# Revised Cardiac Risk Index for Pre-Operative Risk

## INPUTS

|  |  |
| --- | --- |
| Elevated-risk surgery  *Intraperitoneal; intrathoracic; suprainguinal vascular (see* [*2014 ACC/AHA Guideline*](https://pubmed.ncbi.nlm.nih.gov/25085962/)*)* | **Options:**   * No (0) * Yes (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* | **Options:**   * No (0) * Yes (1) |
| History of congestive heart failure  *Pulmonary edema, bilateral rales or S3 gallop; paroxysmal nocturnal dyspnea; chest x-ray (CXR) showing pulmonary vascular redistribution* | **Options:**   * No (0) * Yes (1) |
| History of cerebrovascular disease  *Prior transient ischemic attack (TIA) or stroke* | **Options:**   * No (0) * Yes (1) |
| Pre-operative treatment with insulin | **Options:**   * No (0) * Yes (1) |
| Pre-operative creatinine >2 mg/dL / 176.8 µmol/L | **Options:**   * No (0) * Yes (1) |

## FORMULA

Addition of the selected points:

|  |  |  |
| --- | --- | --- |
| **Risk factor** | **Description** | **Points** |
| Elevated-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 |
| Pre-operative treatment with insulin | -- | +1 |
| Pre-operative creatinine >2 mg/dL / 176.8 µmol/L | -- | +1 |

\*See [2014 ACC/AHA Guideline](https://pubmed.ncbi.nlm.nih.gov/25085962/).

## FACTS & FIGURES

Interpretation:

|  |  |
| --- | --- |
| **RCRI Score** | **Risk of major cardiac event (95% CI)\*** |
| 0 | 3.9% (2.8-5.4%) |
| 1 | 6.0% (4.9-7.4%) |
| 2 | 10.1% (8.1-12.6%) |
| ≥3 | 15% (11.1-20.0%) |

\*Defined as death, myocardial infarction, or cardiac arrest at 30 days after noncardiac surgery (from [Duceppe 2017](https://www.onlinecjc.ca/article/S0828-282X(16)30980-1/abstract)).

## EVIDENCE APPRAISAL

Since the original study was published by [Goldman et al in 1977](https://www.ncbi.nlm.nih.gov/pubmed/904659), a systematic review by [Ford et al (2010)](https://www.ncbi.nlm.nih.gov/pubmed/20048269) including 792,740 patients from 24 studies found the RCRI showed risk of major cardiovascular events (including death) was 2-10 times higher than previously reported. There are two drivers of this effect: the routine use of high-sensitivity cardiac troponin over creatinine kinase, and the inclusion of validation studies that enrolled patients undergoing emergent surgery. It revealed moderate discrimination of major perioperative cardiac complications between low and high risk patients. The RCRI did not perform well in predicting death in all-comers, due to high heterogeneity between studies, and cardiovascular events in patients undergoing vascular surgery.

Beyond this systematic review, data from a total of four prospective studies and one retrospective study were combined to calculate the pooled event rates for each of the RCRI scores ([Duceppe 2017](https://www.ncbi.nlm.nih.gov/pubmed/27865641)). Only one of the studies, the [VISION Pilot Study](https://www.ncbi.nlm.nih.gov/pubmed/22567075), actually had the goal of prospectively validating the RCRI.

The [VISION Pilot Study](https://www.ncbi.nlm.nih.gov/pubmed/22567075) is a large, multicenter, international prospective cohort study of 432 adults >45 years old who underwent noncardiac surgery with either regional or general anesthetic. All patients had their troponin measured post-operatively in the PACU and daily for 72 hours. The primary composite outcome was vascular death, nonfatal MI, non-fatal cardiac arrest, and nonfatal strokes. One objective of the study was to prospectively validate the RCRI criteria using a composite outcome of MI, pulmonary edema, ventricular fibrillation, and complete heart block. The event rates based on RCRI criteria were 2.2% for an RCRI of 0, 8.2% for RCRI of 1, 5.3% for an RCRI of 2, and 36.4% for an RCRI of ≥3.

[Rajagopalan et al (2008)](https://www.ncbi.nlm.nih.gov/pubmed/18586440) prospectively collected NT-ProBNP as well as troponins measured immediately after surgery and on postoperative days 1, 2, 3, and 5 in a cohort of 136 patients undergoing elective vascular surgery for AAA or sub-critical limb ischemia. The objective of the study was to assess the efficacy of NT-ProBNP elevation as a predictor of elevated troponins. Their primary outcome was elevation of troponin-I >0.1 ng/mL . The data had appropriate patient characteristics and endpoints and therefore event rates could be calculated based on RCRI scores and included in the pooled estimates (Duceppe 2017; Sheth 2015).

[Ausset et al (2008)](https://www.ncbi.nlm.nih.gov/pubmed/17666156) prospectively measured troponin levels in 88 patients undergoing elective hip surgery on postoperative days 1, 2, and 3. Positive elevation in troponin level was noted to be 0.08 ng/mL. All patients had their RCRI calculated and event rates were displayed in the results. Interestingly, the study went on to assess whether these elevated troponin measurement were associated with major cardiac events within the first year following surgery and they showed that 45.5% of patients with elevated troponins in the first 3 days following surgery had major cardiac events, while only 3.9% of those who did not have elevated troponins did.

[Sheth et al (2015)](https://www.ncbi.nlm.nih.gov/pubmed/25902738), in association with the Coronary CTA VISION study group, published a large international multicentre prospective cohort study in which 955 patients with (or at risk of) CAD undergoing non-cardiac surgery. Each patient had preoperative coronary CTA in order to assess if burden of stenosis seen on CTA was a useful predictor of perioperative cardiovascular death and MI within 30 days of surgery. RCRI data was collected for each patient and therefore rates of outcome could be stratified by RCRI data and included in the pooled estimate. Vast over-estimation of risk in those who did not have events was demonstrated.

Myocardial injury in non-cardiac surgery (MINS), defined as cardiac biomarker elevation post-surgically, is an important prognostic marker. Studies consistently show increased risk of cardiovascular outcomes and mortality both in the short-term and long-term. This prompted the 2018 RCT of dabigatran in patients with MINS ([MANAGE](https://www.ncbi.nlm.nih.gov/pubmed/29900874)) which revealed an absolute risk reduction from 15% to 11% with 110 mg BID of dabigatran in the composite outcome: major vascular complication, a composite of vascular mortality and non-fatal myocardial infarction, non-haemorrhagic stroke, peripheral arterial thrombosis, amputation, and symptomatic venous thromboembolism ([Devereaux 2018](https://www.ncbi.nlm.nih.gov/pubmed/29900874)).

The likely explanation for these differences is that the original RCRI study monitored creatine kinase muscle and brain isoenzyme (CK-MB) and excluded emergency surgery patients, whereas the external validation studies monitored troponin measurements that are much more sensitive than creatine kinase muscle and brain isoenzyme, and some studies included emergency surgery patients.

A large scale external validation using 34,000 patients and update of the renal variable is underway using data from the VISION study by the Population Health Research Institute (PHRI) at McMaster University. The trial registration is currently available: <https://bmjopen.bmj.com/content/7/1/e013510>.