

East African Medical Journal Vol. 100 No. 12 December 2023

PERIOPERATIVE CARDIOVASCULAR RISK STRATIFICATION AND OUTCOMES IN ADULT PATIENTS UNDERGOING MAJOR NON-CARDIAC SURGERY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

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ABSTRACT

Background: Pre-operative cardiac evaluation of patients undergoing non-cardiac surgery is routinely done to mitigate against adverse cardiovascular events, but the clinical benefit of this approach remains uncertain in low and middle-income countries (LMICs).

Objective: To determine the peri-operative cardiovascular risk category and adverse outcomes of patients undergoing elective major non-cardiac surgery at the Moi Teaching and Referral Hospital (MTRH), Kenya.

Methods: This was prospective observational study. Participants ≥ 40 years old, scheduled for elective major non-cardiac surgery were recruited between March and August 2022. A focused cardiovascular clinical evaluation, serum lipid profile, blood glucose level, renal function test, electrocardiography and echocardiography data were collected. Risk stratification was done using the Revised Cardiac Risk Index (RCRI). Postoperative follow up for acute coronary syndromes, worsening heart failure, unstable arrhythmias in the first 48 hours, thereafter for all-cause mortality at 30 days.

Results: Two hundred and forty-three participants were recruited. Their mean age was 58.5 years and 61.3% were females. The prevalent cardiovascular disease risk factors were: hypertension (38%), diabetes mellitus (9.1%), dyslipidaemia (28%), obesity (18%) and cigarette smoking (6.6%). Diabetes (9.1%), Heart failure (2.1%), previous stroke or transient ischemic attack (1.2%) and chronic kidney disease (1.6%) were the perioperative cardiovascular complications risk factors present. Only 3(1.2%) of the participants were in the high-risk category (RCRI

score of ≥ 3). Worsening HF was the main adverse cardiovascular outcome occurring in 4(1.6%) participants, 2(0.8%) had cardiovascular death.

Conclusion: Patients undergoing elective non-cardiac surgery at MTRH are low risk with an attendant low cardiovascular events.

INTRODUCTION

Perioperative CV complications are a significant source of morbidity and mortality for over 300 million patients worldwide undergoing non-cardiac surgery (NCS) each year¹. Major NCS with prolonged hemodynamic stress are associated with major cardiac complications (2.0-3.5%) and mortality (0.5-1.5%)². Induction of anaesthesia, surgical trauma, bleeding, anaemia, hypoxia and postoperative pain lead to surges in catecholamines, cortisol production and hypercoagulability. These coupled with postoperative rise in inflammatory cytokines may precipitate cardiovascular complications². The most common cardiovascular complications are: acute coronary syndromes, stroke, worsening heart failure and CV death³. The morbidity and mortality are either patient-related based on individual CV risk category or procedure-related^{2,4}. A number of tools have been studied to assess CV risk in this type of patient population and the Revised Cardiac Risk Index (RCRI) is the most validated⁵⁻⁸. The RCRI and other models incorporate cardiovascular risk factors, atherosclerotic cardiovascular disease (ASCVD), and procedure-specific risks to identify individuals who may benefit most from careful medical optimization prior to surgery⁹. RCRI scores are based on diagnosis of six perioperative risk factors: ischemic heart disease, heart failure, prior transient ischemic attack or stroke, chronic kidney disease, diabetes mellitus, and major/high-risk surgery. To calculate the RCRI, 1 point is assigned for each parameter for a range of 0-6 with 6 being the worst. Patients with a RCRI of 0 have an approximate risk of 0.4% for

major cardiovascular complications, whereas those with an index of 3 or greater have an approximate risk of 10% and are considered high-risk.

The growing burden of cardiovascular disease risk factors such as ageing, hypertension, diabetes mellitus, rheumatic heart disease etc, in sub-Saharan Africa portends an increasing risk of cardiovascular complications which form the bulk of perioperative complications^{10,11}. Whereas pre-operative cardiac evaluation is routinely done in most centres performing NCS, the clinical utility of this practice in so far as mitigating adverse CV events is unknown, specifically in LMICs where the burden CV risk factors is high and rising.

This study describes and stratifies the perioperative cardiovascular risk profile of patients undergoing elective major noncardiac surgery at the Moi Teaching & Referral Hospital (MTRH) and their outcomes.

METHODS

We conducted a prospective observational study between March and August 2022 at MTRH, a tertiary medical centre situated in Western Kenya. Ethical approval to conduct this study was obtained from the MTRH & Moi University Institutional Research and Ethics Committee (Ref: IREC/2021/183, *Approval No. 004053*). Adult patients aged 40 years and above who were electively scheduled for major NCS at MTRH and gave written informed consent were eligible for inclusion. We excluded individuals with physical deformities/injuries that could preclude cardiac imaging, as well as

individuals whose surgery was re-classified as emergent.

We had a target sample size of 239 participants based on an estimated prevalence of RCRI scores > 3 (high risk) of 6%. Systematic random sampling was used to recruit from Surgical disciplines' inpatient units until the target sample size was reached.

Following recruitment, participants underwent a focused cardiovascular history taking and a physical examination was conducted thereafter. Two (2) mls of blood was collected for from each participant for random blood glucose testing, and assessment of serum creatinine and electrolytes and a lipid panel. Participants then underwent non-invasive cardiac evaluation (resting ECG using Philips® TC 30 and Echocardiography using Philips® CX50 machine) which were done by a certified Electrocardiography (ECG) and Echocardiography technologist with the results being interpreted by a cardiologist.

Participants were then reviewed again at 48 hours post-operatively to assess for vital status and evaluate for pre-specified CV events that included: acute coronary syndrome (ACS) as per the universal definition of myocardial infarction, acute/worsening heart failure (defined as rapid or gradual onset of symptoms and/or signs of heart failure, severe enough for the patient to be transferred to an intensive care unit or the use of intravenous diuretics), stroke (neurological deficits of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours and confirmed by CT scan) or transient ischemic attacks (neurologic deficits resolving within 24hrs with normal CT scan), haemodynamically significant arrhythmias (New or worsening cardiac arrhythmia that necessitated intervention). These outcomes were captured as diagnosed and indicated in the patients' charts by the primary clinical care team. We did a 30-day post-discharge

telephone visit to all the participants to assess their vital status. For death reports, we sought to confirm the information from a copy of the burial permit or death certificate.

Data analysis

Data was entered into Microsoft Access and analysed using STATA version 16. Descriptive statistics was used to describe patients' characteristics, with mean and the corresponding standard deviation used for continuous variable age. Frequencies and proportions were used for categorical variables such as cardiovascular profile, RCRI strata and postoperative adverse outcomes of the participants. The 95% Confidence Interval (CI) of the risk factors for perioperative complications and adverse outcomes' proportions were presented. Association between cardiac risk index, echocardiography findings and post-operative cardiovascular outcomes was determined using Pearson's Chi-square test of association with the likelihood ratio P-values presented. A P-value <0.05 was taken as cut-off point for statistical significance.

RESULTS

A total of 265 patients were screened of whom 245 met were enrolled. Two planned surgeries were canceled (one withdrew consent for surgery, the other had uncontrolled hypertension), hence 243 participants completed follow-up at 48hrs postoperative. At 30 day follow up, 3 patients were lost to follow up, thus 240 patients completed the 30 day follow up. Their mean age was 58.5 years with 61.3% being female. Hypertension was the most prevalent CVD risk factor (38.7%) and Orthopedic surgery was the commonest procedure. On ECG, none of the participants had a hemodynamically significant arrhythmia or changes suggestive of myocardial ischemia. Based on echocardiography 5 (2.1%) had reduced systolic function (EF <50%). (Table 1).

Table 1
Baseline characteristics

Characteristic	Overall (N=243)
Age (mean [SD])	58.5 (±11.1) years
Sex	Frequency (%)
Female	149 (61.3%)
CVD risk factors	
History of Smoking	16 (6.6%)
Hypertension	94(38.7%)
Diabetes Mellitus	22 (9.1%)
Dyslipidemia	68 (28.1%)
Obesity	43 (17.7%)
Type of surgery	
Abdominal	36 (14.8%)
Thoracic	6 (2.5%)
Endocrine	15 (6.2%)
Gynaecological	62 (25.5%)
Neurosurgical	7 (2.9%)
Orthopaedic	100 (41.2%)
Urological	17 (7.0%)
Echocardiography findings	
Normal (EF >50%)	238 (97.9%)
HFrEF (EF <40%)	3 (1.2%)
HFmrEF (EF 40-50%)	2 (0.8%)
ECG Findings	
Significant Arrhythmias	0(0%)
Ischaemic Changes	0(0%)

The prevalence of risk factors for peri-operative cardiovascular complications (as per the RCRI) was diabetes (22; 9.1%). Heart failure 5(2.1%), elevated serum

Creatinine/CKD 4(1.6%), and prior stroke 3 (1.2%). None of the participants had established ischaemic heart disease. (Table 2).

Table 2
Risk factors for perioperative complications

Risk factors for peri-operative cardiovascular complications	Frequency (%)	95% CI
Ischemic heart disease)	0(0%)	0
Heart Failure	5(2.1%)	0.4-4.1
Chronic kidney disease	4 (1.6%)	0.4-3.3
Prior cerebrovascular events	3(1.2%)	0-2.9
Diabetes mellitus	22 (9.1%)	5.8-12.3

Stratification of perioperative cardiovascular risk using the Revised Cardiac Risk Index Majority (98.8%) of the participants had a RCRI of 1or 2 – corresponding to low risk for

adverse perioperative major cardiovascular events. Only 3 (1.2%) participants had high risk based on the RCRI score of ≥ 3 (Table 3).

Table 3*Revised Cardiac Risk Index score*

Revised Cardiac Risk Index score	Frequency (%)
1 (low risk)	208 (85.6%)
2 (Low risk)	32 (13.2%)
3 (high-risk)	2 (0.8%)
4 (High risk)	1 (0.4%)

A total of 6 (2.5%) participants developed cardiovascular events, four (1.6%) of whom had worsening heart failure. None of the participants developed a stroke, ACS, or arrhythmia post-surgery while there were two mortality events at 30 days (Table 4).

Table 4*Outcomes*

Outcomes	Frequency (n)	Percent (95% CI)
Worsening heart failure	4	1.6 (0.4-3.7)
Stroke	0	0
Mortality	2	0.8 (0-2.1)
Acute coronary syndrome	0	0
Arrhythmia	0	0
None	237	97.5 (95.5-99.2)

Association between cardiac risk index, echocardiography findings and post-operative cardiovascular outcomes

Among patients with high cardiac risk, 1 (33.3%) had worsening heart failure, while among those with low cardiac risk, 3 (1.2%) had worsening heart failure. The association between outcomes and cardiac risk index were not statistically significant (P=0.093).

One (20.0%) of the patients with abnormal echocardiography findings died and 4 (80.0%) had worsening heart failure while among those with normal echocardiography findings, 1(0.4%) died while none had worsening heart failure. The association between echocardiography findings and the outcomes were statistically significant (P value<0.001) (Table 5).

Table 5*Association between cardiac risk index, echocardiography findings and post-operative cardiovascular outcomes*

	Death	Worsening heart failure	None	P value
Cardiac risk index				
Low risk (1 and 2)	2 (0.8%)	3 (1.2%)	235 (97.9%)	0.093
High risk (3 and 4)	0	1 (33.3%)	2 (66.7%)	
Echocardiography findings				
Normal	1 (0.4%)	0	237 (99.6%)	<0.001
Abnormal	1 (20.0%)	4 (80.0%)	0	

DISCUSSION

In this cohort of adults at least 40 years of age undergoing major NCS at MTRH, we found a high burden of prevalent CVD risk factors particularly hypertension, dyslipidaemia, and obesity. These findings reflect the rising incidence of these risk factors in low and middle income countries (LMICs) as a consequence of urbanization and adoption of sedentary lifestyles & poor dietary habits⁽¹⁰⁾. This prevalence is however still lower than those reported from high income country (HICs) studies^{12,13}. Smilowitz and colleagues found a prevalence of hypertension, dyslipidaemia, diabetes mellitus and obesity of 63%, 36%, 27.4%, and 15.2% respectively, while Sazgary et al found the prevalence of hypertension and diabetes mellitus at 64% and 23% respectively¹². The fairly high prevalence of these CVD risk factors in our study population points to a potentially high risk of atherosclerotic cardiovascular disease (ASCVD) burden now or in future in LMICs. The prevalence of risk factors/predictors (heart failure, diabetes mellitus, elevated serum creatinine and history of stroke) of perioperative adverse cardiovascular outcomes in our study was low. None had features of ischaemic heart disease despite the fairly high prevalence of CVD risk factors, this could be attributed to the relatively younger age of the study participants in whom ASCVD could still be mild and asymptomatic and hence not manifested in the evaluation tools we used in this study i.e. resting ECG and echocardiogram. This low prevalence of predictors of adverse perioperative outcomes is reflected in the low proportion of participants who were at high risk, with only 1.2% having high cardiac risk based on the RCRI score. This is lower compared to the proportion of high-risk score found in the US population by Smilowitz in 2013 of 7.7%². The difference could largely be due to the high burden of established ASCVD in the US population of approximately 25%.

Sazgary et al also found a higher prevalence of these risk factors i.e. congestive heart failure 11%, coronary artery disease 27%, prior myocardial infarction 13%, prior stroke 9%, chronic kidney disease 15% and Diabetes mellitus 23%¹². Our study population was also younger than encountered in HICs studies (mean age of 73yrs in the Sazgary study & 66 years in Smilowitz study). However, in view of the prevalence of CVD risk factors, occult ASCVD could have been missed in this population due to the limitations of the tests we used in this study. In terms of perioperative adverse cardiovascular outcomes, the event rate was low, occurring in 2.5% of the study participants, mainly worsening heart failure (1.6%). This was consistent with the low-risk nature of these participants as predicted by RCRI. This event rate is lower compared to rates observed in HICs such as 2.6-3.1% reported in the US in the study done in 2013¹⁴ and 15.2% in Switzerland in 2015¹². This difference is attributed to a lower prevalence of atherosclerotic disease in this population compared to that in the HICs¹¹ where these adverse CV events are largely driven by perioperative myocardial infarction/injury in the presence of atherosclerotic CVD^{3,14-19}. We may have missed some acute myocardial infarction events for two reasons: one, the events may have been asymptomatic because of perioperative analgesia use and two, the fact that we did not test for cardiac troponins perioperatively to demonstrate myocardial necrosis as done in other studies^{3,9,18,20}. However, the low 30-day mortality coupled with low rates of other adverse CV events point to a possibility of truly low incidence ACS in our study population. Heart failure was the main identified risk factor for adverse cardiovascular events in this study. This is demonstrated by the main events being worsening heart failure and one of the two mortalities resulting from heart failure as well. Heart failure findings on echocardiography were significantly

associated with adverse cardiovascular events. This is indicative of heart failure's ability to predict the likelihood of adverse outcomes independent of the RCRI which was not significantly associated with the post-operative adverse outcomes. This is consistent with other studies which have demonstrated HF morbidity to be the commonest complication and demonstrated HF as an independent predictor of adverse CV events and mortality^{4,21-25}. Therefore, improvements in perioperative care are needed for the growing population of patients with heart failure undergoing major NCS.

Study limitations

Our study was a single centre study conducted in a tertiary referral centre which may limit its generalizability to other settings in view of the heterogeneity in CV risk factors and diseases prevalence. In addition, being an observational study and the limitations of our investigations, we may have underreported some risk factors (like IHD) and adverse cardiovascular events such as ACS & arrhythmias since we did not proactively search for arrhythmias with repeat ECG as this was left to the attending physician/surgeon if clinically indicated.

CONCLUSION

Patients undergoing elective major NCS at MTRH have low risk for developing perioperative cardiovascular events despite a high burden of CV risk factors. Worsening heart failure was the main post-operative cardiovascular complication noted but only occurred in 1.6% of the study participants. This calls for individualized perioperative cardiac evaluation & improvements in perioperative care for the growing population of patients with heart failure undergoing major NCS

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