**Title:**

From Bedside to Data: Unpacking Perioperative POCUS Trends in Cape Town, South Africa through PURE (**P**oint-of-care **U**ltrasound **Re**gistry)

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# **Abstract:**

## **Introduction:** This study presents an inaugural analysis of the point-of-care ultrasound registry (PURE) designed to describe the utility of POCUS, its role in management decisions, and the spectrum of its indications and consequential diagnostic outcomes in the perioperative setting of Western Cape, South Africa.

## **Methods:** We performed a retrospective analysis of 104 patients from the PURE registry. The parameters assessed included patient and clinician demographics, comorbidities, American Society of Anaesthesiologists (ASA) classification, indications for POCUS, modalities used, operator experience, resulting diagnoses, and consequent impact on patient management.

**Results:** The mean age of the cohort was 47.63 years with a slightly higher prevalence in females (52.9%). Hypertension was the most common comorbidity (19.7%). Most patients were classified as ASA III or higher (70%). Elective (47.1%) and emergency (45.2%) surgeries were equally represented. Dyspnoea or hypoxia (26.0%) and ventricular function assessment (22.0%) were the leading indications for POCUS. Registrars performed most scans (72.1%). Notably, 52 operators (50.0%) had more than 150 scans as prior experience. Key diagnoses included left ventricular diastolic dysfunction and pericardial effusion, both occurring at 14.0%. The median scan time was 7 minutes. POCUS influenced the management decisions in 52 cases (50%). POCUS scans were reviewed by an expert POCUS user in 64 cases (61.5%) prior to instituting management decisions.

**Conclusion:** The PURE registry serves as a tool to bridge the existing knowledge gap regarding perioperative POCUS applications. The broad array of indications and varied clinical scenarios that POCUS addresses, combined with its influence on management decisions, highlights its indispensability in perioperative care, especially in South Africa, where resource allocation and timely decision-making are crucial. Future progress for the PURE registry should focus on expanding its data collection to other provinces in South Africa and integrating it with other national and international registries.

**Introduction**

Ultrasound has emerged as an indispensable tool in clinical medicine, largely because of its non-invasive characteristics and ability to offer real-time, bedside information. Point-of-care ultrasound (POCUS) has demonstrated excellent proficiency, especially in the scope of perioperative care, where it provides immediate clinical data and plays a pivotal role in decision-making, intervention, and patient monitoring.(1–11) Cardiovascular and lung POCUS form part of the basic and essential skills of all anaesthetists and are becoming the standard of care internationally. (6–10,12,13)

POCUS training is time efficient, allowing ultrasound-naive doctors to rapidly acquire and integrate essential skills. The manageable learning curve ensures that doctors can promptly and effectively integrate POCUS into their practice. When POCUS is performed by a novice examiner with basic training, the technique and images have been shown to be comparable to the gold standard of an expert.(6,8–12,14,15) POCUS should follow an I-AIM approach (indication, acquisition, interpretation, and medical decision-making) to ensure reliable diagnosis and interpretation of findings.(16) The use of POCUS by anaesthetists has led to improved perioperative management decisions and outcomes both locally and internationally. (6,7,9–12,14,17)

In South Africa, the incorporation of perioperative POCUS by anaesthetists is limited, despite the availability of ultrasound resources.(6) Access to formal ultrasonography is also restricted, leading to patients presenting for surgery without appropriate investigations.(12,18) Consequently, the onus of POCUS now often falls on physicians traditionally responsible for referrals, like anaesthetists or surgeons(7) (7) Cardiovascular disease is surging nationally and globally. South Africa's upward shift is marked by urbanization and poverty-linked diseases converging with the first-world patterns. (19,20) The most common indications for perioperative POCUS include hemodynamic instability, undifferentiated cardiac murmur, dyspnoea, hypoxaemia, and poor functional status.(9) POCUS applications are broad and include cardiorespiratory, gastric, airway, thrombosis, and volume assessment ultrasonography.(5)

The requirements for quality assurance and outcome recording are fundamental to the implementation of POCUS in routine practice. Clinical registries allow pragmatic data collection without deviation from standard clinical practice.(21,22) The Danish Anaesthesia Database (DAD) and UCT Obstetric Airway Management Registry (ObAMR) have proven to be cost-effective and produce large sample sizes for research purposes.(21,23) There is a lack of a standardized system for recording and analysing POCUS data in perioperative settings, which has implications for the overall governance of this ubiquitous investigation.(6,8,9,13,24) Data regarding the potential economic and logistical benefits of POCUS are not available, and this persists as a large void in the current published literature. This includes data on the clinical impact of POCUS timing, the impact on time to definitive diagnosis, alterations in working diagnosis, and changes to management plans.(24)

The diagnostic **P**oint of care **U**ltrasound **RE**gistry (PURE) addresses this gap by establishing a standardized system for recording, storing, and reporting POCUS scans. The development of the PURE database collection tool was based on standardized protocols, incorporating the Focused Assessment of Transthoracic Ultrasound (FATE), guidelines from the British Society of Echocardiography (BSE), and Lichtenstein's Bedside Lung Ultrasound Protocol (BLUE).(25–27) The POCUS modalities included are basic and advanced FATE, basic and advanced transthoracic echocardiography (TOE), and lung ultrasound (BLUE protocol).

The goals of this ongoing registry include contribution to quality assurance, outcome assessment, and further investigation of the potential benefits of POCUS in clinical practice. The general objective of the PURE registry is to enhance the understanding and impact of perioperative ultrasound in South Africa, ultimately improving patient management and outcomes. The current study sought to obtain standardized POCUS data using the novel PURE registry data collection tool, enabling a prospective observational analysis of the characteristics, performance, and clinical relevance of POCUS in the perioperative setting in South Africa.

**Methods**

## **Study design**

## A multicenter registry, termed the PURE registry, was instituted after approval by the Human Research Ethics Committee (HREC) of the University of Cape Town's Health Sciences Faculty (Reference: HREC (R041/022)). The study spanned from 01 January 2023 to September 7, 2023, and involved a prospective observational assessment conducted across three hospitals in Western Cape, South Africa. Medical officers, registrars, and consultants employing POCUS were invited to participate in the PURE registry. An initial brief orientation was provided to all participants, accompanied by periodic reminders about the registry protocol and uniform data collection procedure. They were subsequently tasked with logging POCUS scans that adhered to the criteria set in the PURE database.

## **Participants**

POCUS is routinely performed as an aid for diagnosis and appropriate anaesthetic management, and patients requiring POCUS, as determined by their anaesthetists, were incorporated into the registry after obtaining verbal consent. In situations where immediate verbal consent was not attainable, the patient's case was earmarked for retrospective consent acquisition. Common indications span from undifferentiated cardiac murmurs and hemodynamic instability to ailments such as tuberculosis, HIV, malignancy, and conditions such as preeclampsia or eclampsia.

**Site of registry**

Data were collected at the sites of anaesthesia and intensive care under the supervision of the UCT Department of Anaesthesia and Perioperative Medicine, namely Groote Schuur Hospital, New Somerset Hospital, and Mowbray Maternity Hospital in Cape Town, South Africa.

## **Data Collection**

The PURE database was designed based on established protocols, namely the Focused Assessment of Transthoracic Ultrasound (FATE), guidelines of the British Society of Echocardiography (BSE), and Lichtenstein's Bedside Lung Ultrasound Protocol (BLUE). POCUS modalities included both basic and advanced FATE, transoesophageal echocardiography (TOE), and lung POCUS. The REDCap tool, which is an encrypted web application, was employed for online survey creation and database management. An accessible link to the registry, in survey format, was dispatched to anaesthetic medical officers, consultants, and registrars at UCT and was also available as a QR code in theatre environments, with the code being additionally affixed to registry-associated ultrasound machines. Data entry was streamlined, allowing users to access only a single form at any given time, with no subsequent retrieval or access post-submission. The entire data capture process was optimized for mobile usage, taking a mere 3-5 minutes. All accrued data were routinely noted during anaesthetic management, without any deviations from standard care. Each form was imprinted with a timestamp and unique study identifier to ensure data anonymity and patient confidentiality. Access to the REDCap registry was secured with password protocols, available exclusively to the primary investigator, Dr. M. Gibbs, and the MMED candidate, Dr. F. Uys.

**Type of data/specimens collected**

## The data collection process was structured to ensure the capture of comprehensive and relevant information. The chronology and geographical information of each case were documented. Concomitantly, routine patient data, clinical status, and details of their medical and surgical history were extracted from patient notes or verbally obtained from the patient. The anaesthetic chart provided observational data, which were subsequently recorded. Data were collected from the POCUS examination, including the modality employed, suspected diagnoses, and resultant management plans. For an overview of the data taxonomy and structuring, the electronic data collection sheet annexed in the appendix is attached.

## **Ethical considerations**

PURE (PocUs REgistry) was approved by the Human Research Ethics Committee (R041/022), which included simple verbal consent. To date, the registry has been valid. Patient information posters are available in all theatres, with the contact details of the principal investigator and the HREC. This study was formally approved by the Human Research Ethics Committee (HREC) of the University of Cape Town, South Africa (HREC ref. no.) This study complied with the principles of the Declaration of Helsinki.

# **Statistical analysis**

Data were collected using Research Electronic Data Capture (REDCap version 13.4.11), a secure electronic database hosted by the University of Cape Town, before being exported to the Statistical Package for the Social Sciences (IBM SPSS Statistics. Version: 28.0.1.1). Descriptive statistics were used to summarise the data. Continuous variables are summarised as means with standard deviations (SD) for parametric data or medians with interquartile range (IQR) for non-parametric data. Categorical variables were expressed as frequencies and percentages.

**Results**

In the analyses of 104 cases, the cohort had a mean age of 47.63 years (CI:43.84-51.43). The study population comprised of 37 males (35.6%), 55 females (52.9%), and 12 others (11.5%). Hypertension was the most frequently observed comorbidity, present in 47 patients (19.7%), followed by Diabetes Mellitus in 24 (10.0%) and ischemic heart disease in 17 (7.1%). The ASA classification was predominantly ASA III in 58 patients (55.8%). Surgical interventions were elective in 49 cases (47.1%) and emergency in 47 cases (45.2%).

POCUS indications were categorized as dyspnoea or hypoxia in 33 cases (26.0%), ventricular function assessment in 28 (22.0%), undifferentiated murmur in 23 (18.1%), and history of cardiac disease in 13 (10.2%). Both basic FATE and lung ultrasound (Blue Protocol) were performed in 32 cases (23.7%).

In terms of the personnel performing the scans, 75 (72.1%) were registrars, 25 (24.0%) were specialists, and four (3.8%) were medical officers. Notably, 52 operators (50.0%) had conducted more than 150 scans.

The diagnostic outcomes from POCUS revealed that 22 cases (14.0%) were consistent with left ventricular diastolic dysfunction and pericardial effusion. Pulmonary hypertension was identified in 18 patients (11.5%), while 16 patients (10.2%) each showed left ventricular systolic dysfunction and left ventricular hypertrophy.

The quality of the scans yielded 54 (54.0%) good views. Moderate views were observed in 35 scans (35.0%), and 11 scans (11.0%) were categorized as having a poor image quality. 73 POCUS evaluations (70.09%) were preoperatively performed. Intraoperatively, 16 scans (15.5%) were performed and 15 scans (14.4%) were performed postoperatively. The median duration for POCUS to be performed was 7 min.

Alterations in management post-POCUS were observed in 45 patients (43.3%). Among these, 12 (9.0%) required invasive monitoring. Fluid restriction was revised in 17 cases (12.8%), and inotropes were prepared in 10 cases (7.7%). Surgical approach adaptations post-POCUS were evident in 6 cases (5.8%). In contrast, management was reduced in seven cases (6.7%), typified by the withholding of specific interventions or inotropes based on POCUS insights. 64 (61.5%) POCUS cases were reviewed by an expert/senior POCUS user prior to diagnosis and management alterations.

# **Discussion**

This study demonstrates the role and influence of POCUS in the perioperative setting of the Western Cape in South Africa. By analysing a cohort of 104 patients, our research describes the particulars of perioperative POCUS application, encompassing patient and clinician demographics, diverse indications prompting POCUS use, selected modalities, resultant diagnoses, and their subsequent influence on clinical decision-making.

The mean age of the study population, 47.63 years, reiterates the middle-aged adult demographic that our theatres encounter. With an almost equal distribution between males, females, and others, the study had a representation across gender demographics. Hypertension, Diabetes Mellitus, and Ischemic heart disease have emerged as prominent comorbidities, which is consistent with global trends and underlines the need for acute attention to these health concerns in clinical settings.

A significant number of patients were classified as ASA class III. This denotes the urgency and criticality inherent in our cohort, necessitating thorough evaluations, such as POCUS. The elective and emergency nature of surgeries is almost equally distributed, revealing the diverse clinical scenarios in which POCUS is required.

When addressing the specific indications for POCUS, dyspnea or hypoxia took precedence, followed by assessment of ventricular function and undifferentiated murmurs. This range of indications suggests the broad applicability of POCUS for addressing various cardiac and pulmonary conditions. The consistent use of the Basic FATE and Lung ultrasound (Blue Protocol) underscores the concurrent need for basic cardiac and pulmonary assessments in real-time clinical decision-making.

The predominance of registrars in executing scans may reflect evolving training protocols and the integration of POCUS into routine clinical evaluations. Notable expertise, with a majority having more than 150 scans to their credit, emphasizes the trust and reliability vested in POCUS.

Our diagnoses, particularly those concerning left ventricular dysfunction, pericardial effusion, and pulmonary hypertension, underpin the diagnostic prowess of POCUS. The quality of scans predominantly being "good" showcases the efficacy of the tool and the proficiency of the operators.

The impact of management following POCUS is paramount to our discussion. 43.3% of the cases experiencing an alteration in clinical decision-making post-POCUS are in line with the international literature. The initiation of invasive monitoring, fluid restriction, cortical medication alterations, and surgical approach adjustments post-POCUS reaffirms its contribution to patient management. The solicitation of senior consultations in a significant number of post-POCUS cases underlines its pivotal role in collaborative clinical decision-making.

POCUS, as evidenced by our findings, plays an essential role in refining clinical decision-making, patient management, and, consequently, outcomes. POCUS is an invaluable tool in the anaesthetist armamentarium. The ongoing PURE initiative, rooted in its goals of quality assurance, outcome assessment, and exploration into the multifaceted applications of POCUS, holds the promise of elucidating, validating, and amplifying the practice of ultrasound in perioperative care, especially in settings such as South Africa, where resource allocation and timely decision-making are crucial.

**Conclusion**

# The PURE registry serves as a tool to bridge the existing knowledge gap regarding perioperative POCUS applications in South Africa. Our findings underscore the significance of POCUS in enhancing clinical decision making, which subsequently improves patient management and outcomes. The broad array of indications and varied clinical scenarios that POCUS addresses, combined with its influence on management decisions, highlights its indispensability in perioperative care. Future progress in the PURE registry could focus on expanding its data collection to other provinces in South Africa, integrating it with other national and international registries, and continuously updating its protocols in line with evolving clinical evidence. This would not only standardize POCUS practice, but also fortify its position as an essential tool in the perioperative armamentarium.

# **Limitations**

This study had several limitations that should be considered. First, the sample size of 104 cases might not capture the full breadth of the complications or benefits of POCUS, possibly overlooking rare but significant outcomes. Additionally, the reliance on the PURE registry, while comprehensive, has constraints due to its observational nature. Factors such as reporting biases, inconsistencies in data input, and non-standardized data collection across various sites may have influenced the quality and reliability of the data. Another potential source of variability is the expertise of individuals conducting the scans. With the majority of scans being performed by registrars, there is a spectrum in skill levels, possibly leading to fluctuations in the accuracy and quality of POCUS applications compared to those conducted by specialists. Finally, the decision-making process for utilizing POCUS, steered by the attending anaesthetists, may have introduced a selection bias. Some patients who could have benefited might not have been scanned, whereas others might have undergone scans that were not strictly necessary.

**Declaration:**

**None**

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**Author contributions**

FU designed the study with MG input. FU analyzed the data. FU wrote the manuscript, which was critically reviewed and edited by both FU and MG. FU designed all included tables and figures.

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None.

**Conflicts of interest**

All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation. The authors report no relationships that could be understood as a conflict of interest.

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Table 1:



Table 2:

