BMJ Best Practice Preoperative cardiac risk assessment

Straight to the point of care



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Introduction

Approximately 27 million patients undergo noncardiac surgery every year in the US.[1] Of those, about 50,000 have a perioperative myocardial infarction (MI). Furthermore, over one half of the 40,000 perioperative deaths each year are caused by cardiac events.[2] Most perioperative cardiac morbidity and mortality is related to MI, heart failure, or arrhythmias. Patients over 65 years of age are at higher risk of cardiac disease, cardiac morbidity, and death. Considering that this patient population will greatly increase over the coming decades, the number of patients with significant perioperative cardiac risk undergoing noncardiac surgery can be expected to increase globally. Patients with congenital heart disease, especially those with unrepaired lesions or a residual lesion burden and compromised cardiovascular status, also require individualized perioperative management.

Preoperative cardiac risk assessment and perioperative management emphasize the detection, characterization, and treatment of coronary artery disease (CAD), left ventricular (LV) systolic dysfunction, and significant arrhythmias in appropriate patients. The American Heart Association/American College of Cardiology (AHA/ACC) guidelines for managing adults with congenital heart disease recommend a stepwise approach to preoperative cardiac assessment, but there are currently no guidelines for comprehensive perioperative care of children with congenital heart disease undergoing noncardiac surgery.[3] [4] Patients with known or suspected CAD, arrhythmias, history of heart failure, or current symptoms consistent with these conditions should also undergo assessment. In people ages ≥50 years, a more extensive history and physical exam is warranted.

The purpose of individual preoperative cardiac risk assessment is to:[5][6] [7]

- Assess the medical status of the patient and the cardiac risks posed by the planned noncardiac surgery
- Recommend appropriate strategies to reduce the risk of cardiac problems over the entire perioperative period, and to improve long-term cardiac outcomes.

The main overall goals of assessment are to:

- · Identify patients at increased risk of an adverse perioperative cardiac event
- Identify patients with a poor long-term prognosis due to cardiovascular disease. Even though the risk
 at the time of noncardiac surgery may not be prohibitive, appropriate treatment will affect long-term
 prognosis.

The nature of the evaluation should be individualized to the patient and the specific clinical scenario:

- Patients presenting with an acute surgical emergency require only a rapid preoperative assessment, with subsequent management directed at preventing or minimizing cardiac morbidity and death. Such patients can often be more thoroughly evaluated after surgery.
- Patients undergoing an elective procedure with no surgical urgency can undergo a more thorough preoperative evaluation.

Stepwise management approach

Eight steps to optimize perioperative outcomes:[8]

- 1. Assess clinical features
 - The history and physical exam should help to identify markers of cardiac risk and assess the patient's cardiac status.
 - High-risk cardiac conditions include recent myocardial infarction (MI), decompensated heart failure, unstable angina, symptomatic arrhythmias, and symptomatic valvular heart disease.[9]
- 2. Evaluate functional status
 - Patients who are able to exercise on a regular basis without limitations generally have sufficient cardiovascular reserve to withstand stressful operations.
- 3. Consider surgery-specific risk
 - The type of surgery has important implications for perioperative risk. Noncardiac surgery can be stratified into high-risk, intermediate-risk, and low-risk categories (see below 'risk stratification according to type of noncardiac surgery').
- 4. Decide whether further noninvasive evaluation is needed
 - Patients who are at low cardiac risk based on clinical features and functional status, and are undergoing low-risk surgery, do not generally require further evaluation.
 - Patients who are at high cardiac risk based on clinical features, have poor functional status, and are being considered for high-risk noncardiac surgery may benefit from further evaluation.
- 5. Decide when to recommend invasive evaluation
 - Indications for preoperative coronary angiography are similar to those in the nonoperative setting and include patients with evidence of high cardiac risk based on noninvasive testing, angina unresponsive to adequate medical therapy, unstable angina, and proposed intermediate-risk or high-risk noncardiac surgery after equivocal noninvasive test results.
 - Angiography and revascularization are not routinely indicated for patients with stable coronary artery disease (CAD).
- 6. Optimize cardiovascular risk factors, lifestyle interventions, and medical therapy
 - Control of cardiovascular risk factors, including hypertension, dyslipidemia, and diabetes, is important before noncardiac surgery.[5]
 - Patients should be given optimal medical therapy, both perioperatively and in the long term, based on their underlying cardiac condition.
 - Lifestyle modifications before noncardiac surgery may reduce the risk of perioperative complications, but their impact on cardiovascular complications has not been adequately studied. Smoking cessation prior to surgery has the most robust evidence base.[5]
- 7. Perform appropriate perioperative surveillance
 - In patients with known or suspected CAD, the possibility of perioperative ischemia or MI can be estimated based on the magnitude of biomarker elevation, new ECG abnormalities, hemodynamic instability, and the quality and intensity of chest pain or other symptoms.
- 8. Design maximal long-term therapy
 - Assessment for hypercholesterolemia, smoking, hypertension, diabetes mellitus, physical inactivity, peripheral vascular disease, cardiac murmurs, arrhythmias, conduction abnormalities, and/or perioperative ischemia may lead to evaluation and treatments that reduce future cardiovascular risk.

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History and physical examination

The patient history should aim to:

- Identify cardiac conditions (e.g., recent or past myocardial infarction, decompensated heart failure, prior unstable angina, significant arrhythmias, valvular heart disease)
- Identify serious comorbid conditions (e.g., diabetes mellitus, peripheral vascular disease, stroke, renal insufficiency, pulmonary disease)
- Determine patient's functional capacity
- Document all current medications, allergies, tobacco use, and physical exercise habits.

On physical exam, patients with severe aortic stenosis, elevated jugular venous pressure, pulmonary edema, and/or third heart sound are at high surgical risk.

Functional capacity assessment

The functional capacity of the patient to perform common daily activities has been shown to correlate well with maximum oxygen uptake by treadmill testing.[6] On assessment, patients with <4 metabolic equivalents (METS) are considered to have poor functional capacity and are at relatively high risk of a perioperative event, while patients with >10 METS have excellent functional capacity and are at very low risk of perioperative events, even if they have known coronary artery disease. Patients with a functional capacity of 4 to 10 METS are considered to have fair functional capacity and are generally considered at low risk of perioperative events.

1 MET

- Eat, dress, use the toilet
- Walk indoors around the house
- Walk on level ground at 2 mph (3.2 km/hour)
- Perform light housework such as washing dishes.

4 METs

- Climb a flight of stairs (usually 18-21 steps)
- Walk on level ground at 4 mph (6.4 km/hour)
- Run short distances
- Perform vacuuming or lift heavy furniture
- Play golf or doubles tennis.

>10 METs

- Swimming
- Singles tennis
- Basketball
- Skiing.

Cardiac risk stratification using clinical predictors and risk models

The presence of ≥ 1 of the following active cardiac conditions is considered high risk, mandates intensive management, and may result in delay or cancellation of surgery unless the surgery is urgent.[6]

- Unstable coronary syndromes
 - ♦ Unstable or severe angina
 - Recent myocardial infarction (MI)
- · Decompensated heart failure

- · Significant arrhythmias
 - ◊ Mobitz II atrioventricular block
 - ◊ Third-degree atrioventricular block
 - Symptomatic ventricular arrhythmias
 - Supraventricular arrhythmias (including atrial fibrillation) with uncontrolled ventricular rate (heart rate >100 bpm at rest)
 - ♦ Symptomatic bradycardia
 - Newly recognized ventricular tachycardia.
- Severe valvular disease
 - Severe aortic stenosis (mean pressure gradient >40 mmHg, aortic valve area <1.0 cm², or symptomatic)
 - Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or heart failure).

Patients are considered at intermediate risk if there are no active cardiac conditions as defined above, but the patient has 1 or more of the following clinical risk factors:[6]

- · History of heart disease
- · History of compensated or prior heart failure
- · History of cerebrovascular disease
- Diabetes mellitus
- Renal insufficiency.

Patients are considered at low risk if the active cardiac conditions and clinical risk factors defined above are absent.[6]

Diagnostic tests can be used to refine the risk assessment. Some allow for risk stratification to be reassessed based on the test results (e.g., stress testing).

Revised cardiac risk index (RCRI):

The revised cardiac risk index uses 6 variables to predict perioperative cardiovascular risk:[10]

- High-risk surgery (intrathoracic, intra-abdominal, or suprainguinal vascular)
- Ischemic heart disease (defined as a history of MI, pathologic Q waves on the ECG, use of nitrates, abnormal stress test, or chest pain secondary to ischemic causes)
- Presence of congestive heart failure
- · History of cerebrovascular disease
- · Diabetes mellitus requiring insulin therapy
- Preoperative serum creatinine level higher than 2 mg/dL.

Each of the 6 risk variables are assigned 1 point. Patients with 0, 1, or 2 risk factor(s) are assigned to RCRI classes I, II, and III, respectively. Patients with 3 or more risk factors are class IV and considered at high risk. Each class translates into 0.4% (class I), 0.9% (class II), 6.6% (class III), and 11% (class IV) risk for major cardiac events. Overall, the RCRI performs well in stratifying patients at low compared with high risk for all types of noncardiac surgery, but appears less accurate in patients undergoing vascular surgery.

Vascular Study Group of New England cardiac risk index (VSG-CRI):

The VSG-CRIVSGNE risk index was developed specifically for patients undergoing vascular surgery and applies to carotid endarterectomy, lower extremity bypass, and endovascular and open repair of nonruptured abdominal aortic aneurysms.[11] The independent predictors of adverse cardiac events (MI, arrhythmia, and heart failure, but not mortality) were increasing age, smoking, insulin-dependent diabetes mellitus, coronary artery disease, coronary heart failure, abnormal cardiac stress test, long-term beta-blocker therapy, chronic obstructive pulmonary disease, and creatinine ≥1.8 mg/dL. Prior cardiac revascularization was protective. The VSG-CRI predicted increasing levels of risk for cardiac events, ranging from 2.6% for the lowest risk scores (0-3) up to 14.3% for the highest risk score (7-8). This risk index performs better than RCRI for those undergoing vascular surgery.[11]

Risk stratification according to type of noncardiac surgery

High-risk surgery

- Emergency major operations, particularly in older people (>70 years)
- · Aortic or peripheral vascular
- Extensive operations with large volume shifts.

Intermediate-risk surgery

- · Intraperitoneal or intrathoracic
- Carotid endarterectomy
- · Head and neck
- Orthopedic
- Prostate.

Low-risk surgery

- Endoscopic procedures
- Superficial biopsy
- Cataract
- Breast.

Diagnostic tests

Patients at risk of an adverse perioperative cardiac event can typically be identified following history and examination. Patients at low risk generally require no additional testing before noncardiac surgery. However, those with intermediate or high risk undergoing elective noncardiac surgery may require additional testing.

- 1. Preoperative resting 12-lead ECG
 - Not indicated in asymptomatic persons undergoing low-risk surgical procedures (unless the patient has a family history of genetic cardiomyopathy).
 - Recommended for patients with:
 - At least 1 clinical risk factor and undergoing vascular surgical procedures (clinical risk factors include history of ischemic heart disease, compensated or prior heart failure, cerebrovascular disease, diabetes mellitus, renal insufficiency).
 - Known coronary heart disease, peripheral arterial disease, or cerebrovascular disease, who are undergoing intermediate-risk surgical procedures.[6]
 - A family history of genetic cardiomyopathy undergoing any noncardiac surgery, regardless of age or symptoms.[5]
- 2. Biomarkers
 - Brain natriuretic peptide or N-terminal pro-brain natriuretic peptide (BNP/NT-proBNP)
 - BNP appears to be independently predictive for major adverse cardiac events following elective vascular surgery.[12]
 - Use of BNP to predict cardiovascular events in the first 30 days after vascular surgery can significantly improve the predictive performance of the revised cardiac risk index.[13]
 - ◊ Indicated in patients with cardiovascular disease, cardiovascular risk factors (including age ≥65 years), or symptoms suggestive of cardiovascular disease, before intermediate- or high-risk noncardiac surgery.[5]
 - High-sensitivity cardiac troponin T/I (hs-cTn T/I)

- Can be used to rule out myocardial ischemia prior to noncardiac surgery, and as part of surveillance after surgery.[5]
- ◊ Indicated in patients with cardiovascular disease, cardiovascular risk factors (including age ≥65 years), or symptoms suggestive of cardiovascular disease, before intermediate- or high-risk noncardiac surgery.[5]
- 3. Echocardiography or nuclear testing
 - Preoperative noninvasive evaluation of left ventricular (LV) function with echocardiography or nuclear testing is reasonable or recommended for patients with:[6]
 - ◊ Dyspnea of unknown origin.
 - Ourrent or prior heart failure with worsening dyspnea or other change in clinical status if LV function has not been evaluated within 12 months.
 - Other indications for transthoracic echocardiography (TTE):
 - ◊ Recommended for patients with poor functional capacity and/or high NT-proBNP/BNP.
 - Recommended for patients with murmurs detected prior to high-risk noncardiac surgery.
 - Before high-risk noncardiac surgery, also consider TTE for patients with suspected new cardiovascular disease or unexplained signs or symptoms.
 - ◊ Before intermediate-risk noncardiac surgery, consider for patients with poor functional capacity, abnormal ECG, high NT-proBNP/BNP, or ≥1 clinical risk factor.
 - ◊ Family history of genetic cardiomyopathy.
 - A focused cardiac ultrasound (FOCUS) exam may be considered as an alternative to TTE to avoid delaying surgery.[5]
 - Routine perioperative evaluation of LV function is not recommended.[5] [6]
- 4. Stress testing
 - Useful to detect myocardial ischemia and functional capacity.
 - Indicated in patients with active cardiac conditions (e.g., unstable angina, decompensated heart failure, or severe valvular heart disease) who typically need further evaluation.
 - Reasonable for patients with ≥3 clinical predictors of cardiac risk and poor functional capacity (<4 metabolic equivalents [METs]) who require vascular surgery, if the test will change the patient's management.
 - Not useful for patients undergoing low-risk noncardiac surgery.
- 5. Coronary angiography
 - · Indicated in patients with:
 - ◊ Evidence of high cardiac risk, based on noninvasive testing
 - Angina unresponsive to adequate medical therapy or unstable angina
 - Proposed intermediate-risk or high-risk noncardiac surgery after equivocal noninvasive test results.
 - Contraindicated in patients with stable angina.[9] [14]

Cardiac risk stratification using stress testing

- 1. Exercise ECG
 - Provides an estimate of functional capacity, detects myocardial ischemia, and assesses hemodynamic performance during stress. Exercise ECG is the preferred choice when noninvasive testing is indicated and the patient can walk.
 - Perioperative risk stratification based on exercise ECG:

- Low risk: ability to exercise moderately (4-5 METs) without symptoms; patients who can achieve >75% of maximum predicted heart rate without ECG changes.
- ♦ Intermediate risk: patients with abnormal ECG response at >75% of predicted heart rate.
- ♦ High risk: patients with abnormal ECG response at <75% of predicted heart rate.
- 2. Stress imaging
 - Indicated in patients with abnormal baseline ECG (e.g., left ventricular hypertrophy [LVH], digitalis
 effect, left bundle branch block). Pharmacologic perfusion imaging is indicated in patients undergoing
 orthopedic, neurosurgical. or vascular surgery and who are unable to exercise, or who have left bundle
 branch block or have a pacemaker.
 - Dipyridamole is contraindicated in patients treated with theophylline and patients with severe obstructive lung disease or critical carotid stenosis.
 - Obutamine stress echocardiography is comparable to dipyridamole thallium testing as a preoperative evaluation tool, but it should be avoided in patients with severe hypertension, significant arrhythmias, or poor echocardiographic images.

Perioperative risk stratification based on stress imaging:

- More than 4 myocardial segments of redistribution indicates significant risk for perioperative events.
- Redistribution in 3 coronary artery territories and reversible left ventricular cavity dilation indicates higher risk of events.
- Total area of ischemia is more predictive than severity of ischemia in a given segment.

ACS NSQIP universal surgical risk calculator

A surgical risk calculator has been developed by the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) using 21 preoperative factors.[15] These factors include 20 patient characteristics (age, sex, functional class, emergency case, American Society of Anaesthesiologists [ASA] class, corticosteroid use, presence of ascites within 30 days, systemic sepsis, ventilator dependence, presence of disseminated cancer, diabetes mellitus, hypertension, heart failure within 30 days, presence of dyspnea, current smoking status, history of severe COPD, need for dialysis, presence of acute renal failure, height, and weight) and type of procedure. This model had excellent performance for mortality (c-statistic = 0.944; Brier score = 0.011 [where scores approaching 0 are better]), morbidity (c-statistic = 0.816; Brier score = 0.069), and 6 additional complications (c-statistics >0.8).[15] The ACS NSQIP surgical risk calculator offers surgeons the ability to quickly and easily estimate important, patient-specific postoperative risks and present the information in a patient-friendly format.

Perioperative therapy

Perioperative therapy includes:

- Preoperative revascularization with coronary artery bypass grafting or percutaneous coronary intervention
- · Beta-blockers
- Statins.

Alpha-2 agonists are not recommended for perioperative cardiac risk reduction.[16] In one blinded, randomized trial comparing low-dose clonidine with placebo in 10,010 people with, or at risk of, atherosclerotic disease who were undergoing noncardiac surgery, clonidine did not reduce the rate of the composite outcome of death or nonfatal myocardial infarction.[17] In addition, clonidine was found to increase the risk of clinically important hypotension and nonfatal cardiac arrest.

Preoperative revascularization with coronary artery bypass grafting or percutaneous coronary intervention

Angiography and revascularization before noncardiac surgery[6]

- Indicated in patients with stable angina who have significant left main coronary artery stenosis; 3vessel disease (survival benefit is greater when left ventricular ejection fraction <0.50); or 2-vessel disease with significant proximal left anterior descending stenosis and either an ejection fraction <0.50 or a demonstrable ischemia on noninvasive evaluation.
- Recommended in patients with unstable angina or non-ST-segment elevation myocardial infarction (MI), or with acute ST-elevation MI.
- Not routinely indicated in patients with stable coronary artery disease (CAD). Several randomized trials have shown that preoperative coronary artery revascularization before elective major vascular surgery does not alter the long-term outcome in patients with stable CAD. Furthermore, preoperative percutaneous coronary intervention did not reduce the risk of death, MI, or other major cardiovascular events when added to optimal medical therapy.[9] [14]

A coronary stent is used in most percutaneous revascularization procedures. In this case, further delay in noncardiac surgery may be beneficial. Elective noncardiac surgery is not recommended within 4 to 6 weeks of bare metal coronary stent implantation or within 6 to 12 months of drug-eluting coronary stent implantation; or in patients who will need to discontinue P2Y12 inhibitor therapy (e.g., clopidogrel, prasugrel, ticagrelor) or aspirin and thienopyridine therapy perioperatively.[6] The incremental risk of noncardiac surgery on adverse cardiac events among post-stent patients is highest in the initial 6 months following stent implantation and stabilizes at 1.0% after 6 months. Elective, high-risk, inpatient surgery, and patients with a drug-eluting stent, may benefit most from a 6-month delay after stent placement.[18]

Beta-blockers

The perioperative use of beta-blocker therapy during noncardiac surgery may be beneficial in reducing ischemia, risk of myocardial infarction (MI), and death in patients with known coronary artery disease.[6] [19]

Beta-blocker therapy

- Should be continued in patients being treated for angina, symptomatic arrhythmias, hypertension, or other American College of Cardiology/American Heart Association (ACC/AHA) class I guideline indications.
- In patients with intermediate- or high-risk myocardial ischemia noted in preoperative risk stratification tests, it may be reasonable to begin perioperative beta-blockers.
- Routinely giving high-dose beta-blockers in the absence of dose titration is not useful and may be harmful to patients not taking beta-blockers who are undergoing noncardiac surgery.
- In patients in whom beta-blocker therapy is initiated, it may be reasonable to begin perioperative betablockers long enough in advance to assess safety and tolerability, preferably 2 or more days (up to 30 days) before surgery. Beta-blocker therapy should not be started on the day of surgery.

Therapy can be started with metoprolol 25 mg orally given twice daily, and increased to maintain the heart rate <60 bpm, or bisoprolol 5 to 10 mg orally once daily. It should be started 2 to 30 days before elective surgery and continued for 48 hours to 7 days after surgery.

Perioperative extended-release metoprolol has been shown to reduce the risk of MI, cardiac revascularization, and clinically significant atrial fibrillation 30 days after randomization, compared with placebo. However, available evidence suggests that the use of beta-blockers in patients with, or at risk of, atherosclerotic disease may result in significant excess risk of death, stroke, and clinically significant hypotension and bradycardia. Caution is therefore recommended with the routine use of beta-blockers.[5] [19] [20]

Statins

- The available evidence suggests a protective effect of perioperative statin use on cardiac complications during noncardiac surgery. Statin therapy results in a 44% reduction in mortality after noncardiac surgery.[21]
- Therapy should be continued in patients treated with statins who are scheduled for noncardiac surgery.
- Statin therapy is reasonable in patients undergoing vascular surgery regardless of the cardiac risk. For
 patients not on statin therapy who are undergoing urgent or emergent major vascular surgery, statins
 should be initiated before surgery if possible.[6] However, the European Society of Cardiology (ESC)
 only recommends perioperative statins for patients with an existing indication for statins due to unclear
 evidence for their routine use.[5]

Surveillance

For perioperative myocardial ischemia

• Intraoperative and postoperative ST-segment monitoring can be useful to monitor patients with known coronary artery disease or those undergoing vascular surgery.

For perioperative myocardial infarction:

- Postoperative troponin measurement is recommended in patients with ECG changes, or with chest pain typical of acute coronary syndrome.[6]
- The ESC recommends surveillance with high-sensitivity cardiac troponin T/I (hs-cTn T/I) in patients with cardiovascular disease, cardiovascular risk factors (including age ≥65 years), or symptoms suggestive of cardiovascular disease undergoing intermediate- or high-risk noncardiac surgery. Hs-cTn T/I should be measured before surgery and at 24 hours and 48 hours after surgery.[5]

Special circumstances

Symptomatic aortic stenosis

- Severe aortic stenosis poses a significant risk for noncardiac surgery. Guidelines suggest that elective noncardiac surgery should generally be postponed or cancelled in such patients.[6]
- Patients require aortic valve replacement before elective but necessary noncardiac surgery.

Asymptomatic aortic stenosis

- If the aortic stenosis is severe but asymptomatic, the surgery should preferably be postponed or cancelled if the valve has not been evaluated within the previous year.
- In patients who refuse cardiac surgery, or who are otherwise not candidates for aortic valve replacement, noncardiac surgery has a mortality risk of approximately 10%. If a patient is not a candidate for valve replacement, percutaneous balloon aortic valvuloplasty may be reasonable as a bridge to surgery: in hemodynamically unstable adult patients with aortic stenosis, who are at high risk for aortic valve replacement surgery; and adult patients with aortic stenosis in whom aortic valve replacement cannot be performed because of serious comorbid conditions. Percutaneous valve replacement is available as a therapeutic modality.

Pulmonary hypertension

• Guidelines recommend assessing patients for intermediate-risk and high-risk features of pulmonary hypertension that increase the risk of perioperative complications. Patients should be assessed by an anesthesiologist and an expert in pulmonary hypertension, where feasible.[22]

Patients on psychotropic medications[23]

Antidepressant treatment for chronically depressed patients should not be discontinued prior to anesthesia.

- Patients chronically treated with a tricyclic antidepressant should undergo cardiac evaluation prior to anesthesia.
- Irreversible monoamine oxidase inhibitors (MAOIs) should be discontinued at least 2 weeks prior to anesthesia. In order to avoid relapse of underlying disease, medication should be changed to a reversible MAOI.
- The incidence of postoperative confusion is significantly higher in schizophrenic patients if medication is discontinued prior to surgery. Thus, antipsychotic medication should be continued perioperatively in patients with chronic schizophrenia.
- Lithium administration should be stopped 72 hours before surgery. It can be restarted afterward if the patient has normal ranges of electrolytes, is hemodynamically stable, and is able to eat and drink.

Preoperative assessment of older surgical patient[24]

- Data from the National Hospital Discharge Survey demonstrate increasing hospital utilization by older people. [25] [26] Responding to the need for quality improvement in perioperative geriatric surgical care, the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society formulated best practice guidelines to ensure optimal care of the geriatric surgical patient. [24] The guideline development panel prioritized a number of preoperative domains specific to older individuals (e.g., cognitive impairment, frailty, polypharmacy) and, additionally, issues commonly encountered in this population (e.g., risk of malnutrition, lack of family or social support). Consensus statements and evidence-based recommendations for improving the preoperative assessment of the geriatric surgical patient were summarized in a checklist: [24]
 - Perform a complete history and physical examination
 - ♦ Assess cognitive ability and capacity to understand the anticipated surgery
 - Screen for depression
 - Identify and document risk factors for developing postoperative delirium
 - ◊ Screen for alcohol and other substance abuse/dependence
 - Perform a preoperative cardiac evaluation according to the American College of Cardiology/ American Heart Association algorithm for patients undergoing noncardiac surgery[6]
 - Identify risk factors for postoperative pulmonary complications and implement preventive strategies
 - Occument functional status and history of falls
 - ◊ Determine baseline frailty score
 - Evaluate nutritional status and consider preoperative interventions if the patient is at severe nutritional risk
 - Occument medication history and consider appropriate perioperative adjustments. Monitor for polypharmacy
 - Obtaining the patient's treatment goals and expectations in the context of the possible treatment outcomes
 - Obtermine the patient's family and social support system
 - Order appropriate preoperative diagnostic tests focused on older patients.

American College of Cardiology/American Heart Association (ACC/AHA) guidelines synopsis

Urgency of noncardiac surgery[6]

• It is important to determine the urgency of noncardiac surgery. In many cases, patient- or surgeryspecific factors dictate immediate surgery and may not allow for further cardiac assessment or treatment. Perioperative medical management, surveillance, and postoperative risk stratification is appropriate in these cases.

Cardiac testing not required[6]

• Patients with bypass surgery in the previous 5 years or percutaneous coronary intervention from 6 months to 5 years previously, and no clinical evidence of ischemia, generally have low risk of

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cardiac complications from surgery. They may proceed without further testing, particularly if they are functionally very active and asymptomatic.

• Patients with favorable invasive/noninvasive testing in the previous 2 years generally require no further cardiac workup, if they have been asymptomatic since the test and are functionally active.

Noninvasive cardiac testing[6]

- Results of noninvasive testing can be used to define further management, including intensified medical therapy or the decision to proceed directly with surgery or cardiac catheterization. Cardiac catheterization may lead to coronary revascularization and is particularly justifiable when it is likely to improve the patient's long-term prognosis (e.g., in those with left main stem stenosis, or 3-vessel disease and impaired left ventricular function).
- Poor functional capacity or a combination of high-risk surgery and moderate functional capacity, in a patient with intermediate clinical predictors of cardiac risk, may mean there are benefits to further noninvasive cardiac testing.
- In highly functional asymptomatic patients, management will rarely be changed on the basis of results of any further cardiovascular testing. It is therefore appropriate to proceed with the planned surgery. Estimation of functional status is an important aspect of the guidelines.

Risk of noncardiac surgery according to clinical predictors of cardiac risk, functional capacity, and type of surgery[6]

- Patients with minor or no clinical predictors of cardiac risk and moderate or excellent functional capacity can safely undergo noncardiac surgery.
- Patients with intermediate clinical predictors of cardiac risk and moderate or excellent functional capacity can generally undergo low- or intermediate-risk surgery with low event rates.
- Patients with unstable coronary syndrome, decompensated heart failure, symptomatic arrhythmias, or severe valvular heart disease who are scheduled for elective noncardiac surgery should have surgery canceled or delayed until the cardiac problem is clarified and treated.
- The type of surgery may itself identify a patient with a greater likelihood of underlying heart disease and higher perioperative morbidity and mortality. Perhaps the most extensively studied example is vascular surgery, in which underlying coronary and cerebrovascular disease is present in a substantial portion of patients. If the patient is undergoing vascular surgery, studies suggest that testing should be considered only if it will change management. Other types of surgery may be associated with similar risks to vascular surgery, but have not been studied extensively.
- Routine coronary revascularization is not recommended before noncardiac surgery to reduce perioperative cardiac events.

Preoperative cardiac risk assessment

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Cardiac evaluation and care algorithm for noncardiac surgery Adapted from Fleisher LA, et al. J Am Coll Cardiol. 2014;64:e77-e137

European Society of Cardiology (ESC) guideline synopsis

The ESC recommends an accurate focused history, physical examination, and preoperative risk assessment for all patients. The urgency of the surgery and patient and surgery-related risk factors determine the extent of further preoperative testing.[5] If time allows, treatment of cardiovascular disease (CVD) and cardiovascular risk factors should be optimized before noncardiac surgery.

Assess urgency of surgical procedure[5]

- In urgent cases, patient- or surgery-specific factors dictate the strategy and do not allow further cardiac testing or treatment. In these cases, the attending physician provides recommendations on perioperative medical management, surveillance for cardiac events, and continuation of chronic cardiovascular medical therapy.
- If the procedure is time-sensitive but not urgent, cardiac testing should be individualized with multidisciplinary consultation. If time allows, assess as per elective noncardiac surgery.

Elective noncardiac surgery: patients aged <65 years with no CVD or cardiovascular risk factors[5]

- If the procedure is low- or intermediate-risk, no further assessment is needed.
- If the procedure is high-risk, consider ECG and biomarkers in patients aged >45 years.
- Patients with a family history of genetic cardiomyopathy should be evaluated with an ECG and echocardiogram, regardless of symptoms or age.

Elective noncardiac surgery: patients aged ≥65 years, or patients with cardiovascular risk factors or established CVD[5]

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- If the procedure is low-risk, no further assessment is needed. Consider disease-specific recommendations in patients with established CVD.
- If the procedure is intermediate- or high-risk, perform ECG and measure biomarkers. Consider assessing functional capacity.
- In patients with established CVD undergoing a high-risk procedure, decision on whether to proceed with surgery should be made with following multidisciplinary consultation, including cardiology, taking into account individual patient goals and preferences. Noncardiac surgery should probably be avoided in patients with severe heart failure, cardiogenic shock, severe pulmonary hypertension, or severe frailty.

Further assessment for patients with signs or symptoms suggestive of CVD[5]

- Newly detected murmurs: perform echocardiogram in patients with murmur suggestive of significant pathology prior to high-risk noncardiac surgery, regardless of symptoms, and prior to any noncardiac surgery in a patient with murmur and symptoms of CVD.
- Chest pain: further diagnostic workup is recommended prior to elective noncardiac surgery for patients with chest pain or other symptoms suggestive of coronary artery disease. If the patient needs acute surgery, multidisciplinary assessment is used to choose treatment with the lowest overall risk.
- Unexplained dyspnea and/or peripheral edema: perform ECG and measure NT-proBNP/BNP before noncardiac surgery. If NT-proBNP/BNP is elevated, perform echocardiogram.
- Management of new or pre-existing cardiovascular conditions should be individualized, taking into account the preoperative risk and recommendations of relevant specialty guidelines.

Canadian Cardiovascular Society guidelines on perioperative cardiac risk assessment synopsis

These guidelines make the following recommendations for people \geq 45 years of age (or adults 18 to 44 years of age with known significant cardiovascular disease) undergoing noncardiac surgery:

- Not delaying surgery for a preoperative cardiac risk assessment in patients who require emergency surgery.[27]
- Undertaking preoperative cardiac risk assessment only if the patients' history or physical examination suggests there is a potential undiagnosed severe obstructive intracardiac abnormality, severe pulmonary hypertension, or an unstable cardiovascular condition in those requiring urgent or semi-urgent surgery.[27]
- Preoperative cardiac risk assessment in patients who undergoing elective noncardiac surgery.[27]
- Measuring N-terminal pro-brain natriuretic peptide (NT-proBNP) or BNP before noncardiac surgery to enhance perioperative cardiac risk estimation in patients ages 65 years or older, are 45 to 64 years of age with significant cardiovascular disease, or have an Revised Cardiac Risk Index (RCRI) score ≥ 1.[27]
- Withholding ACE inhibitor/angiotensin receptor blockers (ARBs) starting 24 hours before noncardiac surgery in patients treated chronically with an ACE inhibitor/ARB.[27]

In addition, these guidelines recommend against:

- Performing preoperative resting echocardiography, preoperative coronary computed tomography angiography, or preoperative exercise stress to enhance perioperative cardiac risk estimation.
- The continuation of aspirin to prevent perioperative cardiac events, except in patients with a recent coronary artery stent and patients undergoing carotid endarterectomy.[27]
- Beta-blocker initiation within 24 hours before noncardiac surgery, which is consistent with other national guidelines.[27]
- Preoperative prophylactic coronary revascularization for patients with stable coronary artery disease who undergo noncardiac surgery.[27]

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Preoperative risk assessment and postoperative monitoring flow diagram. If suspected undiagnosed severe obstructive intracardiac abnormality or severe PHTN a preoperative echocardiogram is recommended. If possible unstable cardiac condition (e.g., unstable angina) then risks and benefits of delaying, canceling, or proceeding with surgery need to be discussed with the patient. RCRI score (each worth 1 point): history of coronary artery disease, cerebrovascular disease, congestive heart failure, preoperative insulin use, preoperative creatinine > 177 micromoles/L, and high-risk surgery (i.e., intraperitoneal, intrathoracic, or suprainguinal vascular surgery). BNP, brain natriuretic peptide; ECG, electrocardiogram; NT-proBNP, N-terminal pro-brain natriuretic peptide; PACU, postanesthesia care unit; PHTN, pulmonary hypertension; RCRI, Revised Cardiac Risk Index Adapted from Duceppe E, et al. Can J Cardiol. 2017;33(1):17-32

Key articles

- Halvorsen S, Mehilli J, Cassese S, et al. 2022 ESC guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery. Eur Heart J. 2022 Oct 14;43(39):3826-924.
 Full text (https://www.doi.org/10.1093/eurheartj/ehac270) Abstract (http://www.ncbi.nlm.nih.gov/ pubmed/36017553?tool=bestpractice.bmj.com)
- Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. J Am Coll Cardiol. 2014;64:e77-e137. Full text (http://circ.ahajournals.org/content/130/24/e278.full.pdf+html) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/25091544?tool=bestpractice.bmj.com)
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Images



Figure 1: Cardiac evaluation and care algorithm for noncardiac surgery

Adapted from Fleisher LA, et al. J Am Coll Cardiol. 2014;64:e77-e137



Figure 2: Preoperative risk assessment and postoperative monitoring flow diagram. If suspected undiagnosed severe obstructive intracardiac abnormality or severe PHTN a preoperative echocardiogram is recommended. If possible unstable cardiac condition (e.g., unstable angina) then risks and benefits of delaying, canceling, or proceeding with surgery need to be discussed with the patient. RCRI score (each worth 1 point): history of coronary artery disease, cerebrovascular disease, congestive heart failure, preoperative insulin use, preoperative creatinine > 177 micromoles/L, and high-risk surgery (i.e., intraperitoneal, intrathoracic, or suprainguinal vascular surgery). BNP, brain natriuretic peptide; ECG, electrocardiogram; NT-proBNP, N-terminal pro-brain natriuretic peptide; PACU, postanesthesia care unit; PHTN, pulmonary hypertension; RCRI, Revised Cardiac Risk Index

Adapted from Duceppe E, et al. Can J Cardiol. 2017;33(1):17-32

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Figure 1 – BMJ Best Practice Numeral Style

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