

Updated Review of the Revised Cardiac Risk Index for Pre-Operative Risk

Rahul Aggarwal, MD

Evidence to Action: Official Journal of MDCalc

Vol. 012026, Issue 01, 2026

Article Information

Keywords: goldman, lee index, mace, rcric, revised, revised cardiac, revised cardiac risk, Revised Cardiac Risk Index for Pre-Operative Risk, Revised Cardiac Risk Index, cardiac risk, cardiac risk index, pre-operative

<https://doi.org/10.65357/001c.156122>

Submitted: October 18, 2025 EDT

Accepted: December 19, 2025 EDT

Published: March 01, 2026 EDT

Abstract

The Revised Cardiac Risk Index (RCRI) estimates the risk of major cardiac events in patients undergoing noncardiac surgery. It was originally derived in 4315 patients (1999) and showed modest discrimination, with similar findings in subsequent validation studies (AUC 0.75). The RCRI remains a simple, validated, and widely used bedside tool recommended by current ACC/AHA perioperative guidelines, though newer models may offer improved accuracy in select populations. The RCRI should always be interpreted in the context of the overall clinical picture, including the patient's functional capacity, frailty, type and urgency of surgery, and findings from biomarkers or imaging when available.

I. HOW TO USE

When to Use

Patients undergoing elective non-cardiac surgery (non-emergent) to evaluate cardiac risk.

Pearls / Pitfalls

- Can be used in the inpatient or outpatient preoperative setting
- Should be used as part of a team-based assessment rather than as a stand-alone determinant of perioperative testing or management.
- Does not incorporate functional capacity, frailty, or cardiac biomarkers (e.g., BNP, troponin), which newer models and guidelines may include
- Not validated for emergent surgeries
- May underestimate risk in high-risk vascular procedures
- An elevated risk is generally considered $\geq 1\%$ predicted MACE, often corresponding to RCRI > 1 .

Why to Use

- Provides individualized risk stratification prior to undergoing non-cardiac surgery (non emergently), which can be helpful in discussions of informed consent.
- In patients with elevated risk (RCRI ≥ 1), helps direct further preoperative risk stratification (e.g. with serum NT-proBNP or BNP) and determine

appropriate cardiac monitoring post-op (EKG, troponins).

II. NEXT STEPS

Advice

For patients with RCRI ≤ 1 (low risk) and no concerning cardiac symptoms or history, no additional cardiac testing is needed before surgery if no new or worsening cardiac symptoms. For those with RCRI ≥ 2 (elevated risk), evaluate functional capacity (e.g., DASI) and consider cardiac biomarkers (e.g., troponin) to refine risk assessment. Optimize chronic conditions (e.g., ischemic heart disease, heart failure, diabetes) and continue or adjust medications per guideline-based recommendations. Use the RCRI within a team-based approach. It informs perioperative strategy but does not replace clinical judgment.

Limitations and Important Considerations: The RCRI is intended for use in stable adults undergoing noncardiac surgery and should not be used in isolation. Risk estimates may be less reliable in patients with unstable or recent acute coronary syndrome, recent PCI or CABG, moderate or severe valvular disease, advanced or decompensated heart failure, pulmonary arterial hypertension, end-stage renal disease, severe liver disease, significant frailty, congenital heart disease, or in the setting of urgent or emergency surgery. RCRI performance is less reliable in patients undergoing major vascular surgery as it may underestimate risk. In these situations, guideline-directed evaluation and clinical judgment should take

Critical Actions

RCRI Score	Risk of major cardiac event* [95% confidence interval]
0	3.9% [2.8%-5.4%]
1	6.0% [4.9%-7.4%]
2	10.1% [8.1%-12.6%]
≥3	15.0% [11.1%-20.0%]

precedence over numeric risk scores ([2024 American College of Cardiology guidelines](#)).

Management

- **Low Risk (RCRI ≤1):** Proceed to surgery without additional cardiac testing if no concerning clinical features.
- **Elevated Risk (RCRI ≥2):**
 - Assess functional capacity (e.g., Duke Activity Status Index).
 - If poor (<4 METs) or unknown, and testing results would alter management, consider stress imaging or coronary CT angiography.
 - Obtain biomarkers (e.g., BNP/NT-proBNP or troponin) before surgery to refine risk, as recommended for elevated-risk patients.
 - Optimize comorbidities (heart failure, ischemic heart disease, arrhythmias) and ensure guideline-directed medical therapy (GDMT) is continued or initiated when appropriate.

III. EVIDENCE

Evidence Appraisal

The Revised Cardiac Risk Index (RCRI) was [published in 1999](#) and is a six-item risk score derived and validated for predicting major cardiac complications in 4315 patients aged 50 or above who underwent nonemergent noncardiac procedures with an expected length of stay ≥2 days at Brigham and Women's Hospital between 1989 and 1994. The original study used two thirds of the patients (i.e. n=2893) were for deriving the model, and one-third (i.e. n=1422) was used for validating the model. RCRI achieved an AUROC of 0.759 in the derivation cohort and 0.806 in the validation cohort.

Subsequent meta-analyses and validation studies confirmed moderate discrimination (AUC ~0.75) across diverse populations, with reduced accuracy in vascular surgery (AUC ~0.64) and for mortality (AUC ~0.62). Later cohorts, including the VISION Pilot Study (2011) and CCS systematic review (2017), found higher observed event rates than in the original derivation, suggesting underestimation in modern surgical settings.

Recent evidence (e.g., Lurati Buse et al 2021) indicates that combining RCRI with functional capacity or biomarker assessment (BNP, troponin) improves predictive

performance. The 2024 AHA/ACC and 2022 ESC guidelines continue to endorse RCRI as a validated tool within a stepwise, multimodal risk assessment framework.

The [2017 Canadian Cardiovascular Society \(CCS\) perioperative cardiac risk guidelines](#) include the RCRI as a validated tool for estimating cardiac risk before noncardiac surgery. They discuss a systematic review of 24 studies (n = 792,740) (Ford et al 2010), in which the RCRI demonstrated moderate discrimination for predicting 30-day myocardial infarction, cardiac arrest, or death. Updated pooled event rates were 3.9% for RCRI = 0, 6.0% for RCRI = 1, 10.1% for RCRI = 2, and 15.0% for RCRI ≥ 3, which are higher than the original derivation estimates, likely due to inclusion of troponin-based outcomes and higher-risk populations. Updated pooled event rates were 3.9% for RCRI = 0, 6.0% for RCRI = 1, 10.1% for RCRI = 2, and 15.0% for RCRI ≥ 3, which are higher than the original derivation estimates, likely due to inclusion of troponin-based outcomes (compared to older CK monitoring) and higher-risk populations (including emergent surgery).

The [2024 American College of Cardiology guidelines](#) consider RCRI as one possible tool for risk stratification, while offering other potential tools as well. The guidelines emphasize the importance of a comprehensive assessment of each patient (e.g., accounting for patient frailty, functional capacity, biomarkers when needed etc)

Formula

Facts & Figures

RCRI ≤1 – low risk

RCRI ≥1 – elevated risk

Literature

Original/Primary

<https://www.ncbi.nlm.nih.gov/pubmed/10477528>

Lee TH, Marcantonio ER, Mangione CM, Thomas EJ, Polanczyk CA, Cook EF, Sugarbaker DJ, Donaldson MC, Poss R, Ho KK, Ludwig LE, Pedan A, Goldman L. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation*. 1999 Sep 7;100(10):1043-9. PubMed PMID: 10477528.

Addition of the selected points:

Risk Factor	Description	Points
High-risk surgery	Intraperitoneal; intrathoracic; suprainguinal vascular	+1
History of ischemic heart disease	History of myocardial infarction (MI); history of positive exercise test; current chest pain considered due to myocardial ischemia; use of nitrate therapy or ECG with pathological Q waves	+1
History of congestive heart failure	Pulmonary edema, bilateral rales or S3 gallop; paroxysmal nocturnal dyspnea; chest x-ray (CXR) showing pulmonary vascular redistribution	+1
History of cerebrovascular disease	Prior transient ischemic attack (TIA) or stroke	+1
Preoperative treatment with insulin	--	+1
Preoperative creatinine >2 mg/dL / 176.8 µmol/L	--	+1

Validation

Ford MK, Beattie WS, Wijeyesundera DN. Systematic review: prediction of perioperative cardiac complications and mortality by the revised cardiac risk index. *Ann Intern Med.* 2010;152(1):26-35.

Fronczek J, Polok K, Devereaux PJ, Górka J, Archbold RA, Biccard B, Duceppe E, Le Manach Y, Sessler DI, Duchńska M, Szczeklik W. External validation of the Revised Cardiac Risk Index and National Surgical Quality Improvement Program Myocardial Infarction and Cardiac Arrest calculator in noncardiac vascular surgery. *Br J Anaesth.* 2019 Oct;123(4):421-429. doi: 10.1016/j.bja.2019.05.029. Epub 2019 Jun 27. PMID: 31256916.

Roshanov PS, Sessler DI, Chow CK, Garg AX, Walsh MW, Lam NN, Hildebrand AM, Biccard BM, Acedillo RR, MacNeil SD, Lee VW, Szczeklik W, Mrkobrada M, Thabane L, Devereaux PJ. Predicting Myocardial Injury and Other Cardiac Complications After Elective Non-cardiac Surgery with the Revised Cardiac Risk Index: The VISION Study. *Can J Cardiol.* 2021 Aug;37(8):1215-1224. doi: 10.1016/j.cjca.2021.03.015. Epub 2021 Mar 23. PMID: 33766613.

Cohn SL, Fernandez Ros N. Comparison of 4 Cardiac Risk Calculators in Predicting Postoperative Cardiac Complications After Noncardiac Operations. *Am J Cardiol.* 2018 Jan 1;121(1):125-130. doi: 10.1016/j.amjcard.2017.09.031. Epub 2017 Oct 13. PMID: 29126584.

<http://www.ncbi.nlm.nih.gov/pubmed/22567075>

VISION Pilot Study investigators, Devereaux PJ, Bradley D, Chan MT, et al. An international prospective cohort study evaluating major vascular complications among patients undergoing noncardiac surgery: the VISION Pilot Study. *Open Med.* 2011;5(4):e193-200.

<http://www.ncbi.nlm.nih.gov/pubmed/17666156>

Ausset S, Auroy Y, Lambert E, et al. Cardiac troponin I release after hip surgery correlates with poor long-term cardiac outcome. *Eur J Anaesthesiol.* 2008;25(2):158-64.

<http://www.ncbi.nlm.nih.gov/pubmed/25902738>

Sheth T, Chan M, Butler C, et al. Prognostic capabilities of coronary computed tomographic angiography be-

fore non-cardiac surgery: prospective cohort study. *BMJ.* 2015;350:h1907.

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. *Can J Anaesth.* 2013 Sep;60(9):855-63. doi: 10.1007/s12630-013-9988-5. Epub 2013 Jun 28. PMID: 23813289.

Lurati Buse GA, Puelacher C, Menosi Gualandro D, et al. Association between self-reported functional capacity and major adverse cardiac events in patients at elevated risk undergoing non-cardiac surgery: a prospective diagnostic cohort study. *Br J Anaesth.* 2021 Jan;126(1):102-110. doi: 10.1016/j.bja.2020.08.041.

Guidelines

<https://pubmed.ncbi.nlm.nih.gov/39316661/Thompson> A, Fleischmann KE, Smilowitz NR, et al. 2024 AHA/ACC/ACS/ASNC/HRS/SCA/SCCT/SCMR/SVM Guideline for Perioperative Cardiovascular Management for Noncardiac Surgery: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol.* 2024. <https://doi.org/10.1016/j.jacc.2024.06.013>

Halvorsen S, Mehilli J, Cassese S, Hall TS, Abdelhamid M, Barbato E, De Hert S, de Laval I, Geisler T, Hinterbuchner L, Ibanez B, Lenarczyk R, Mansmann UR, McGreavy P, Mueller C, Muneretto C, Niessner A, Potpara TS, Ristić A, Sade LE, Schirmer H, Schüpke S, Sillesen H, Skulstad H, Torracca L, Tutarel O, Van Der Meer P, Wojakowski W, Zacharowski K; ESC Scientific Document Group. 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery. *Eur Heart J.* 2022 Oct 14;43(39):3826-3924. doi: 10.1093/eurheartj/ehac270. Erratum in: *Eur Heart J.* 2023 Nov 7;44(42):4421. doi: 10.1093/eurheartj/ehad577. PMID: 36017553.

<http://www.ncbi.nlm.nih.gov/pubmed/27865641>

Duceppe E, Parlow J, Macdonald P, et al. Canadian Cardiovascular Society Guidelines on Perioperative Cardiac Risk Assessment and Management for Patients Who Undergo Noncardiac Surgery. *Can J Cardiol*. 2017;33(1):17-32.

Other References

<https://www.ncbi.nlm.nih.gov/pubmed/904659>

Goldman L, Caldera DL, Nussbaum SR, Southwick FS, Krogstad D, Murray B, Burke DS, O'Malley TA, Goroll AH, Caplan CH, Nolan J, Carabello B, Slater EE. Multifactorial index of cardiac risk in noncardiac surgical procedures. *N Engl J Med*. 1977 Oct 20;297(16):845-50. PubMed PMID: 904659.

<http://www.ncbi.nlm.nih.gov/pubmed/18586440>

Rajagopalan S, Croal BL, Bachoo P, Hillis GS, Cuthbertson BH, Brittenden J. N-terminal pro B-type natriuretic peptide is an independent predictor of postoperative myocardial injury in patients undergoing major vascular surgery. *J Vasc Surg*. 2008;48(4):912-7.

<http://www.ncbi.nlm.nih.gov/pubmed/24076282>

Rodseth RN, Biccand BM, Le Manach Y, et al. The prognostic value of pre-operative and post-operative B-type natriuretic peptides in patients undergoing noncardiac surgery: B-type natriuretic peptide and N-terminal fragment of pro-B-type natriuretic peptide: a systematic review and individual patient data meta-analysis. *J Am Coll Cardiol*. 2014;63(2):170-80.