1	0,4%	

TABLE 3: PROFILE OF DOCTORS AND OVERVIEW OF PoCUS EXAMINATIONS								
Variable	Category	Overall		Had PoCUS		Did not have PoCUS		p-value for between-group test
n		372		107		265		
		n	%	n	%	n	%	
Doctor qualification	Medical officer	178	47,8%	64	59,8%	114	43,0%	<0.0001 (V=0.49)
	Community service	114	30,6%	9	8,4%	105	39,6%	
	Registrar	46	12,4%	34	31,8%	12	4,5%	
	Intern	32	8,6%	0	0,0%	32	12,1%	
	Unknown	2	0,5%	0	0,0%	2	0,8%	-
Doctor attended PoCUS course	No	173	46,5%	16	15,0%	157	59,2%	<0.0001 (phi=0.40)
	Yes	199	53,5%	91	85,0%	108	40,8%	
Doctor PoCUS accredited	No	325	87,4%	79	73,8%	246	92,8%	<0.0001 (phi=0.26)
	Yes	47	12,6%	28	26,2%	19	7,2%	
PoCUS performed	No	295	79,3%					
	Yes	107	28,8%					
PoCUS findings (excluding Procedural guidance) (n=95)	Negative	55	57,9%	55	57,9%			
	Positive	37	38,9%	37	38,9%			
	Inconclusive	1	1,1%	1	1,1%			
	Unknown	2	2,1%	2	2,1%			
Procedural guidance success (n=15)	Successful	13	86,7%	13	86,7%			
	Unsuccessful	1	6,7%	1	6,7%			
	Unknown	1	6,7%	1	6,7%			
PoCUS potentially indicated	No	65	17,5%	1	0,9%	64	24,2%	<0.0001 (phi=0.28)
	Yes	307	82,5%	106	99,1%	201	75,8%	

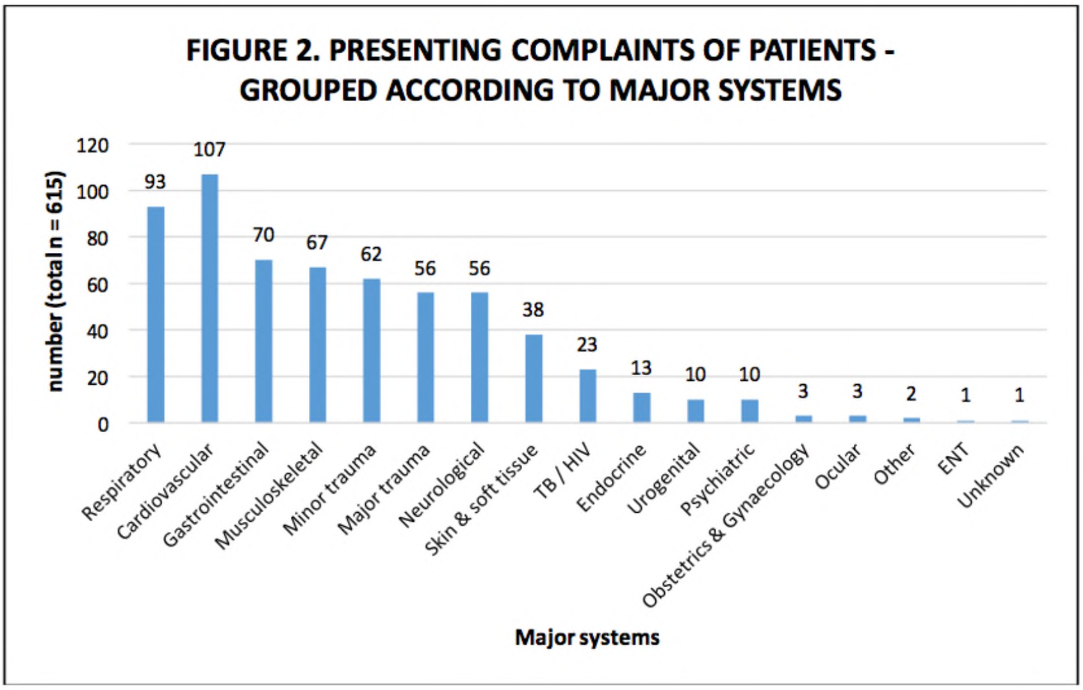
FIGURE 2. PRESENTING COMPLAINTS OF PATIENTS - GROUPED ACCORDING TO MAJOR SYSTEMS
number (total n = 615)
120
100
80
60
40
20
0
93
107
70
67
62
56
56
38
23
13
10
10
3
3
2
1
1
Respiratory
Cardiovascular
Gastrointestinal
Musculoskeletal
Minor trauma
Major trauma
Neurological
Skin & soft tissue
TB / HIV
Endocrine
Urogenital
Psychiatric
Obstetrics & Gynaecology
Ocular
Other
ENT
Unknown
Major systems

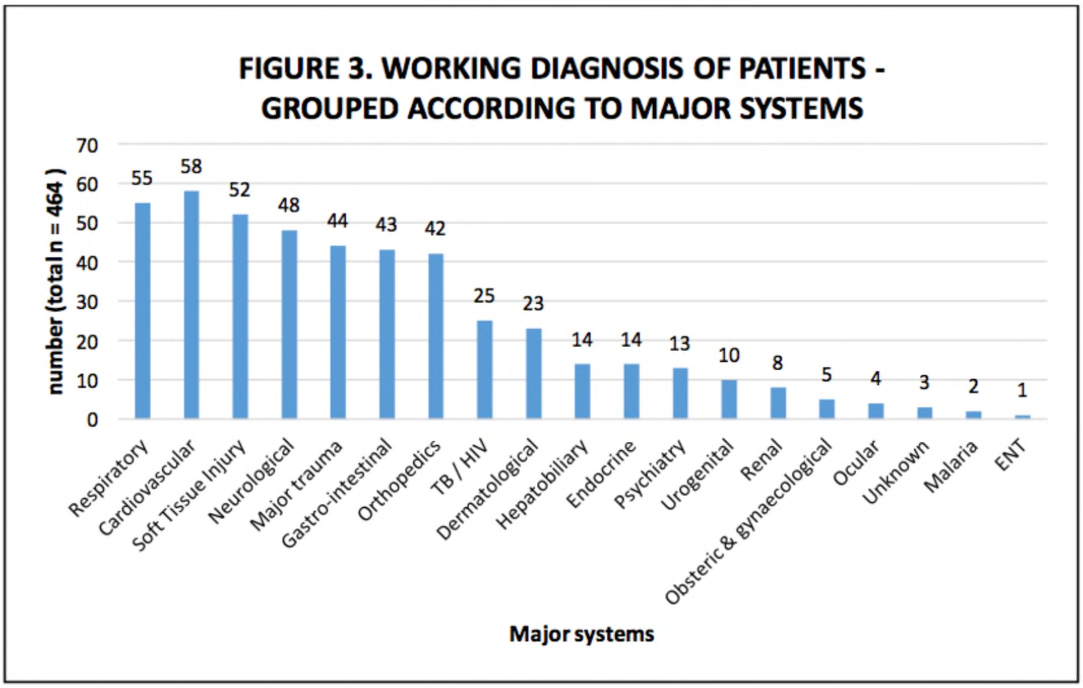
FIGURE 3. WORKING DIAGNOSIS OF PATIENTS - GROUPED ACCORDING TO MAJOR SYSTEMS
number (total n = 464)
70
60
50
40
30
20
10
0
55
58
52
48
44
43
42
25
23
14
14
13
10
8
5
4
3
2
1
Respiratory
Cardiovascular
Soft Tissue Injury
Neurological
Major trauma
Gastro-intestinal
Orthopedics
TB / HIV
Dermatological
Hepatobiliary
Endocrine
Psychiatry
Urogenital
Renal
Obsteric & gynaecological
Ocular
Unknown
Malaria
ENT
Major systems

TABLE 4. PoCUS APPLICATIONS PERFORMED				
Rank	PoCUS application	Total n = 137	% of total	% of PoCUS exams out of total number of patients (n=107) *
1	e-FAST	45	32,8%	42,0%
2	DVT	19	13,9%	17,8%
3	Procedural guidance	15	10,9%	14,01%
	Nerve block	*9*	*6,6%*	*8,4%*
	Vascular access	*6*	*4,4%*	*5,6%*
4	Basic cardiac	12	8,8%	11,2%
5	Ocular	12	8,8%	11,2%
6	Gastrointestinal / abdominal	9	6,6%	8,4%
7	Lung	7	5,1%	6,5%
8	AAA	7	5,1%	6,5%
9	Haemodynamic	4	2,9%	3,7%
10	Soft Tissue	2	1,5%	1,9%
11	Obstetric-gynaecological / pelvic	2	1,5%	1,9%
12	Hepato-biliary	1	0,7%	0,9%
13	FASH	1	0,7%	0,9%
14	Bladder	1	0,7%	0,9%

The most commonly performed ultrasounds are shown in descending order of frequency

* The last column in Table 4 depicts the percentage of the individual component PoCUS examinations performed out of the the total number of patients (107) that were investigated by PoCUS.

TABLE 5. PoCUS APPLICATIONS – POTENTIALLY INDICATED VERSUS THOSE ACTUALLY PERFORMED									
PoCUS Rank	PoCUS application	PoCUS – strong indication (n=665)		PoCUS – weak indication (n=93)		PoCUS actually performed (n=137)		Missed rate ^	P-value for comparing proportions *
		n	%	n	%	n	%		
1	Lung	105	28,2	2	0,5	7	1,9	93,3	<0.0001
2	Cardiac	104	28,0	4	1,1	12	3,2	88,5	<0.0001
3	Haemodynamic	76	20,4	29	7,8	4	1,1	94,7	<0.0001
4	e-FAST	58	15,6	0	0,0	45	12,1	22,4	0,17
5	Procedural guidance	41	11,0	7	1,9	15	4,0	63,4	0,003
	Nerve block	*33*	*8,9*	*2*	*0,5*	*9*	*2,4*	*72,7*	*0,001*
	Vascular access	*8*	*2,2*	*5*	*1,3*	*6*	*1,6*	*25,0*	*0,55*
6	Gastrointestinal / abdominal	39	10,5	8	2,2	9	2,4	76,9	<0.0001
7	FASH	35	9,4	1	0,3	1	0,3	97,1	<0.0001
8	DVT	27	7,3	0	0,0	19	5,1	29,6	0,21
9	Hepato / biliary	27	7,3	4	1,1	1	0,3	96,3	<0.0001
10	Renal	27	7,3	6	1,6	0	0,0	100,0	<0.0001
11	AAA	26	7,0	1	0,3	7	1,9	73,1	0,007
12	Soft Tissue	20	5,4	6	1,6	2	0,5	90,0	0,001
13	Ocular	19	5,1	4	1,1	12	3,2	36,8	0,19
14	Musculoskeletal	9	2,4	12	3,2	0	0,0	100,0	0,0026
15	Obstetric-gynaecological / pelvic	8	2,2	2	0,5	2	0,5	75,0	0,045
16	Bladder	3	0,8	0	0,0	1	0,3	66,7	0,36

^ Missed rate = (potentially indicated PoCUS strong indication – PoCUS actually done) X 100
potentially indicated PoCUS strong indication

* p-value comparing proportions (potentially indicated PoCUS strong indication vs PoCUS actually done

TABLE 6. FRAMEWORK FOR RECOMMENDING A PoCUS CURRICULUM FOR SOUTH AFRICA - adapted from van Hoving et al 2012[17]					
PoCUS applications	Disease prevalence (P)	Disease impact (I)	PoCUS difficulty (D)	P x I x D	Rank
e-FAST	5	4	5	100	1
Lung	5	4	4	80	2
Basic focused echo	5	4	3	60	3
Haemodynamic	3	5	4	60	4
FASH	3	3	4	36	5
Nerve block	3	3	3	27	6
O&G	2	4	4	32	7
Hepatobiliary	3	3	3	27	8
AAA	1	5	5	25	9
Vascular access	2	3	4	24	10
Abd/GIT	3	2	3	18	11
DVT	1	3	5	15	12
Renal	2	2	3	12	13
Ocular	2	2	3	12	14

Weighting of disease prevalence, disease impact and difficulty of PocUS application - adapted from van Hoving et al 2012[17]			
Weight	Disease prevalence	Disease impact	PoCUS diffiiculty
1	Rare	Non-urgent	Difficult
2	Infrequent	Intermediate	Advanced
3	Average	Serious but not life-threatening	Intermediate - moderate
4	Fairly common	Potentially life-threatening	Core
5	Very common	Life-threatening	Easy

R14/49 Dr Tamsyn Baillie Stanton

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140658

NAME: (Principal Investigator) Dr Tamsyn Baillie Stanton

DEPARTMENT: Emergency Medicine
Helen Joseph Hospital
Emergency Department

PROJECT TITLE: Utilization of Emergency Point of Care Ultrasound in an Emergency Department in Johannesburg

DATE CONSIDERED: 27/06/2014

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Prof Mike Wells

APPROVED BY: ______________________
Professor P Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 11/01/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review in June and will therefore be due in the month of June each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

______________________ Principal Investigator Signature

Date **11/01/2017**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES