Management and outcomes of patients with ST-segment elevation myocardial infarction in the Western Cape Province of South Africa

B. Beyers[1], J. Cilliers[1], A. Doubell[2], P. Herbst[2], E. Ngarande[2], L. Joubert[2] and A. Pecoraro[2]

[1]Department of Medicine, Faculty of Medicine and Health Sciences, Stellenbosch University and Tygerberg Hospital, Parow, Cape Town, South Africa
[2]Division of Cardiology, Department of Medicine, Faculty of Medicine and Health Sciences, Stellenbosch University and Tygerberg Hospital, Parow, Cape Town, South Africa

Address for correspondence:
Dr Brian Deon Beyers
20 Village Close
Kenever
Durbanville
7550
South Africa

Email:
briandeonbeyers@icloud.com

Brian Beyers ID: https://orcid.org/0000-0002-2317-5706
Alfonso Pecoraro ID: https://orcid.org/0000-0001-6549-9402
DOI: https://doi.org/10.24170/22-1-6753

ABSTRACT

Ischaemic heart disease (IHD) is the leading cause of mortality globally and ranking among the top 5 causes of death in South Africa (SA). Acute coronary syndromes (ACS), particularly ST-segment elevation myocardial infarction (STEMI), contribute significantly to this burden. Despite its importance, SA lacks comprehensive ACS data, limiting the detection, estimation of cases, and understanding of patient outcomes. This study aimed to assess STEMI care within the Tygerberg Hospital (TBH) referral network in SA's Western Cape Province. The study objectives were to evaluate the distribution of patients undergoing primary percutaneous coronary intervention (PCI) vs. the pharmacoinvasive strategy, assess mortality and ACS recurrence, and investigate reasons for not performing angiography or PCI.

This retrospective analysis of STEMI data from the Tygerberg Registry of ACS (TRACS) included 292 patients admitted between April - December 2020. The pharmacoinvasive strategy was employed in 65.1% of cases, with 18.5% receiving primary PCI. In-hospital and 30-day mortality rates were 5.5% and 6.9%, respectively, with a 3.1% recurrence of ACS.

The study concluded that despite SA's healthcare limitations, the pharmacoinvasive strategy, facilitated by a hub and spoke outreach model, yields outcomes comparable to international cohorts. This underscores the clinical relevance of protocolised STEMI care in resource-limited settings. SA Heart® 2025;22:6-11

INTRODUCTION

Ischemic heart disease (IHD) is the leading cause of mortality[1] world-wide, surpassing the combined death toll of TB, HIV, and malaria worldwide.[2] In South Africa (SA), while TB, diabetes mellitus (DM), and stroke are the leading causes of death, cardiovascular disease consistently ranks amongst the top 5.[3] Within IHD, acute coronary syndromes (ACS) are the most common cause of death, chiefly attributed to ST-segment elevation myocardial infarction (STEMI). Unfortunately, South African data reporting the incidence and prevalence of ACS are limited.[4] European registries indicate a STEMI incidence ranging from 50 to 60 per 100 000 population[1,5] implying that Tygerberg Hospital (TBH) in SA's Western Cape Province, serving a population of 2 400 000 people,[6,7] should be treating 950 to 1 150 STEMI cases annually. In a retrospective study conducted in TBH in 2018 evaluating STEMI patient care intervals, only 492 cases of STEMI were recorded in a year.[8] A 2020 study by Cilliers, et al., performed in TBH over an 8-month period, identified a total of 284 patients admitted with STEMI, amounting to an extrapolated incidence of 426 patients per annum.[9] The stark contrast between expected and actual cases (1 200 vs. 492 and 426, respectively) remains unexplained. Given the population's risk profile,[10] a considerably lower STEMI incidence seems unlikely. A more plausible reason is under detection due to poor help-seeking behaviour, deficient referral pathways, inaccurate diagnoses, and patients succumbing before accessing healthcare facilities or reaching tertiary facilities.

In SA, healthcare is split between the private and public sectors, highlighting socio-economic gaps in medical access. The private sector serves mainly those with medical insurance, while 84% of South Africans rely on government-funded care.[10] Moreover, SA's expansive land area, 5 times larger than the United Kingdom (UK),[11] leads to longer transport delays in STEMI

care. Additionally, with only a quarter of the nation's catheterisation laboratories in public healthcare centres,[12] access to vital services are limited, further affecting STEMI outcomes.

Two reperfusion strategies can be employed in managing patients with STEMI. Primary percutaneous coronary intervention (PCI), where an occluded coronary artery is mechanically reopened, is the preferred approach, as seen in a UK study where 93.8% of patients presenting with STEMI underwent primary PCI.[13] However, due to the vast geographic spread of referral facilities in SA's Western Cape Province, primary PCI is feasible in only a minority of cases within the recommended 90-minute timeframe.[1] This limitation leads to a reliance on a pharmacoinvasive strategy, involving fibrinolysis at referral centres followed by transfer to a tertiary hospital for further management. The STREAM study demonstrated the pharmacoinvasive strategy's non-inferiority compared to primary PCI.[14]

Within the TBH referral network, healthcare facilities operate on a hub and spoke model, with TBH as the tertiary referral centre (hub). Here, a protocolised STEMI management strategy is enforced, mandated across all referral centres. Due to the province's expansive geography and scarce PCI-capable sites, the pharmacoinvasive strategy is the most common strategy employed within the TBH network. TBH ensures the consistent implementation of this strategy through regular outreach efforts conducted by cardiologists to referral centres, thereby enhancing STEMI care across the network.[15]

Various metrics can assess STEMI management in a referral network. Access to medical care can be gauged by symptom onset-to-diagnosis delay, while reperfusion efficiency can be evaluated by door-to-reperfusion delay. In a 2018 study in TBH, a median door-to-reperfusion delay of 67 minutes was reported.[8] Mortality rates can be measured and compared with other centres or expected rates derived from calculating STEMI-specific Time in Myocardial Infarction (TIMI) scores for each patient.[16] This latter method is particularly applicable to SA, where outcome data for STEMI is scarce. Reports from high income countries suggest 30-day mortality rates after STEMI ranging from 2.5% - 10%,[17,18] indicating better outcomes with improved reperfusion strategies over recent decades. However, findings from low-to-middle income countries suggest poorer STEMI outcomes compared to high-income countries.[19,20]

Our study aims to assess STEMI care within the TBH referral network, by evaluating the different reperfusion strategies implemented, as well as the in-hospital and 30-day mortality rates.

METHODS

The Tygerberg Registry of ACS (TRACS registry) constitutes a repository encompassing patients aged 18 years and above, referred to TBH from facilities within the hub and spoke referral network, presenting with either STEMI or high-risk non-STEMI, defined as the presence of haemodynamic instability, refractory chest pain, life-threatening arrhythmia, acute heart failure, significant ST-segment changes, or markedly elevated cardiac biomarkers.[4] This observational study entails a retrospective analysis of patient data extracted from the TRACS registry, specifically focusing on individuals diagnosed with STEMI between 1 April - 3 December 2020. The data retrieved from the registry was analysed to delineate patient demographics and ascertain cardiovascular risk factors, including HIV status and obesity (defined as a body mass index (BMI) >30kg/m^2). Furthermore, the study evaluated the management strategies employed for patients with STEMI, alongside evaluating mortality rates (both in-hospital and 30 days post-discharge) and the incidence of ACS recurrence within 30 days post-discharge from TBH. Lastly, the study evaluated reasons why angiography and PCI procedures were not performed, sourced from the registry data. Patient outcomes in terms of mortality will be compared to predicted values based on the STEMI specific TIMI score.

STATISTICAL ANALYSIS

The data management process involved the systematic importation of information into the Research Electronic Data Capture (REDCap) system. Subsequently, a statistical analysis was carried out utilising the Strata software platform. Data normality served as the guiding criterion for the chosen method of presentation. For comparative analysis of patient outcomes, a 2-sample proportion z-test was used, with statistical significance set at a p-value of less than 0.05.

ETHICS

This study received approval from the Health Research Ethics Committee (HREC) of the Faculty of Medicine and Health Sciences at Stellenbosch University, under the reference number N20/03/030. It was conducted in adherence to the Declaration of Helsinki (2013 version). Every patient provided written consent to participate. In cases where patients had passed away before providing consent, a waiver was granted.

RESULTS

A total of 292 patients were admitted with STEMI during the study period. Among them, 187 (64.0%) were male, with a median age of 58 years (interquartile range (IQR) 49 to 65

years). The most prevalent cardiovascular risk factors were active or previous cigarette smoking (72.6%) and systemic hypertension (68.5%). The study population included 39 HIV positive patients (13.4%) (Table I).

The pharmacoinvasive strategy was employed in 190 patients (65.1%), with 54 patients (18.5%) receiving primary PCI (Figure 1, Table II). In 48 patients (16.4%), neither primary PCI nor fibrinolysis was administered. Following fibrinolysis at the referral facility, a total of 170 patients (89.5%) underwent angiography, of which 37 patients (19.5%) required rescue PCI. Among the subgroup not receiving fibrinolysis or primary PCI, 23 patients (47.9%) underwent angiography at TBH. In the study population, a total of 45 patients (15.6%) did not undergo angiography, of which 20 patients received fibrinolysis and 25 patients did not receive either fibrinolysis or angiography. Reasons for not performing angiography included renal failure (14 patients) and patient mortality before the procedure could be performed (12 patients). The most common reason for not performing PCI at the time of angiography was patients with an indication for a

TABLE I: Demographics.

Measure	Variable	n=292 n%
Demographic profile	Male gender	187 (64.0)
	Age in years; median (IQR)	58 (49 - 65)
Cardiovascular risk factor prevalence	Pre-existing IHD	10 (3.4)
	Family history of premature IHD	18 (6.2)
	Systemic hypertension	200 (68.5)
	Diabetes mellitus, any type	100 (34.2)
	Obesity	119 (40.8)
	Active or previous cigarette smoking	212 (72.6)
	HIV infection	39 (13.4)

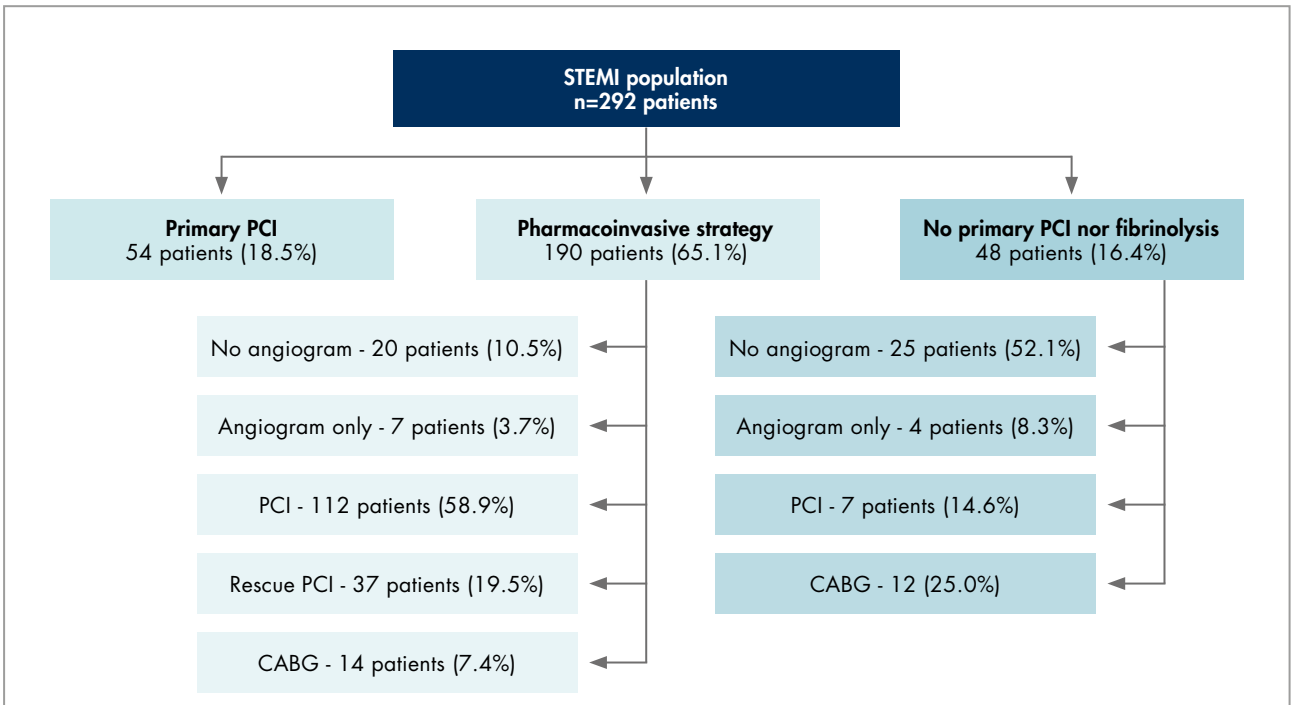

FIGURE 1: Algorithm with management strategies.
CABG: Coronary artery bypass graft, PCI: percutaneous coronary intervention, STEMI: ST-segment elevation myocardial infarction.

TABLE II: Management strategies and outcomes.

Measure	Variable	Population (n)	n (%)
Management strategies	Primary PCI	292	54 (18.5)
	Pharmacoinvasive strategy		190 (65.1)
	No primary PCI or fibrinolysis		48 (16.4)
Reasons for not performing angiography	Renal failure	45	14 (31.1)
	Patient mortality		12 (26.7)
	Other*		19 (42.3)
Reasons for not performing PCI during angiography	Late presentation with occluded artery	37	4 (11.0)
	CABG performed		26 (70.3)
	Indication for CABG, not performed yet		3 (8.1)
	Non-obstructed coronary arteries		2 (5.4)
	Other*		2 (5.4)

*Other reasons include lack of patient consent and the opinion of the attending cardiology consultant.

TABLE III: Outcomes.

Measure	Primary PCI (A) n=54	Pharmaco-invasive strategy (B) n=190	No primary PCI or fibrinolysis (C) n=48	Total n=292	Strategy A vs. B p-value	Strategy B vs. C p-value	Strategy A vs. C p-value
Total mortalities	**1 (1.9)**	**8 (4.2)**	**11 (22.9)**	**20 (6.9)**	**<0.05**	**<0.05**	**<0.05**
Of which in hospital	1 (1.9)	8 (4.2)	7 (14.6)	16 (15.5)	<0.05	<0.05	<0.05
Of which within 30 days of discharge	0 (0.0)	0 (0.0)	4 (8.3)	4 (1.4)	N/A	<0.05	<0.05
Recurrence of ACS within 30 days	**0 (0.0)**	**0 (0.0)**	**9 (18.8)**	**9 (3.1)**	**N/A**	**<0.05**	**<0.05**

coronary artery bypass graft (CABG) (29 patients, of which 26 were performed during the same admission).

A total of 20 patients (6.9%) died within 30 days of hospital discharge, with 16 patients (5.5%) demising during admission and an additional 4 patients (1.4%) succumbing within 30 days of hospital discharge. In-hospital mortality rates were 1.9% in the primary PCI group, 4.2% in the pharmacoinvasive strategy group, and 22.9% in the group of patients not receiving either intervention ($p<0.05$). Moreover, no patients demised within 30 days after discharge in the primary PCI and pharmacoinvasive groups, contrasting with 4 deaths (8.3%) in the group not receiving fibrinolysis nor primary PCI ($p<0.05$). Rescue PCI was performed in 37 patients, with 5 patients (13.5%) demising in hospital and 1 additional death recorded within 30 days of hospital discharge, amounting to an overall mortality rate of 16.2% in this subgroup. Recurrence of ACS within 30 days post-discharge was absent in both the primary PCI and pharmacoinvasive groups, while 9 patients (18.8%) encountered such recurrence in the group not receiving either management strategy ($p<0.05$) (Table III).

The STEMI specific TIMI scores were available for a total of 88 patients in the study population, with a median score of 4 points (IQR 2-5). This amounts to a predicted mortality rate of 7.3%. A total of 6 in-hospital deaths were recorded in this subgroup, amounting to a mortality rate of 6.9%.

DISCUSSION

This study demonstrated a lower than expected in-hospital and 30-day mortality in patients with STEMI when compared to other cohorts from low-to-middle income countries and comparable to those reported from high income countries.[17,18] The mortality rate among patients undergoing primary PCI was the lowest (1.9%), whilst the pharmacoinvasive strategy group demonstrated a comparatively low mortality rate (4.2%), similar to findings from European registries and the STREAM trial.[22] Notably, neither primary PCI nor the pharmacoinvasive strategy led to ACS recurrence within 30 days post-hospital discharge. Conversely, patients with STEMI not undergoing the pharmacoinvasive or primary PCI strategy had less favourable outcomes,

with a 30-day mortality rate of 22.9% ($p<0.05$). The mortality rate was higher in the rescue PCI group when compared to other patients within the pharmacoinvasive group (16.2% vs. 1.3%, $p<0.05$). A significant difference was observed between the pharmacoinvasive group and those not receiving fibrinolysis or primary PCI in terms of both mortality and ACS recurrence. In an analysis involving 88 patients, the predicted 30-day mortality based on the STEMI-specific TIMI score[16] was 7.3%, closely resembling the actual mortality rate of 6.9%. These figures suggest that patients appropriately treated and referred have favourable outcomes and resources should be directed at pre-hospital care, especially patients not offered reperfusion at first medical contact.

Over the 9-month study period, 292 patients were identified, translating to an annual incidence of 389 patients. This figure is lower than that recorded in a 2018 TBH study[8] and significantly lower than the expected incidence based on European data.[1,5] This may be due to several factors, including help-seeking behaviour, prolonged transport delays leading to pre-transfer mortality, as well as the timing of the study overlapping with the COVID-19 pandemic where fewer cases of ACS were seen than during non-pandemic periods.[22]

The median age of patients in our study was younger than the age of STEMI populations in European registries.[23] Prevalence rates of systemic hypertension and DM surpass the rate in the general SA population.[24] Cigarette smoking prevalence among STEMI patients in this study exceeded 65%, contrasting with the 18% prevalence in the general population.[24,25] Although not considered a major cardiovascular risk factor, the HIV prevalence in the study population closely mirrors that of the general population, being 13%.[26]

Most of the patients were treated with a pharmacoinvasive strategy, with the majority successfully reperfused with fibrinolytic therapy (80.5%). High rates of fibrinolysis (65%) were achieved, reflecting on effective management within the referral network (Figure 2). Despite the limited access to PCI-capable facilities within the public healthcare sector, high rates of angiography (86.9%) and PCI (73.2%) were observed in the group of patients receiving successful fibrinolytic therapy. This study demonstrates that a pharmacoinvasive strategy is not only feasible in our setting, but that short-term outcomes are similar to high income countries.

The higher mortality rate of patients undergoing rescue PCI is likely due to a delay to reperfusion. Early recognition of failed reperfusion and improving transport to TBH should improve the outcome of patients in this group. Patients not undergoing a reperfusion strategy had the worst outcome. This supports the strategy of early fibrinolysis at first medical contact, with timeous referral to a PCI-capable facility. In addition, improving patient awareness of STEMI symptoms and improving help-seeking behaviour could shorten patient delays. Furthermore, educating healthcare workers to accurately diagnose and treat STEMI should improve outcomes.

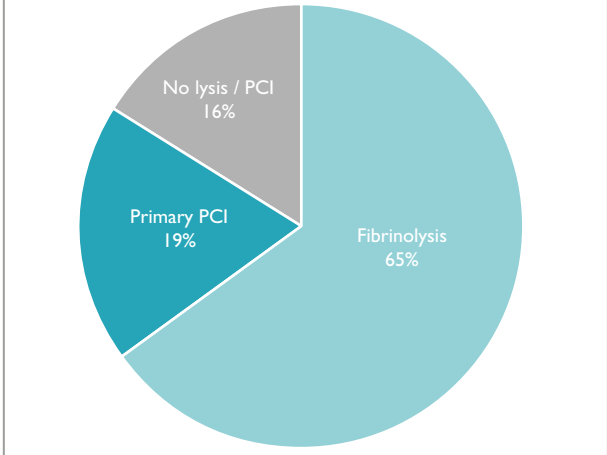

FIGURE 2: Initial management strategy employed.

CONCLUSION

Despite challenges within SA's healthcare system, this study in a region utilising a protocolised pharmacoinvasive strategy demonstrates outcomes similar to published cohorts. The challenges of implementing an efficient pharmacoinvasive strategy were overcome by establishing an outreach system built on a hub and spoke model. Limitations included the exclusion of patients demising prior to referral to TBH and patients not seeking medical attention - although these limitations are similar to that reported in published cohorts. Further investigation into the observed discrepancy between expected and actual numbers of STEMI cases at TBH and SA is warranted.

FUNDING SOURCES

Funds involved in the data collection, ethics committee application, and publication of the study were granted by the Division of Cardiology Research Fund, University of Stellenbosch, Tygerberg Hospital, Cape Town, South Africa.

Conflict of interest: none declared.

REFERENCES

1. Ibanez B, James S, Agewall S, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur Heart J 2018;39: 119–77.
2. Byrne J, Eksteen G, Crickmore C (2016). Heart Foundation. Cardiovascular disease statistics reference document [online]. Retrieved 2024: https://www.heartfoundation.co.za/wp-content/uploads/2017/10/CVD-Stats-Reference-Document-2016-FOR-MEDIA-1.pdf.
3. Statistics South Africa (2020). Statistical release mortality and causes of death in South Africa [online]. Retrieved 2024: https://www.statssa.gov.za/publications/P03093/ P0309320l7.pdf.
4. Cilliers J, 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.
5. Roffi M, Patrono C, Collet JP, et al. 2015 ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task force for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 2016;37:267-315.
6. Hertz JT, Reardon JM, Rodrigues CG, et al. Acute myocardial infarction in sub-Saharan Africa: The need for data. PLoS One 2014;9:5.
7. Council for Medical Schemes (2019). CMS annual report 2018/2019 [online]. Retrieved 2024: https://www.medicalschemes.com/files/Annual%20Reports/CMSAR2018_19.pdf.
8. Beyers BD, Doubell AF, Griffiths B, et al. ST-segment elevation myocardial infarction: Evaluating the time interval from diagnosis to fibrinolysis at centres in the drainage area of Tygerberg Hospital, Cape Town, South Africa. S Afr Med J. 2020;110:327-331.
9. Ntsekhe M, Fourie JM, Scholtz W, et al. PASCAR and WHF Cardiovascular Diseases Scorecard project. Cardiovasc J Afr 2021;32:49-58.
10. Younger DS. Health care in South Africa. Neurol Clin 2016.4:1127–1136.
11. Alexander M (2018). South Africa Gateway. How big is South Africa? (Online). Retrieved 2024: https://southafrica-info.com/land/how-big-is-south-africa/.
12. Kaifoszova Z, Kala P, Alexander T, et al. Stent for Life Initiative: Leading example in building STEMI systems of care in emerging countries. EuroIntervention 2014;10:87–95.
13. McLenachan J, Gray H, de Belder M, et al. Developing primary PCI as a national reperfusion strategy for patients with ST-elevation myocardial infarction: The UK experience. EuroIntervention 2012;8:99–107.
14. Armstrong P, Gershlick A, Goldstein P, et al. The Strategic Reperfusion Early after Myocardial Infarction (STREAM) study. Am Heart J 2010;160:1.
15. Van Deventer J, Doubell A, Herbst P, et al. Evaluation of the SUNHEART Cardiology Outreach Programme. SA Heart® 2017;2:82-6.
16. Morrow D, Antman E, Charlesworth A, et al. TIMI risk score for ST-elevation myocardial infarction: A convenient, bedside, clinical score for risk assessment at presentation: An intravenous nPA for treatment of infarcting myocardium early II trial substudy. Circulation 2000;(17):2031-37.
17. Roe M, Messenger J, Weintraub W, et al. Treatments, trends, and outcomes of acute myocardial infarction and percutaneous coronary intervention. J Am Coll Cardiol 2010;4:254-63.
18. Rosamond W, Chambless L, Heiss G, et al. Twenty two-year trends in incidence of myocardial infarction, coronary heart disease mortality, and case fatality in 4 US communities, 1987-2008. Circulation 2012;15:1848-57.
19. Gao R, Patel A, Gao W, et al. Prospective observational study of acute coronary syndromes in China: Practice patterns and outcomes. Heart 2008;5:554-60.
20. Xavier D, Pais P, Devereaux P, et al. Treatment and outcomes of acute coronary syndromes in India (CREATE): A prospective analysis of registry data. Lancet 2008;9622:1435-42.
21. ElGuindy A. STREAM and FAST-MI – Pharmacoinvasive therapy: A continued role for fibrinolysis in the primary PCI era. Glob Cardiol Sci Pract 2014;2:56.
22. Pecoraro A, Herbst P, Joubert L. Dwindling myocardial infarctions. Eur Heart J 2020;37:3497-99.
23. Zeymer U, Ludman P, Danchin N, et al. The European Society of Cardiology ACCA-EAPCI Registry on ST elevation myocardial infarction. Eur Heart J 2017;3:138-39.
24. Kohli-Lynch C, Erzse A, Rayner B, et al. Hypertension in the South African public healthcare system: A cost-of-illness and burden of disease study. BMJ Open 2022;2.
25. Reddy P, Zuma K, Shisana O, et al. Prevalence of tobacco use among adults in South Africa: Results from the first South African National Health and Nutrition Examination Survey. S Afr Med J 2015;8:648.
26. Ditaunyane L, Nematandani A (2023). Human Sciences Research Council. New HIV survey highlights progress and ongoing disparities in South Africa's HIV epidemic – HSRC (online). Retrieved 2024: https://hsrc.ac.za/press-releases/hsc/new-hiv-survey-highlights-progress-and-ongoing-disparities-in-south-africas-hiv-epidemic/.