South Afr J Anaesth Analg. 2024;30(2):45-50
https://doi.org/10.36303/SAJAA.3044

South Afr J Anaesth Analg
ISSN 2220-1181 EISSN 2220-1173

ORIGINAL RESEARCH

Implementation of the prospective PURE (Point of Care Ultrasound Registry)

F Uys,[1] CL Pfister,[1] T Kallenbach,[2] MW Gibbs[1]

[1] Department of Anaesthesia and Perioperative Medicine, Groote Schuur Hospital, University of Cape Town, South Africa
[2] Department of Anaesthesia and Perioperative Medicine, New Somerset Hospital, University of Cape Town, South Africa
Corresponding author, email: *uysfra001@myuct.ac.za*

Background: Clinical registries are pivotal for advancing patient care and clinical research. The prospective Point of Care Ultrasound Registry (PURE) is a unique, pioneering initiative that aims to accumulate essential ultrasound data through a dedicated collection tool. This study investigates user satisfaction with the implementation of PURE, a first-of-its-kind registry, focusing on a spectrum of implementation outcomes.

Methods: Using a cross-sectional survey approach, this study evaluated diverse implementation metrics such as acceptability, appropriateness, adoption, accessibility, feasibility, efficacy and efficiency. Statistical analyses were conducted to determine the overall user satisfaction with the implementation of this novel registry.

Results: The study yielded a mean implementation score (IS) of 3.83 (95% CI 3.59–4.07). Effectiveness (E) had a mean score of 1.93 (95% CI 1.80–2.05) and Cumulative Implementation Factor (A) averaged 1.90 (95% CI 1.78–2.03). Notably, 11 of the 30 participants achieved an IS above 4, with a predominant 21 of 30 surpassing an IS of 3.8. Nevertheless, the scores for efficiency and feasibility, registered at 0.392/0.625 and 0.165/0.250, respectively, indicate areas for improvement.

Conclusion: While PURE represents an innovative step forward in point-of-care ultrasound (POCUS) data collection, its initial implementation did not fully resonate with user satisfaction expectations. Significant possibilities for enhancement lie particularly within the efficiency and feasibility sectors. To improve its utility, measures such as optimising the data collection tool, bolstering training programmes, merging with existing systems, and implementing thorough evaluation and feedback processes are recommended. A nuanced understanding of the time pressure faced by anaesthetists during data input can provide valuable insights into further areas of potential refinement.

Keywords: point-of-care ultrasound (POCUS), perioperative, anaesthesia, clinical registry, database, implementation science, FATE (Focused Assessment of Transthoracic Ultrasound)

Introduction

Ultrasound has become an essential tool in clinical medicine due to its non-invasive nature and ability to provide high-quality information at the bedside. Point-of-care ultrasound (POCUS) is particularly effective in perioperative care, offering immediate answers to clinical questions and aiding in decision-making and monitoring.[1-11] Cardiovascular and lung POCUS form part of the basic and essential skills of all anaesthetists, gaining widespread acknowledgment and adoption as essential diagnostic tools in anaesthetic and intensive care settings globally, including South Africa.[6-10,12,13]

POCUS training is time-efficient, allowing ultrasound-naive doctors to rapidly acquire and integrate essential skills. The relatively small learning curve ensures that doctors can integrate POCUS into their practice promptly and effectively. When POCUS is performed by a novice examiner with basic training, the technique and images have been shown to be comparable with 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 restricted, leading to patients presenting for surgery without appropriate investigations.[12,18] Hence, POCUS is now being performed by physicians who were previously responsible for referrals, such as anaesthetists or surgeons.[7] Cardiovascular disease is surging nationally and globally. South Africa's upward shift is marked by urbanisation and poverty-linked diseases converging with first-world patterns.[19,20] POCUS is an adjunct to clinical examinations, designed to complement, not replace, traditional clinical assessments and specialised investigations. Its application is diverse, aiding in clarifying findings from clinical exams, assisting in emergency scenarios involving acutely ill patients, and enhancing the safety of procedural interventions. Common perioperative uses of POCUS include addressing haemodynamic instability, evaluating undifferentiated cardiac murmurs, and assessing dyspnoea and hypoxaemia.[5,9]

The requirement for quality assurance and outcome recording is fundamental to the implementation of POCUS in routine practice. Clinical registries allow for pragmatic data collection without deviation from standard clinical practice.[21,22] The Danish Anaesthesia Database (DAD) and the 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 standardised 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 economical and logistical benefits of POCUS are not available and this continues to be 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, alteration in working diagnosis and changes to management plans.[24]

The **P**oint of care **U**ltrasound **RE**gistry (PURE) addresses this gap by establishing a standardised system for recording, storing and reporting POCUS scans. The development of the PURE data collection tool was based on standardised protocols, incorporating the Focused Assessment of Transthoracic Ultrasound (FATE),[25] the guidelines from the British Society of Echocardiography (BSE),[26] and the Lichtenstein's Bedside Lung Ultrasound Protocol (BLUE).[27] The POCUS modalities included are basic and advanced FATE, basic and advanced transthoracic echocardiography (TTE) as an extension of FATE, and lung ultrasound (BLUE protocol).

The goals of this ongoing registry include contribution to quality assurance, outcomes assessment, and further investigation into the potential benefits and pitfalls of POCUS in clinical practice. The general objective of the PURE data collection tool is to enhance the understanding and impact of perioperative ultrasound in South Africa, ultimately improving patient management and outcomes.

The successful implementation of healthcare registries plays a vital role in enhancing patient care and advancing clinical research.[28] The focus of this paper was to prioritise the initial stage of establishing a thriving registry by evaluating the successful implementation of the registry within our department. Our primary aim was to evaluate user satisfaction with the implementation of the PURE data collection tool, focusing on various implementation outcomes.

Methods

Study design

We conducted a cross-sectional survey to assess user satisfaction with the PURE data collection tool. User satisfaction was evaluated by assessing implementation outcomes, specifically acceptability, appropriateness, adoption, accessibility, feasibility, efficacy and efficiency. These outcomes are derived from Proctor et al.'s[28] research on implementation science. See a description of these outcomes in Table I.

Participants

The study population comprised all clinicians from the Department of Anaesthesia and Perioperative Medicine at the University of Cape Town (UCT). Eligible participants included specialists, registrars and medical officers working in anaesthesia or critical care.

Data collection

Data for the PURE data collection tool were collected at various sites of anaesthesia and intensive care under the supervision of the UCT Department of Anaesthesia and Perioperative Medicine at the Groote Schuur Hospital and Mowbray Maternity Hospital in Cape Town, South Africa. The survey consisted of 13 Likert-style questions, including two questions evaluating the six implementation outcomes and one question assessing the accessibility outcome factor (see Table II for the Likert-style questions used in the survey). The survey was made available online in a digital format for ease of completion and was emailed to the first 30 eligible clinicians who had used the registry. POCUS use is not commonplace for every anaesthetist, and there may be diverse practices. We selected a sample size of 30 in accordance with Borg and Gall's guidelines for relational and behavioural surveys.[29] This choice adheres to the central limit theorem (CLT) that sample means approach a normal distribution with a minimum of 30 samples. This ensures a minimum requirement for an accurate representation of ultrasound practices in our department.[29,30]

Table I: Implementation outcome definitions[28]

Implementation outcome	Definition
Acceptability	The perception among users that the PURE data collection tool is palatable, or satisfactory. Satisfaction with the various aspects of the data collection tool (e.g. content, complexity, comfort and delivery).
Appropriateness	Refers to the perceived fit, relevance, compatibility, suitability and usefulness of the PURE data collection tool within daily perioperative practice.
Accessibility	The ease of which the user can access the data collection tool.
Adoption	The intention, initial decision or action to try the PURE data collection tool. Adoption also may be referred to as "uptake"'
Feasibility	The practicality and suitability of using the PURE data collection tool within the perioperative setting, emphasising its actual fit and utility for everyday use.
Efficacy	The degree to which the PURE data collection tool meets the needs and expectations of its users.
Efficiency	The ability of the PURE data collection tool to collect and process data in a timely manner.

Table II: Likert-style questions based on each implementation outcome

Implementation outcome	Question 1	Question 2
Acceptability	I feel comfortable using the PURE data collection tool without assistance.	The level of complexity of the PURE data collection tool is appropriate for my needs of completing a POCUS database.
Appropriateness	The PURE data collection tool is relevant to my perioperative standard POCUS practice.	The PURE data collection tool assists me in making perioperative clinical decisions.
Accessibility	I can easily access the PURE data collection tool.	
Adoption	I intend to continue using the PURE data collection tool in the future.	I would recommend the use of the PURE data collection tool to my colleagues.
Feasibility	Implementing the PURE data collection tool required minimal additional resources (e.g. time, staff and equipment).	The PURE data collection tool has practical utility within the perioperative setting.
Effectiveness	The PURE data collection tool helps me manage and document point-of-care ultrasound.	I am satisfied with the accuracy and completeness of the PURE data collection tool.
Efficiency	I can complete the PURE data collection tool in a timely manner.	Using the PURE data collection tool did not negatively impact my efficiency in performing clinical duties.

Ethical approval

PURE (POCUS REgistry) was approved by the Human Research Ethics Committee (HREC) (R041/022). Simple verbal consent from the patient was approved by HREC. Implied written consent from participants was given by completing the electronic questionnaire. This study on user satisfaction analysis was formally approved by the Human Research Ethics Committee (HREC) of the University of Cape Town, South Africa (HREC ref. no. 219/2023) and complies with the Declaration of Helsinki.

Statistical analysis

The weighted implementation score (IS) was calculated using the formula IS = Effectiveness (E) + Cumulative Implementation Factors (A) (see the description of IS in Table III). The IS ranges from 0 to 5, with a score of 5 indicating complete satisfaction. To determine satisfactory responses, a mean score greater than 4 was required. The score was designed based on implementation outcome measurements developed by Proctor et al.[28] Furthermore, majority support for PURE's implementation was achieved with 21 out of 30 participants (70% support) recording an implementation score of 4 or 5, resulting in a calculated 95% confidence interval (CI) of 54–86% with a standard error of 0.081. Importantly, we chose the 70% threshold because it ensured that the lower limit of our confidence interval remained above the 50% mark, signifying clear majority support even when accounting for sample variability. This strategic choice of 70% was made to ensure that our claim of majority support was robust, as it would always surpass the simple majority threshold in the context of the provided confidence interval, thus lending greater statistical validity to our findings. Table III gives a detailed breakdown of the calculation process for the candidate implementation score.

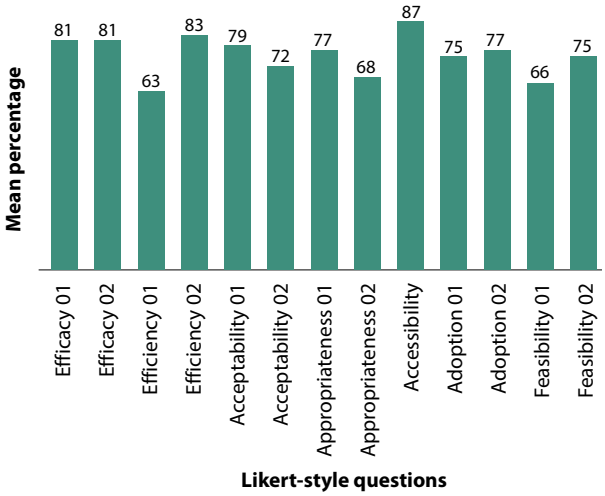

Figure 1: Individual questions mean percentage (weighted)

Table III: Implementation score

Implementation score (IS) = Effectiveness (E) + Cumulative Implementation Factors (A) IS (5 or 100%) = E (2.5 or 50%) + A (2.5 or 50%)	
Effectiveness (E) (2.5 or 50%)	**Cumulative Implementation Factors (A)** (2.5 or 50%)
Effectiveness (E) = Efficacy + Efficiency	Cumulative Implementation Factors (A) = Acceptability + Appropriateness + Accessibility + Adoption + Feasibility
Each outcome factor contributes 25% 2 questions per outcome factor Each question contributes 12.5% to the total	Each outcome factor contributes 10% 2 questions per outcome factor Each question contributes 5% The factor accessibility has one question and will contribute 10%
Formula:	
Implementation score = [(Efficiency$_1$ x ,125) + (Efficiency$_2$ x ,125) + (Efficacy$_1$ x ,125) + (Efficacy$_2$ x ,125)] + [(Acceptability$_1$ x 0.05) + (Acceptability$_2$ x 0.05)+ (Appropriateness$_1$ x 0.05) + (Appropriateness$_2$ x 0.05) + (Accessibility$_1$ x 0.1) + (Adoption$_1$ x 0.05) + (Adoption$_2$ x 0.05) + (Feasibility$_1$ x 0.05) + (Feasibility$_2$ x 0.05)]	

Table IV: Individual questions weighted scores

	Min.	Max.	Mean	Std. Deviation	Weighted mean percentage
Efficacy 01	.125	.625	.504	.116	81
Efficacy 02	.375	.625	.504	.096	81
Efficiency 01	.125	.625	.392	.130	63
Efficiency 02	.375	.625	.525	.089	83
Acceptability 01	.100	.250	.198	.050	79
Acceptability 02	.050	.250	.180	.057	72
Appropriateness 01	.050	.250	.192	.053	77
Appropriateness 02	.050	.250	.168	.046	68
Accessibility	.300	.500	.433	.076	87
Adoption 01	.050	.250	.187	.047	75
Adoption 02	.050	.250	.193	.045	77
Feasibility 01	.050	.250	.165	.059	66
Feasibility 02	.050	.250	.187	.047	75

The response data were collected using Microsoft® Excel before being exported to the Statistical Package for the Social Sciences (IBM SPSS Statistics; Ver 28.0.1.1). Data were confirmed to be parametric by the Shapiro-Wilk test. Parametric descriptive summary statistics were produced, and a 95% CI was presented for the point estimates.

Results

We had a 100% response rate with 30 respondents. The analysis of the survey responses revealed that the mean IS for all participants was 3.83 out of 5 (95% CI 3.59–4.07). The mean score for "Effectiveness (E)" was 1.93 out of 2.5 (95% CI 1.80–2.05) and "Cumulative Implementation Factors (A)" was 1.90 out of 2.5 (95% CI 1.78–2.03). Of the 30 participants, 11 achieved a total IS greater than 4, and most participants (21 out of 30) obtained an IS higher than 3.8 (see Table IV for the weighted scores of all individual questions). The lowest scores were observed for the efficiency question ('I can complete the PURE data collection tool in a timely manner') with a mean score of 0.392 out of 0.625 and the feasibility question ('Implementing the PURE registry required minimal additional resources') with a mean score of 0.165 out of 0.250.

Discussion

The current study showcases data from an innovative multicentred POCUS registry using a convenience sample of clinicians who have used the PURE data collection tool. This registry is the first of its kind in the perioperative environment of South Africa. Its primary objectives are to deepen our understanding of perioperative ultrasound use in South Africa and to strengthen governance and quality assurance for frequently performed scans.

The implementation of the prospective PURE data collection tool did not meet the set criteria for user satisfaction. The mean IS for all participants was 3.8 (95% CI 3.59–4.07), indicating a moderate level of user satisfaction (a score of more than 4 is deemed a satisfactory response). While most participants expressed overall positive perceptions (21 out of 30 obtained a mean IS higher than 3.8), the effectiveness (mean = 1.93) and cumulative implementation factors (mean = 1.9) fell short of expectations. The efficiency and feasibility aspects received the lowest scores, indicating areas for improvement.

Efficiency refers to the ability to complete tasks within a reasonable timeframe without undue burden.[28] The low mean score for the efficiency question ("I can complete the PURE data collection tool in a timely manner") not only highlights a potential issue with the data collection process but also underscores the importance of efficiency in clinical settings. Efficient data collection is crucial not just for operational effectiveness but also to prevent burnout among healthcare professionals. This aspect is particularly vital in high-pressure environments such as anaesthesiology. To enhance efficiency, optimising the user interface of the data collection tool and providing training and support to users are recommended. Streamlining the tool's design, minimising unnecessary steps and incorporating user-friendly features can expedite data entry. In addition, a responsive support system can increase user proficiency and address any challenges encountered during the data collection process.

Feasibility pertains to the practicality and resources needed to implement the PURE data collection tool.[28] The modest mean score (0.165/0.25) for the feasibility question, which relates to the registry requiring "minimal additional resources, e.g. time, staff, equipment" indicates perceived barriers to its smooth integration into anaesthetists' workflow. Based on user feedback and this score, it is clear that the primary "additional resource" concern is the time taken to complete the collection tool. Feasibility can be improved by integrating the data collection tool into existing systems and minimising redundancy. Adding a basic data entry branch that caters to most POCUS cases and implementing functionality to print POCUS results can streamline the workflow, minimise repetition and reduce perceived burden. By encouraging anaesthetists to use the registry as a personal

logbook for POCUS cases, the registry can further minimise repetition, facilitate easy recording of cases over time, and motivate recurrent use.

Continuous evaluation and feedback mechanisms are crucial for continuous improvement. Regular assessments of user satisfaction, usability and workflow impact, along with user engagement through focus groups, surveys and feedback loops, can provide valuable insights into refining the data collection tool and addressing emerging issues.

By implementing these strategies, the efficiency and feasibility of the prospective PURE data collection tool can be enhanced, leading to increased user satisfaction and successful adoption of the registry for improved patient care and research outcomes.

Limitations

The limitations of the study include a small sample size (30 participants), which may limit generalisability. In addition, the survey relied on self-reporting measures, introducing the possibility of response bias. The study did not explore potential confounding variables that could influence user satisfaction, such as prior experience or technological proficiency.

Conclusion

In conclusion, while the implementation of the prospective PURE data collection tool fell marginally short of achieving user satisfaction, there are opportunities for improvement. Efforts to enhance efficiency and feasibility should focus on optimising the user interface of the data collection tool, providing comprehensive training and support, integrating with existing systems, and establishing evaluation and feedback mechanisms. By addressing these areas, the implementation process can be streamlined, leading to increased user satisfaction and the successful adoption of the PURE data collection tool for improved patient care and research outcomes.

Acknowledgments

We would like to thank the members of the UCT Department of Anaesthesia and Perioperative Medicine as well as Groote Schuur Hospital and Mowbray Maternity Hospital for their cooperation in this project.

Conflicts of interest

All authors take the responsibility for all aspects of reliability and freedom from bias of the data presented and their discussed interpretation. The authors declare no conflict of interest.

Funding source

No funding was required.

Ethical approval

PURE (POCUS REgistry) was approved by the Human Research Ethics Committee (HREC) (R041/022). Simple verbal consent from the patient was approved by HREC. Implied written consent from participants was given by completing the electronic questionnaire. This study on user satisfaction analysis was formally approved by the Human Research Ethics Committee (HREC) of the University of Cape Town, South Africa (HREC ref. no. 219/2023) and complies with the Declaration of Helsinki

ORCID

F Uys https://orcid.org/0000-0003-2127-7976
CL Pfister https://orcid.org/0000-0003-4197-3696
T Kallenbach https://orcid.org/0000-0002-5359-3992
MW Gibbs https://orcid.org/0000-0002-3283-2552

References

1. Pachtman Shetty SL, Koenig S, Tenenbaum S, Meirowitz N. Point-of-care lung ultrasound patterns in late third-trimester gravidas with and without preeclampsia. Am J Obstet Gynecol MFM. 2021;3(2):100310. https://doi.org/10.1016/j.ajogmf.2021.100310.
2. Ortner CM, Krishnamoorthy V, Neethling E, et al. Point-of-care ultrasound abnormalities in late-onset severe preeclampsia: prevalence and association with serum albumin and brain natriuretic peptide. Anesth Analg. 2019;128(6):1208-16. https://doi.org/10.1213/ANE.0000000000003759.
3. Ortner CM, Padilla C, Carvalho B. Cardiac ultrasonography in obstetrics: a necessary skill for the present and future anesthesiologist. Int J Obstet Anesth. 2022;50:103545. https://doi.org/10.1016/j.ijoa.2022.103545.
4. Dennis AT. Transthoracic echocardiography in obstetric anaesthesia and obstetric critical illness. Int J Obstet Anesth. 2011;20(2):160-8. https://doi.org/10.1016/j.ijoa.2010.11.007.
5. Zieleskiewicz L, Bouvet L, Einav S, Duclos G, Leone M. Diagnostic point-of-care ultrasound: applications in obstetric anaesthetic management. Anaesthesia. 2018;73(10):1265-79. https://doi.org/10.1097/01.aoa.0000575188.21413.7e.
6. Kathrada M, Jagga M, Mzoneli Y, Swanevelder J, Gibbs M. Perioperative ultrasound among South African anaesthetists: a survey of current practice and availability. S Afr J Anaesth Analg. 2021;27(6):271-7. https://doi.org/10.36303/SAJAA.2021.27.6.2636.
7. Barber RL, Fletcher SN. A review of echocardiography in anaesthetic and peri-operative practice. Part 1: impact and utility. Anaesthesia. 2014;69(7):764-76. https://doi.org/10.1111/anae.12663.
8. Turton E. Point-of-care ultrasound for all - teaching, training and use at every opportunity. S Afr J Anaesth Analg. 2021;27(6):256-7. https://doi.org/10.36303/SAJAA.2021.27.6.2752.
9. Neethling E, Roodt F, Beck C, Swanevelder JLC. Point-of-care and lung ultrasound incorporated in daily practice. S Afr Med J. 2018;108(5):376. https://doi.org/10.7196/SAMJ.2018.v108i5.13313.
10. Coker BJ, Zimmerman JM. Why anesthesiologists must incorporate focused cardiac ultrasound into daily practice. Anesth Analg. 2017;124(3):761-5. https://doi.org/10.1213/ANE.0000000000001854.
11. Canty DJ, Royse CF, Kilpatrick D, Williams DL, Royse AG. The impact of pre-operative focused transthoracic echocardiography in emergency non-cardiac surgery patients with known or risk of cardiac disease: Pre-operative echocardiography in emergency surgery. Anaesthesia. 2012;67(7):714-20. https://doi.org/10.1111/j.1365-2044.2012.07118.x.
12. Cowie B. Three years' experience of focused cardiovascular ultrasound in the peri-operative period: Focused peri-operative cardiovascular ultrasound. Anaesthesia. 2011;66(4):268-73. https://doi.org/10.1111/j.1365-2044.2011.06622.x.
13. Huson MAM, Kaminstein D, Kahn D, et al. Cardiac ultrasound in resource-limited settings (CURLS): towards a wider use of basic echo applications in Africa. Ultrasound J. 2019;11(1):34. https://doi.org/10.1186/s13089-019-0149-0.
14. Kanji HD, McCallum JL, Bhagirath KM, Neitzel AS. Curriculum development and evaluation of a hemodynamic critical care ultrasound: A systematic review of the literature. Crit Care Med. 2016;44(8):e742-50. https://doi.org/10.1097/CCM.0000000000001661.
15. Gibson LE, White-Dzuro GA, Lindsay PJ, et al. Ensuring competency in focused cardiac ultrasound: a systematic review of training programs. J Intensive Care. 2020;8(1):93. https://doi.org/10.1186/s40560-020-00503-x.
16. Li L, Yong RJ, Kaye AD, Urman RD. Perioperative Point of Care Ultrasound (POCUS) for Anesthesiologists: an Overview. Curr Pain Headache Rep. 2020;24(5):20. https://doi.org/10.1007/s11916-020-0847-0.
17. Kudsk-Iversen S, Matos-Puig R. The use of ultrasonography in the perioperative management of penetrating chest trauma with indwelling blade. S Afr J Anaesth Analg. 2014;20(6):245-8. https://doi.org/10.1080/22201181.2014.983703.
18. Bedeker WF, Lachman AS, Borkum M, Hellenberg D, Cupido CS. Impact of transthoracic echocardiography at district hospital level. S Afr Med J. 2015;105(10):817. https://doi.org/10.7196/SAMJnew.8102.
19. Uys F, Beeton A, Van Der Walt S, et al. Profile and management of acute coronary syndromes at primary- and secondary-level healthcare facilities in Cape Town. Cardiovasc J Afr. 2022;33(3):40-6. https://doi.org/10.5830/CVJA-2021-054.
20. Mayosi BM. The 10 'Best Buys' to combat heart disease, diabetes and stroke in Africa. Heart. 2013;99(14):973-4. https://doi.org/10.1136/heartjnl-2013-304130.
21. Antonsen K, Rosenstock C, Hyldborg Lundstrom L. The Danish Anaesthesia Database. Clin Epidemiol. 2016;8:435-8. https://doi.org/10.2147/CLEP.S99517.

22. Armstrong RA, Mouton R, Hinchliffe RJ. Routinely collected data and patient-centred research in anaesthesia and peri-operative care: a narrative review. Anaesthesia. 2021;76(8):1122-8. https://doi.org/10.1111/anae.15303.
23. Smit MI, Hofmeyr R, Van Dyk D, et al. Implementation and initial validation of a multicentre obstetric airway management registry. S Afr J Anaesth Analg. 2020;26(4):198-205. https://doi.org/10.36303/SAJAA.2020.26.4.2423.
24. Partyka C, Flannagan S, Carbonatto G, et al. Prospective, multicentre observational study of point-of-care ultrasound practice in emergency departments across Australia and New Zealand: The POCUS-ED Registry. Emerg Med Australas. 2022;34(6):959-67. https://doi.org/10.1111/1742-6723.14021.
25. Holm JH, Frederiksen CA, Juhl-Olsen P, Sloth E. Perioperative use of Focus Assessed Transthoracic Echocardiography (FATE). Anesth Analg. 2012;115(5):1029-32. https://doi.org/10.1213/ANE.0b013e31826dd867.
26. Wharton G, Steeds R, Allen J, et al. A minimum dataset for a standard adult transthoracic echocardiogram: a guideline protocol from the British Society of Echocardiography. Echo Res Pract. 2015;2(1):G9-24. https://doi.org/10.1530/ERP-14-0079.
27. Lichtenstein D. Lung ultrasound in acute respiratory failure an introduction to the BLUE-protocol. MINERVA Anestesiol. 2009;75(5):313-7.
28. Proctor E, Silmere H, Raghavan R, et al. Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda. Adm Policy Ment Health Ment Health Serv Res. 2011;38(2):65-76. https://doi.org/10.1007/s10488-010-0319-7.
29. Memon MA, Ting H, Cheah JH, et al. Sample size for survey research: review and recommendations. J Appl Struct Equ Model. 2020;4(2):i-xx. https://doi.org/10.47263/JASEM.4(2)01.
30. DeliCe A. The sampling issues in quantitative research. Edu Sci: Theory Practice. 2010;10(4):2001-18.

Supplementary files available online