

Cardiac catheterisation laboratory procedures and in-hospital outcomes at a tertiary facility: A 1-year review from Groote Schuur Hospital, Cape Town, South Africa

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INTRODUCTION

CVD was the leading cause of death in 2022, both globally and in South Africa.^(1,2) In the South African context, CVD management is complicated by a unique quadruple burden: the human immunodeficiency virus pandemic, tuberculosis, non-communicable diseases (NCD), and violence or injury. As populations age and infectious disease management improves, the epidemiological shift toward NCDs, particularly CVD, places an unprecedented strain on healthcare infrastructure.⁽³⁾ Cath labs are central to CVD diagnosis and management, yet access varies widely. High-income countries generally have 24-hour availability, whereas low- and middle-income countries face infrastructure and workforce constraints.⁽⁴⁾ In South Africa, 76.6% of the country's 62 cath labs are privately owned, and consequently, only accessible through the private sector.⁽⁴⁾ High rates of cardiovascular risk factors further strain cath lab services. A South African study conducted between 2013 and 2020 found that over half of adults aged > 45 years had hypertension, rising to about two-thirds in those > 55 years.⁽⁵⁾ Additional reports indicate that 15.3% of adults have diabetes, 67.3% have dyslipidaemia, and 25.8% smoke tobacco products.⁽⁶⁻⁸⁾

ABSTRACT

Background: Cardiovascular disease (CVD) is the leading cause of death in South Africa; however, comprehensive data on public-sector cardiac catheterisation laboratory (cath lab) procedural patterns and outcomes remain scarce.

Methods: We conducted a retrospective observational study using the Groote Schuur Hospital Cardiac Catheterisation (GSH-CATH) registry at Groote Schuur Hospital (GSH), Cape Town, South Africa, analysing all adult patients undergoing non-electrophysiology procedures between December 2022 and November 2023.

Results: A total of 1 694 procedures were performed in 1 239 patients (median age of 58 years, 60.5% female). The primary indications were acute coronary syndrome (ACS) (56.7%) and valvular heart disease (17.7%), with diagnostic coronary angiography (DCA) (40.9%), DCA with percutaneous coronary intervention (PCI), or PCI only (26.0%) being the most frequent procedures. Cardiovascular risk factors were highly prevalent, including hypertension (65.4%), smoking (44.1%), and diabetes (32.5%). The overall procedural complication rate was 6.5%, primarily driven by access-site events (3.2%). Intra-procedural and in-hospital mortality rates were 0.3% and 3.6%, respectively. Systemic hypertension was significantly associated with procedural complications ($p = 0.03$).

Conclusion: This study provides the first comprehensive evaluation of cath lab activity at a South African tertiary facility, highlighting high procedural volume and a unique female-dominant demographic, despite a high proportion of patients requiring emergency or time-sensitive interventions. These findings establish a baseline for quality improvement and resource allocation in the South African public health sector.

Keywords: catheterisation laboratory, coronary angiography, percutaneous coronary intervention.

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International cath lab registries frequently focus on specific procedures, such as DCA or PCI, providing limited insight into overall procedural patterns. Broader registries are reported from Spain, Pakistan, and Uganda. The Spanish national registry reported an average of 906 procedures per cath lab in 2023, including DCA (67.1%), PCI (31.2%), valvular interventions (3.6%), non-valvular structural interventions (1.0%), and adult congenital heart disease procedures (0.8%).⁽⁹⁾ In Pakistan, Khan, et al. reported 259 procedures in a single-centre study in 2015, primarily for ACS (53.0%) and chronic coronary syndromes

(29.7%), comprising DCA (43.6%), PCI (46.3%), and valvular interventions (9.7%) in a 67.2% male cohort.⁽¹⁰⁾ In Uganda, 8 years of cath lab activity at a public hospital averaged 365 procedures per year, including DCA (65.2%), pacemaker-related and electrophysiology procedures (17.1%), PCI (14.0%), and valvular interventions (3.0%).⁽¹¹⁾ To date, no South African study has reported on the full spectrum of cath lab procedures, either at a private or public facility.

Cath lab complications and outcomes are influenced not only by operator skill, but also by patient factors, including age, cardiovascular risk, and the need for urgent intervention. Access-site complications are common; Tavakol, et al. reported rates of 0.2–1.0%.⁽¹²⁾ Bhatt, et al. found femoral access-site complications of 1.8% for diagnostic and 4.0% for interventional procedures, with major bleeding in 2.0–6.0% and haematomas in 2.0–12.0%.⁽¹³⁾ The multinational RIVAL (radial vs. femoral) trial reported rates of 4.0% for the femoral approach and 3.7% for the radial approach.⁽¹⁴⁾ Other procedural complications identified by Tavakol, et al. included bradyarrhythmias and syncope (3.5%), peri-procedural myocardial infarction (MI) during PCI (5–30%), stroke during PCI (0.2–0.4%), aortic dissection (< 0.1%), and coronary artery perforation (0.3–0.6%).⁽¹²⁾ Overall, in-hospital mortality is reported at 1.0%, with intra-procedural mortality at 0.1%.⁽¹⁵⁾ Local South African data remain limited: the Tygerberg Registry of Acute Coronary Syndromes (TRACS) registry, limited to patients with ACS, reported 5.5% in-hospital mortality for ST-segment elevation myocardial infarction (STEMI), and 3.9% for high-risk non-ST-segment elevation acute coronary syndrome (NSTEMI-ACS); however, not all patients underwent cath lab procedures.^(16,17)

GSH in Cape Town, South Africa, is a tertiary public hospital equipped with 2 cath labs. These labs operate primarily between 08:00 and 16:00 on weekdays, with only limited emergency procedures performed outside of these hours. A broad range of procedures is performed for patients referred to GSH, which is the only facility with cath lab services serving a vast geographic area of the Western Cape Province of South Africa. To address the lack of local data, we report the spectrum and outcomes of procedures performed at GSH.

METHODS

The GSH-CATH registry was established to address the lack of comprehensive cath lab data in South Africa. This prospective, observational registry captures demographic, clinical, and procedural data, as well as procedural and in-hospital outcomes for all adult patients (> 18 years) undergoing cath lab procedures at GSH, with enrolment beginning on 1 December 2022. Pacemaker-related and electrophysiology procedures were excluded, as they are recorded in separate registries. To ensure clarity, the registry defined each cath lab admission as a single analytical entry. Any number of procedures performed during a single cath lab visit (e.g. DCA followed by PCI) were recorded as multiple procedures within 1 registry entry. Procedures performed during separate cath lab admissions were recorded as distinct entries, irrespective of whether they involved the

same patient on multiple occasions or occurred during the same hospitalisation.

For this subgroup analysis, we conducted a retrospective observational study of registry data captured between 1 December 2022 and 30 November 2023. The primary objectives were to document the spectrum and frequency of cath lab procedures and evaluate associated peri-procedural complications and mortality. Data variables included patient demographics, cardiovascular risk profiles, diagnostic indications, and procedural outcomes as reported by the lead clinician in the cath lab procedure report. In-hospital mortality was recorded via hospital record review during the initial data capture. Intra-procedural complications and mortality were defined as events occurring during the cath lab admission, whereas in-hospital mortality included deaths occurring after cath lab discharge but prior to hospital discharge. No additional clinical data were collected beyond the registry parameters. Consequently, specific causes of death and the severity of pre-existing comorbidities were not assessed. Patients with incomplete data for any primary study variable were excluded from the final analysis.

TABLE I: Demographics, diagnostic indications for cath lab procedures, and mortalities.

Characteristic	n = 1 239 n (%)
Demographics	
Age (years)	58 (50–67)*
Gender, female	749 (60.5)
Diagnostic indications for cath lab procedures	
NSTEMI-ACS	426 (34.3)
STEMI	278 (22.4)
Valvular heart disease	219 (17.7)
Chronic coronary syndrome	189 (15.2)
Congenital heart disease	34 (2.7)
Pericardial disease	34 (2.7)
Cardiomyopathy	17 (1.4)
Pulmonary hypertension	15 (1.2)
Workup for transplant	10 (0.8)
Arrhythmia	5 (0.4)
Aortic dissection	5 (0.4)
Transplant donor workup	3 (0.2)
Atrial myxoma	3 (0.2)
Infective endocarditis	1 (0.1)
Mortalities	
49 (4.0)**	
Intra-procedural mortalities	4 (0.3)
In-hospital mortalities following cath lab discharge	45 (3.6)

* Median (interquartile range)

** Percentages may not sum to the total due to independent rounding of component figures.

Cath lab: cardiac catheterisation laboratory, NSTEMI-ACS: non-ST-segment elevation acute coronary syndrome, STEMI: ST-segment elevation myocardial infarction.

TABLE II: Cath lab procedures and complications.

Procedures	n = 1 694 n (%)
Procedure type	
DCA	693 (40.9)
DCA with PCI, or PCI only	441 (26.0)
Left ventriculogram	367 (21.7)
Haemodynamic study	123 (7.3)
Pericardiocentesis	33 (1.9)
Valvular intervention	15 (0.9)
Endomyocardial biopsy	10 (0.6)
Intra-aortic balloon pump insertion	6 (0.4)
Congenital heart disease procedure	4 (0.2)
Other	2 (0.1)
Complications	
Access-site complications	55 (3.2)
No-reflow or peri-procedural MI**	12 (0.7)
Coronary dissection or perforation	11 (0.6)
Arrhythmia	10 (0.6)
Vasovagal episode	7 (0.4)
Coronary vasospasm	5 (0.3)
Stroke	5 (0.3)
Thrombus embolisation	4 (0.2)
Aortic dissection	1 (0.1)

* Percentages may not sum to the total due to independent rounding of component figures.

** As defined by the Fourth Universal Definition of Myocardial Infarction.⁽¹⁸⁾

Cath lab: cardiac catheterisation laboratory, DCA: diagnostic coronary angiography, MI: myocardial infarction, PCI: percutaneous coronary intervention.

Statistical analysis

Statistical analysis was conducted in collaboration with the Division of Epidemiology and Biostatistics at the University of Cape Town, using descriptive and comparative techniques. Continuous variables are summarised as medians with interquartile ranges (IQR), while categorical variables are reported as frequencies and percentages. Categorical comparisons were performed using Pearson's chi-squared test. Statistical significance was defined as a *p*-value < 0.05. For analytical precision, complication rates were calculated using the total number of procedures as the denominator (procedural

basis), whereas mortality rates were calculated per patient, with each unique cath lab admission as the unit of analysis.

Ethical approval

Institutional ethical approval for this sub-study was granted by the University of Cape Town Human Research Ethics Committee (reference: 780/2025). The overarching GSH-CATH registry was previously approved by the University of Cape Town Human Research Ethics Committee (reference: R047/2020) on 30 April 2021, with an extension valid until 30 April 2028. All research was conducted in strict adherence to patient anonymity protocols outlined in the original registry framework and in accordance with the Declaration of Helsinki.

RESULTS

A total of 1 694 procedures were performed during 1 239 cath lab visits, averaging 141 procedures per month or approximately 33 per week. Most patients (66.5%) underwent a single procedure, while 38 patients (3.1%) had ≥ 3 procedures during the same cath lab admission. The most frequently performed procedure was DCA (40.9%), followed by DCA with PCI or PCI only (26.0%), and left ventriculography (21.7%) (Table II). The most frequently performed combination procedure was a haemodynamic study with DCA (performed in 69 patients). Procedural indications were most commonly ACS (56.7%). Of these, NSTEMI-ACS and STEMI accounted for 34.3% (426 cases) and 22.4% (278 cases) of the ACS cohort, respectively (Table I).

Among 1 694 procedures, 110 complications were recorded, corresponding to a per-procedure complication rate of 6.5%. Across 1 239 cath lab admissions, 94 patients experienced a single complication, while 8 patients sustained 2 complications during the same admission. Access-site complications occurred in 55 procedures (3.2%), while no-reflow or peri-procedural MI (defined by the Fourth Universal Definition of Myocardial Infarction) occurred in 12 procedures (0.7%).⁽¹⁸⁾ Coronary dissection or perforation and arrhythmia each occurred in 0.6% of procedures. Intra-procedural mortality was observed in 4/1 239 patients (0.3%), with an additional 45 patients (3.6%) dying during hospital admission following the procedure (Table I).

This cohort had a median age of 58 years (IQR 50–67 years),

TABLE III: Complication rates stratified by cardiovascular risk factors.

Cardiovascular risk factors	Patients with disease		Patients without disease		<i>p</i> -value*
	<i>n</i>	Complications, <i>n</i> (%)	<i>n</i>	Complications, <i>n</i> (%)	
Hypertension**	810	77 (10.5)	429	25 (6.2)	0.03
Diabetes***	403	33 (8.9)	836	69 (9.0)	0.97
Dyslipidaemia***	525	46 (9.4)	704	56 (8.6)	0.61
Active cigarette smoking	547	42 (8.3)	692	60 (9.5)	0.53

* Pearson's chi-squared test.

** Systemic hypertension.

*** Diabetes mellitus and dyslipidaemia of any type.

with a female predominance (60.5%) (Table I). Among the patients, 65.4% had hypertension, 43.2% had hyperlipidaemia, 32.5% had diabetes, and 44.1% were active smokers. Analysis of individual cardiovascular risk factors revealed that only systemic hypertension was significantly associated with procedural complications (10.5% vs. 6.2%; $p = 0.03$). When risk factors were grouped (e.g. diabetes combined with hypertension), no statistically significant associations with procedural complications were observed (Table III).

DISCUSSION

The annual procedural volume at GSH (1 694 procedures) demonstrates significant operational efficiency, exceeding single-centre registries in Pakistan (259 procedures) and Uganda (365 procedures), and surpassing the average annual volume per lab in the Spanish national registry (906 procedures).⁽⁹⁻¹¹⁾ This high throughput is particularly notable given the cath lab's primary operation within standard working hours (08:00–16:00), which necessitates a selective referral pattern and often a pharmacoinvasive approach for after-hours ACS cases. Consistent with global trends, DCA predominated at 40.9%, followed by PCI at 26.0%.⁽⁹⁻¹¹⁾ However, excluding pacemaker and electrophysiology procedures, which are typically associated with shorter procedural times and lower inherent risks, likely shifts the reported spectrum toward a more complex workload dominated by urgent, high-risk interventional cases, compared with holistic registries.⁽¹⁹⁾ This comprehensive role is further evidenced by a diverse range of complex diagnostic indications, including transplant donor workups, pulmonary hypertension studies, and endomyocardial biopsies.

The overall complication rate in our study was 6.5%, higher than the 3.6% reported by Khan, et al.; however, direct comparisons are limited by differences in diagnostic indications and procedural scope, as only 4 procedure types were included in their study.⁽¹⁰⁾ Our 3.2% access-site complication rate is lower than recorded in the RIVAL trial (3.7–4.0%), suggesting that vascular access safety at GSH is comparable to high-level clinical trial standards.⁽¹⁴⁾ When excluding minor events, including access-site complications and vasovagal episodes, the major complication rate was 2.8%. Peri-procedural MI occurred in 0.7% of procedures, while serious complications, such as stroke, aortic dissection, or coronary perforation, each occurred in < 0.7%, consistent with previously published data.⁽¹²⁾ While mortality rates exceeded global averages (0.3% intra-procedural and 3.6% in-hospital), they must be interpreted alongside the clinical complexity of the GSH population.⁽¹⁵⁾ Unlike low-risk registries, 56.7% of patients in our study presented with ACS, with STEMI accounting for nearly a quarter (22.4%) of the overall study population.

In our cohort, the median age was 58 years, with a marked female predominance (60.5%), contrasting with the standard male predominance (often > 65%) reported in regional and global CVD registries.^(9-11,16,17) This is a unique finding that likely reflects the specific risk profile of the South African public

sector. In South Africa, women have a significantly higher prevalence of obesity and hypertension than men, which are major drivers of cardiovascular morbidity.⁽⁵⁾ Furthermore, valvular heart disease remains a major burden in the public sector, often stemming from rheumatic heart disease, which disproportionately affects females in sub-Saharan Africa.⁽³⁾ Moreover, the prevalence of active smoking (44.1%) and diabetes (32.5%) significantly exceeds national averages, reflecting the concentration of high-risk patients referred to a tertiary level.^(6,8) Dyslipidaemia was lower than the national prevalence, possibly due to underdiagnosis or incomplete testing during admission. Systemic hypertension was identified as the only significant predictor of procedural complications ($p = 0.03$), reinforcing the concept that the pre-procedural physiological state is a critical safety determinant.

Limitations and recommendations

Several limitations warrant consideration. As a single-centre, registry-based analysis, this study relied on clinician-reported data, which precluded external verification of cardiovascular risk factors, a granular assessment of mortality causes, or the physiological severity of cases, such as the presence of cardiogenic shock at presentation. Furthermore, the outcomes reflect the aggregate experience of multiple operators within a training institution rather than individual clinician performance.

Future research should prioritise multicentre, prospective cohorts that incorporate longitudinal follow-up and operator-level metrics to further refine risk stratification and resource allocation in the South African context. Expanding registry parameters to include pacemaker and electrophysiology data will provide a more holistic representation of cath lab activity and its associated safety profile. Additionally, more detailed recording of specific access-site complications will provide essential data to drive targeted quality improvement initiatives and establish a robust foundation for evidence-based health policy development.

CONCLUSION

This study provides the first comprehensive audit of cath lab activity within a South African tertiary centre, delineating a procedural spectrum that extends significantly beyond the diagnostic and interventional coronary cases typically reported in global registries. Our findings reveal a population with an exceptionally high burden of cardiovascular risk factors managed within a high-volume public-sector environment characterised by urgent and life-threatening clinical presentations. While complication and mortality rates appeared higher than those in some international high-income country registries, these results must be interpreted through the lens of patient complexity and the diverse, high-risk emergency indications managed at our facility.

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REFERENCES

1. who.int [Internet]. Cardiovascular diseases (CVDs). Geneva: World Health Organization; 2025. Available from: [https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)). Accessed 12 December 2025.
2. statssa.gov.za [Internet]. Mortality and causes of death in South Africa, 2022: Findings from death notification. Pretoria: Statistics South Africa; 2024. Report number: P0309.3. Available from: <https://www.statssa.gov.za/publications/P03093/P030932022.pdf>.
3. Minja NW, Nakagaayi D, Aliku T, et al. Cardiovascular diseases in Africa in the twenty-first century: Gaps and priorities going forward. *Front Cardiovasc Med* 2022;9:1008335. <https://doi.org/10.3389/fcvm.2022.1008335>.
4. Stassen W, Wallis L, Lambert C, Castren M, Kurland L. Percutaneous coronary intervention still not accessible for many South Africans. *Afr J Emerg Med* 2017;7(3):105-107. <https://doi.org/10.1016/j.afjem.2017.04.009>.
5. Micklesfield LK, Kolkenbeck-Ruh A, Mukoma G, et al. The Healthy Aging Adult South Africa report card: A systematic review of the evidence between 2013 and 2020 for middle-aged South African men and women. *Cardiovasc J Afr* 2022;33(4):200-219. <https://doi.org/10.5830/CVJA-2022-015>.
6. Pheiffer C, Pillay-van Wyk V, Turawa E, et al. Prevalence of type 2 diabetes in South Africa: A systematic review and meta-analysis. *Int J Environ Res Public Health* 2021;18(11):5868. <https://doi.org/10.3390/ijerph18115868>.
7. Reiger S, Jardim TV, Abrahams-Gessel S, et al. Awareness, treatment, and control of dyslipidemia in rural South Africa: The HAALSI (Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa) study. *PLoS One* 2017;12(10):e0187347. <https://doi.org/10.1371/journal.pone.0187347>.
8. health.gov.za [Internet]. Global adult tobacco survey: South Africa report 2021. Pretoria: National Department of Health; 2024. Available from: https://www.health.gov.za/wp-content/uploads/2024/06/2021-Global-Adult-Tobacco-Survey-South-Africa-Report-Launched-13-June-2024_compressed-1-1.pdf.
9. Bastante T, Arzamendi D, Martín-Moreiras J, et al. Spanish cardiac catheterisation and coronary intervention registry. 33rd official report of the Interventional Cardiology Association of the Spanish Society of Cardiology (1990-2023). *Rev Esp Cardiol (Engl Ed)* 2024;77(11):936-946. Spanish. <https://doi.org/10.1016/j.rec.2024.07.015>.
10. Khan SB, Ali U, Ullah I, Khalid M, Ali H. Cardiac catheterization lab procedures: Safe journey in safe hands. *Pak Heart J* 2016;49(2):71-75. Available from: <https://pakheartjournal.com/index.php/pk/article/view/1083>.
11. Rwebembera J, Aliku T, Kayima J, et al. Starting and operating a public cardiac catheterization laboratory in a low resource setting: The eight-year story of the Uganda Heart Institute Catheter Laboratory. *Glob Heart* 2021;16(1):11. <https://doi.org/10.5334/gh.859>.
12. Tavakol M, Ashraf S, Brener SJ. Risks and complications of coronary angiography: A comprehensive review. *Glob J Health Sci* 2011;4(1):65-93. <https://doi.org/10.5539/gjhs.v4n1p65>.
13. Bhatti S, Cooke R, Shetty R, Jovin IS. Femoral vascular access-site complications in the cardiac catheterization laboratory: Diagnosis and management. *Interv Cardiol* 2011;3(4):503-514. Available from: <https://www.openaccessjournals.com/articles/femoral-vascular-accesssite-complications-in-the-cardiac-catheterization-laboratory-diagnosis-and-management.pdf>.
14. Jolly SS, Yusuf S, Cairns J, et al. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): A randomised, parallel group, multicentre trial. *Lancet* 2011;377(9775):1409-1420. [https://doi.org/10.1016/S0140-6736\(11\)60404-2](https://doi.org/10.1016/S0140-6736(11)60404-2).
15. Al-Hijji MA, Lennon RJ, Gulati R, et al. Safety and risk of major complications with diagnostic cardiac catheterization. *Circ Cardiovasc Interv* 2019;12(7):e007791. <https://doi.org/10.1161/CIRCINTERVENTIONS.119.007791>.
16. Cilliers JCD, Joubert L, Beyers B, et al. The incidence and outcomes of high-risk acute coronary syndromes in Western Cape Province, South Africa: A prospective cohort study. *S Afr Med J* 2023;113(5):25-29. Available from: <https://pubmed.ncbi.nlm.nih.gov/37170600/>.
17. Beyers B, Cilliers JD, Doubell A, et al. Management and outcomes of patients with ST-segment elevation myocardial infarction in the Western Cape Province of South Africa. *SA Heart* 2025;22(1):6-11. <https://doi.org/10.24170/22-1-6753>.
18. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth Universal Definition of Myocardial Infarction (2018). *Circulation* 2018;138(20):e618-e651. <https://doi.org/10.1161/CIR.0000000000000617>.
19. Mkokko P, Barole N, Solomon K, Chin A. Feasibility and safety of interventional electrophysiology and catheter ablation in the South African public sector: Challenges and opportunities for comprehensive cardiac electrophysiology in South Africa. *J Arrhythm* 2022;38(6):1042-1048. <https://doi.org/10.1002/joa3.12783>.