

**STUDY ON CARDIOVASCULAR INDEX–“CVRI” A NEW INDEX FOR
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ABSTRACT

To identify group of very low risk patients who do not need any further CVS evaluation. To study whether the addition of simple easily available investigation like ECG, chest – x ray have a role in further improving the discriminatory ability of CVRI index. A prospective observational study of 1000 consecutive patients admitted in Gandhi Hospital. A Total of 1000 patients were enrolled in the study with age distribution. Age < 40 years were 15.8 %, 41-60 years of 56.2%, 61-80 years of 27.1 % & >80 years 0.9 %. Mean age of patients in study 53.2 ± 13.4 years. The new index can quickly stratify patients undergoing non cardiac surgery into low, intermediate, and high-risk groups on the basis of 6 easily acquired data elements. The new CVRI model has important implications on the efficient triage and management of patients scheduled for non cardiac surgery. These findings will require further prospective validation in a broad range of surgical sub populations.

KEYWORDS: Cardiovascular Risk Index (CVRI), Electrocardiogram (ECG), Left Ventricular Hypertrophy (LVH), Congestive Heart Failure (CHF), Coronary Artery Disease (CAD), Non ST Elevated Myocardial Infarction (NSTEMI).

INTRODUCTION

Millions of patients undergo non cardiac surgeries worldwide every year.^[1] The incidence of in hospital cardiovascular events in these patients varies depending on the clinical profile of the patient and type of surgery performed.^[2-5]

Many patients undergoing major non cardiac surgery are at risk for a cardiovascular event. Cardiovascular complications account for majority of cause of postoperative morbidity & mortality with incidence ranging from 0.5 % to 30 %.^[6]

Each year 10% of the adult population undergoes a non-cardiac surgery. A third of these surgeries are performed in the geriatric population who are at increased risk for a cardiac event. The overall mortality rate of all surgeries is 0.3%. Major surgeries the mortality rate is less than 1% in patients younger than 65 years, but increases to 5% for patients between 65 and 80 years.^[7]

Death in the postoperative period in the first 48 hours is mainly due to cardiac causes while death between 48 hours and 6 weeks is often due to pneumonia, sepsis, pulmonary embolism, cardiac arrest and renal failure.^[8]

The most commonly used models are the Revised Cardiac Risk index (RCRI) and the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) risk calculator. The RCRI model is simple, but does not have a strong discriminatory ability. The NSQIP risk calculator on the other hand has a stronger discriminatory ability, but is complex, requires a calculator, and is not handy for use by the busy house staff and clinicians who take care of these patients.^[9]

There is a trend towards performing procedures in older and sicker patients among whom the prevalence or risk factors for cardiovascular disease is increasing. This tendency and the fear of perioperative cardiac complications prompt preoperative risk identification, stratification and modification of risk factors.

Several risk models have been proposed for the assessment of perioperative cardiovascular risk, and these are incorporated into the evaluation algorithms proposed by the American College of Cardiology/American Heart Association and European Society of Cardiology/European Society of Anesthesiology guidelines.^[10]

AIMS

To validate CVRI - new index of preoperative CVS evaluation in Indian population.

OBJECTIVES

1. To validate CVRI - new simple index of preoperative CVS evaluation in Indian population.
2. To identify group of very low risk patients who do not need any further CVS evaluation.
3. To study whether the addition of simple easily available investigation like ECG, chest – x ray have a role in further improving the discriminatory ability of CVRI index.

MATERIALS AND METHODS

A prospective observational study of 1000 consecutive patients admitted in various surgical wards & Cardiology OPD for Non Cardiac Surgery in Gandhi Medical College & Hospital, Secunderabad Telangana State from September 2019 to March 2020.

INCLUSION CRITERIA

All patients attended to cardiology OPD from September 2019 to March 2020 for preoperative evaluation of Non cardiac surgery.

EXCLUSION CRITERIA

Patient who have acute coronary syndrome (STEMI, NSTEMI / UA), Acute Decompensated heart failure.

All the patients attending for preoperative risk evaluation for Non cardiac surgery.

The laboratory investigations required are

- Essential investigations: ECG, Chest X-ray, CBP.
- Trans thoracic echocardiography (TTE), stress test, CAG,
- Troponin T, CPK – MB
- Additional investigation (if required)

PROCEDURE

All patients attending cardiology OPD for preoperative evaluation of non cardiac surgery by calculating simple index CVRI – Cardiovascular risk index.

We report a new index based on 6 easily acquired data elements

1. Age >= 75 years.
2. Hemoglobin <12 mg/dl.
3. Symptoms of angina or dyspnea,
4. History of heart disease,
5. Vascular surgery, and.
6. Emergency surgery.
7. That can strongly predict the 30 - day risk of post-operative cardiovascular events in patients undergoing non cardiac surgery.

CVRI NEW INDEX PARAMETERS.

PARAMETER	YES	NO
Age >= 75 YRS	1	0
Haemoglobin < 12g/dl	1	0
Angina / Shortness of Breath	1	0
Heart disease	1	0
Vascular surgery	1	0
Emergency surgery	1	0

The new CVRI stratifies patients into 3 well-demarcated risk groups:

- Low risk with a CVRI : 0 to 1
- Intermediate risk with a CVRI : 2 to 3
- High risk with a CVRI >3
- Angina was defined as oppressive chest pain on exertion.
- Patients were asked whether they had shortness of breath during regular daily activities and were labeled as having dyspnea accordingly.

Patients were designated as having heart disease if they had

- History of prior myocardial infarction, NSTEMI, UA ,SIHD
- Coronary angioplasty,
- Cardiac surgery,
- Heart failure,
- Atrial fibrillation,
- Moderate/severe valvular disease confirmed by echocardiography.
- Any other heart disease like cardiomyopathy

Vascular surgery

- Aortic surgery
- Nonaortic surgery
- Carotid endarterectomy
- Aneurysmal repair
- Peripheral arterial surgery
- Vascular access for haemodialysis

Emergency: life or limb threatened without intervention within 24 hours .

- Patient having any ECG abnormality, cardiomegaly on Chest X-ray , dyspnea of unknown origin ,CVRI score of 3 or more undergone Trans Thoracic Echocardiography to evaluate cardiac risk.
- Cardiomegaly is defined as Cardiothoracic ratio more than 50% for adult and 55% for infants.
- Cardiothoracic ratio derived by measuring maximum cardiac diameter at Cardio phrenic angle to the maximum internal thoracic diameter at the level of diaphragm.
- After 30 days after surgery to document the occurrence of the outcome like Death, Myocardial infarction &Stroke.

DEFINITION OF OUTCOMES

- The primary outcome of the study was the

occurrence of death, myocardial infarction, or stroke at 30 days after surgery.

- Death of any cause was considered an endpoint.
- Myocardial infarction was diagnosed based on an elevated troponin level >0.03 ng/ml, the presence of clinical symptoms of myocardial ischemia and/or ischemic electrocardiographic (ECG) changes (ST-segment elevation, ST-segment depression, or T-wave inversion).
- Troponin levels were not routinely checked on all enrolled patients.
- They were ordered based on routine clinical practice whenever the treating physician suspected myocardial infarction based on the clinical status of the patient or ECG findings.
- Stroke was diagnosed by a neurology consultant based on new neurological findings that were confirmed by imaging studies.

RESULTS

Table 1: Age Distribution.

Age group (years)	No of patients	Percentage (%)
<=40	158	15.8%
41-60	562	56.2%
61-80	271	27.1%
> 80	9	0.9%
Total	1000	100%

Table 2: Types of Surgery & Percentage.

Type of Surgery	No. of Patients	Percentage (%)
General Surgery	378	37.8
Orthopedic Surgery	190	19
Gynaecologic & Obstetric Surgery	139	13.9
Urological Surgery	123	12.3
Neurosurgery	97	9.7
ENT Surgery	32	3.2
Ophthalmological Surgery	13	1.3
Plastic Surgery	13	1.3
Cardiothoracic Surgery	11	1.1
Gastrointestinal Surgery	2	0.2
Dental	1	0.1
Paediatric Surgery	1	0.1
Pulmonological Surgery	1	0.1
Total	1000	100

Table 3: Abnormality in Imaging.

Abnormality in Imaging	No. of Patients	Percentage (%)
ECG	241	24.1
CXR	121	53.3
TTE	92	40.5

Table 4: Primary Outcome of Study after Surgery.

Type of Cardiovascular	No. of Patients	Percentage (%)
ACS	4	0.4
Stroke	4	0.4
Death	19	1.9

Table 5: Cardiovascular Events Among CVRI Score.

CVRI Score	Cardiovascular Event		Total
	NO	Yes	
0	520	8	528
	98.5%	1.5%	100.0%
1	343	7	350
	98.0%	2.0%	100.0%
2	90	4	94
	95.7%	4.3%	100.0%
> / = 3	23	5	2/8
	82.1%	17.9%	100.0%
Total	976	24	1000
	97.6%	2.4%	100.0%
p-Value < 0.01			

Table 6: CVRI Score & Percentage of Death Correlation.

CVRI Score	No. of Patients	No. of Death	(%) of Death
0	528	6	1.1
1	350	6	1.7
2	94	3	3
3	25	4	16

Table 7: Chest – X Ray & Cardiovascular Events Correlation.

CXR	Cardiovascular Events		Total
	No	Yes	
Abnormal	116	5	121
	95.9%	4.1%	100.0%
Normal	860	19	879
	97.8%	2.2%	100.0%
Total	976	24	1000
	97.6%	2.4%	100.0%
p-Value – 0.198			

Table 8: ECG Correlation with cardiovascular Events.

ECG	Cardiovascular Events		Total
	No	Yes	
Abnormal	227	14	241
	94.2%	5.8%	100.0%
Normal	749	10	759
	98.7%	1.3%	100.0%
Total	976	24	1000
	97.6%	2.4%	100.0%
p-Value – < 0.01			

Table 9: TTE & Primary Events (Death, MI, Stroke) Correlation.

TTE	Primary Events (%)	No. of Events	Total	P value
Normal	4 (2.3%)	168 (97.7%)	172	< 0.0001
Abnormal	6 (6.4%)	87 (93.6%)	93	< 0.0001
NOT DONE	14 (1.4%)	721 (98.6%)	735	-
Total	24	976	1000	< 0.0001

Table 10: CVRI Score & Primary Outcomes.

Comparison Among Outcomes in CVRI Groups							
Outcome	CVRI=0	CVRI=1	CVRI=2	CVRI>=3	TOTAL	% of Patients	P value (total)
Death MI or Stroke	8 (1.5%)	6 (1.7%)	4 (4.2%)	6	24	2.4	< 0.0001
Death	6 (1.1%)	6 (1.3%)	3 (6%)	4 (17%)	19	1.9	< 0.0001
MI	1 (0.1%)	0 (0%)	1 (0.1%)	2 (0.2%)	4	0.4	< 0.01
Stroke	1 (0.1%)	0	0	0	1	0.1	0.82

Table 11: ROSC Correlation between CVRI Score & ECG, CXR (PA), TTE.

Area Under the Curve					
Test Result Variable (s)	Area	SE	p-value	Asymptomatic 95% Confidence Interval	
				Lower Bound	Upper Bound
CRVI and abnormal ECG	0.669	0.06	< 0.01	0.55	0.79
CRVI and abnormal CXR	0.557	0.06	0.34	0.43	0.68
CRVI and abnormal TTE	0.617	0.07	0.04	0.49	0.75

DISCUSSION

In our study, increasing trend of doing surgery for geriatric population constituting (27.9 % elderly people with age > 60 years), Beliveau et al. had 1/3rd of non-cardiac surgery performed in elderly population.

The incidence of Death in our study increased steadily with the increase in CVRI (1.1% for CVRI of 0, 1.7% for CVRI of 1, 3% for CVRI of 2, 16% for CVRI of 3, and 0 % for CVRI >3; p value<0.01.

Dakik et al. Pre-Operative Cardiovascular Evaluation showed the incidence of the death increased steadily with the increase in CVRI (0% for CVRI of 0, 0.5% for CVRI of 1, 2.0% for CVRI of 2, 5.6% for CVRI of 3, and 15.7% for CVRI >3; p value for trend <0.0001).^[11]

Total Deaths occurred in our study 1.9% patients, similar to a large prospective study (The Vascular Events in Non cardiac Surgery Patients Cohort Evaluation [VISION] Study), which included 40,004 patients of which 715 patients (1.8%) died within 30 days of surgery.^[12]

During the last several decades, advances in perioperative care have included less invasive surgery, improved anesthetic techniques, enhanced intraoperative monitoring and more rapid mobilization after surgery. At the same time, the age and the number of comorbidities of patients undergoing surgery have increased substantially.^[13]

Our study had Acute MI in 4 patients (0.4 %) with CVRI score – 0 shows 0.1% (n=1) & CVRI score – 3 score shows 2% (n=2) after non cardiac surgery, indicating that increase in CVRI score risk, incidence of MI is also increasing. Dakik et al showed CVRI – 0, > = 3 risk of MI was 0%, 2.2 % with p value of <0.0001 Perioperative MIs likely result from triggers that initiate inflammatory, hypercoagulable, hypoxic and stress states.

Risk of stroke 0.1% (n=1) in CVRI score 0 while in CVRI score >= 3, it was 0%. Dakik et al. also had similar results of 0% & 0% respectively with p – 0.16, which was not significant.

Our study found that 2.4 % of patients had cardiovascular events after non cardiac surgery, comparable to study by Lee et al, who found 1.4 % major cardiovascular outcome.^[14]

However Study by Lee and colleagues likely represent an estimate of the current incidence of major perioperative cardiac events among unselected adults undergoing non cardiac surgery exclusion of emergent surgical cases that requires hospital admission and hence affecting the major cardiovascular outcome.

Increasing numbers of elderly people undergoing non cardiac surgery today. Emergent cases represent about 10% of non cardiac surgeries, and patients undergoing emergent surgery are at higher risk of major perioperative cardiac events than patients undergoing elective surgery (odds ratio 2.6, 95% CI 1.2–5.6).^[15]

We report a new index based on 6 easily acquired data elements (age >=75 years, history of heart disease, symptoms of angina or dyspnea, hemoglobin , vascular surgery, and emergency surgery) that can strongly predict the 30-day risk of post-operative cardiovascular events in patients undergoing non-cardiac surgery.

The new CVRI stratifies patients into 3 well-demarcated risk groups: low risk with a CVRI of 0 to 1, intermediate risk with a CVRI of 2 to 3, and high risk with a CVRI >3.

Currently, the 2 most commonly used indices for pre-operative cardiovascular assessment are the RCRI and NSQIP score.

The American College of Cardiology/American Heart Association guidelines recommend the use of either of these scores for pre-operative cardiovascular evaluation.

The RCRI index (reported in 1999) was derived from a study of 4,315 patients undergoing non-cardiac surgery in one tertiary care teaching hospital.

Recent large cohort studies have suggested that the RCRI might underestimate the risk of cardiovascular events in contemporary surgical practice.^[16]

Statistical comparison between the 2 ROCs was highly significant, the adding simple investigation increasing discriminatory power of score (0.65 to 0.73). Our model stratifies patients into low-, intermediate-, and high-risk groups. Each of these approaches has advantages and disadvantages.

The primary outcome measures in the RCRI and NSQIP scores are not the same, but they both focus on cardiac

events (myocardial infarction, pulmonary edema, ventricular fibrillation, primary cardiac arrest, and complete heart block for RCRI, and myocardial infarction or cardiac arrest for NSQIP).

We have elected to include death from all causes as one of the primary outcome measures in our model in order to make it more comprehensive for physicians and patients as well. Patients undergoing non cardiac surgery are concerned, not only about cardiac complications, but also about the risk of death secondary either to surgical or cardiac complications.

However, several of the elements in our new index are indirectly correlated with functional capacity (age, anemia, heart failure, symptoms of angina or dyspnea) and that is probably why our model was a strong predictor of outcomes, despite the absence of functional capacity.

This has important implications for the triage of those patients. The 6 simple data elements of the CVRI can be easily collected by the surgeon when he or she sees a patient in clinic or by the triage nurse in the preadmission unit, and those with a CVRI of zero can be quickly identified as low-risk patients and, in the majority of cases, would not require any further evaluation by a cardiologist or any special monitoring post-operatively.

At the same time, the new index can also quickly identify the small group of patients with a high risk of post-operative cardiovascular events (CVRI >3) that would require more extensive pre-operative cardiovascular evaluation and closer post-operative monitoring.

This stratification would be very helpful for the proper allocation of medical resources (cardiology consultation, cardiac tests, and post-operative monitoring) to the high-risk patients and for the expeditious triage of the much larger group of low-risk patients who would not need such resources.

CONCLUSIONS

1. We report a new cardiovascular risk index that is simple to acquire and has a powerful discriminatory ability to predict cardiovascular events post non cardiac surgery.
2. The new index can quickly stratify patients undergoing non cardiac surgery into low-, intermediate-, and high-risk groups on the basis of 6 easily acquired data elements.
3. Moreover, the new index is able to identify a large group of low-risk patients that, in general, might not require pre-operative cardiovascular evaluation or any special monitoring postoperatively.
4. The new CVRI model has important implications on the efficient triage and management of patients scheduled for non cardiac surgery.

5. These findings will require further prospective validation in a broad range of surgical sub populations.

REFERENCES

1. Weiser TG, Regenbogen SE, Thompson KD, et al. An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet*, 2008; 372: 139–44.
2. Pearse RM, Moreno RP, Bauer P, Pelosi P, Metnitz P, Spies C, Vallet B, Vincent JL, Hoeft A, Rhodes A. Mortality after surgery in Europe: a 7 day cohort study. *The Lancet*, 2012 Sep 22; 380(9847): 1059–65.
3. Botto F, Alonso-Coello P, Chan MT, et al. Myocardial injury after noncardiac surgery: a large, international, prospective cohort study establishing diagnostic criteria, characteristics, predictors, and 30-day outcomes. *Anesthesiology*, 2014; 120: 564–78.
4. Fleisher LA, Eagle KA. Lowering cardiac risk in noncardiac surgery. *New England Journal of Medicine*, 2001 Dec 6; 345(23): 1677–82.
5. Dakik HA, Kobrossi S, Tamim H. The yield of routine pre-operative cardiovascular evaluation in stable patients scheduled for elective non-cardiac surgery. *International journal of cardiology*, 2015 May 1; 186: 325–7.
6. Bakker EJ, Ravensbergen NJ, Poldermans D. Perioperative cardiac evaluation, monitoring, and risk reduction strategies in noncardiac surgery patients. *Current opinion in critical care*, 2011 Oct 1; 17(5): 409–15.
7. Beliveau MM, Multach M. Perioperative care for the elderly patient. *Med Clin North Am*, 2003; 87: 273–89.
8. Merli GJ, Weitz HH eds. *Medical management of the surgical patient*. W B. Saunders Co, Philadelphia, 1998.
9. Ford MK, Beattie WS, Wijesundera DN. Systematic review: prediction of perioperative cardiac complications and mortality by the revised cardiac risk index. *Annals of internal medicine*, 2010 Jan 5; 152(1): 26–35.
10. Kristensen SD, Knuuti J, Saraste A, et al. 2014 ESC/ESA guidelines on non-cardiac surgery: cardiovascular assessment and management: the Joint Task Force on Non-Cardiac Surgery: Cardiovascular Assessment and Management of the European Society of Cardiology (ESC) and the European Society of Anesthesiology (ESA). *Eur Heart J*, 2014; 35: 2383–431.
11. Dakik HA, Chehab O, Eldirani M, Sbeity E, Karam C, Abou Hassan O, Msheik M, Hassan H, Msheik A, Kaspar C, Makki M. A new index for pre-operative cardiovascular evaluation. *Journal of the American College of Cardiology*,. 2019 Jun 25; 73(24): 3067–78.
12. Vascular Events in Noncardiac Surgery Patients Cohort Evaluation (VISION) Study Investigators.

- Association between complications and death within 30 days after noncardiac surgery. *CMAJ*, 2019 Jul 29; 191(30): E830-7.
13. Smilowitz NR, Gupta N, Guo Y, Beckman JA, Bangalore S, Berger JS. Trends in cardiovascular risk factor and disease prevalence in patients undergoing non-cardiac surgery. *Heart*, 2018 Jul 1; 104(14): 1180-6.
 14. Lee TH, Marcantonio ER, Mangione CM, et al.
 15. Kumar R, McKinney WP, Raj G, Heudebert GR, Heller HJ, Koetting M, McIntire DD. Adverse cardiac events after surgery. *Journal of general internal medicine*, 2001 Aug; 16(8): 507-18.
 16. Davis C, Tait G, Carroll J, Wijeyesundera DN, Beattie WS. The Revised Cardiac Risk Index in the new millennium: a single-centre prospective cohort re-evaluation of the original variables in 9,519 consecutive elective surgical patients. *Canadian Journal of Anesthesia/Journal canadien d' anesthesie*, 2013 Sep 1; 60(9): 855-63.