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Chapter 1

Perioperative Cardiovascular Evaluation and Management for Noncardiac Surgery

Matthew G. Bean, DO • Annemarie Thompson, MD • Kamrouz Ghadimi, MD

Key Points

1. Preoperative assessment of the cardiac patient undergoing noncardiac surgery includes risk assessment for major adverse cardiac events (MACEs).
2. Categorizing risk for MACEs is dependent on patient risk factors, including the noncardiac procedure, patient age, emergent status of the procedure, preexisting organ dysfunction, and independence in daily activities.
3. Cardiac risk model calculators exist to facilitate quantification of risk and aid the perioperative physician with optimizing patient care.
4. The 2014 American College of Cardiology (ACC)/American Heart Association (AHA) guideline document of perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery provides a valuable stepwise approach to the care of the patient with cardiovascular disease presenting for noncardiac surgery.
5. Within the 2014 ACC/AHA guideline document are important updates related to the perioperative administration of various cardiac-related medications.
6. Antiplatelet therapy and the temporal relationship between percutaneous coronary interventions (PCIs) and scheduled surgery determine timing of and perioperative management during noncardiac surgery.
7. The 2016 ACC/AHA guideline focused update on duration of dual antiplatelet therapy (DAPT) in patients with coronary artery disease provides important updates related to the timing of surgery and management of DAPT after PCI.
8. No specific recommendations are available regarding transfusion and the decision to transfuse; the hemoglobin goal is decided by the perioperative team.
9. Pulmonary arterial hypertension and subsequent right ventricular dysfunction are a major cause of poor perioperative outcomes, and the perioperative team should optimize ventilation/perfusion matching and reduce pulmonary vascular resistance.

Patients undergoing surgery experience a well-described stress response of sympathetic nervous system activation, insulin resistance, cytokine production, leukocyte demargination, and pituitary hormone secretion. These physiologic changes, in addition to preexisting patient comorbidities, surgical complexity, and postoperative complications, may contribute to the occurrence of adverse perioperative cardiovascular events in patients undergoing noncardiac surgery. Every patient should undergo an individualized

risk assessment to delineate the risks, benefits, and alternatives of surgical intervention as part of a perioperative team approach. In the absence of a net benefit, interventions for optimizing cardiovascular health or consideration of alternative approaches should be performed to ensure the maximum potential benefit at a minimum risk to the patient.

This chapter reviews preoperative cardiac evaluation, including a discussion of common risk calculators, to assist perioperative clinicians with risk assessment and surgical planning. The American College of Cardiology (ACC) and American Heart Association (AHA) clinical practice guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery is also reviewed. Recommendations regarding specific and frequently encountered perioperative challenges are discussed, such as medical therapy with β-blockers, angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs), α_2-agonists, aspirin (including dual antiplatelet therapy [DAPT]), vitamin K antagonists (VKAs), and new oral anticoagulants (NOACs) are addressed. Perioperative management of anemia, pulmonary vascular disease, and right ventricular (RV) dysfunction is also discussed.

PREOPERATIVE CARDIAC ASSESSMENT: CATEGORIZING RISK

Compared with their healthier counterparts, patients with underlying cardiovascular disease have an increased risk of perioperative cardiac complications. This is in part due to the presence of coronary artery disease (CAD), leading to impaired left ventricular ejection fraction (LVEF) and in part due to the physiologic factors associated with surgery that predispose patients to myocardial ischemia. Oxygen supply and demand mismatch may occur secondary to blood loss and hemodynamic changes related to anesthetic administration and surgical stimulation.

Validated algorithms have been developed to determine the cardiovascular risk of mortality and morbidity encountered per patient for each noncardiac operation. Stratification is performed to objectively determine and categorize patients as low, intermediate, or high risk. High-risk patients include those with recent myocardial infarction (MI) or unstable angina, decompensated heart failure (HF), high-grade arrhythmias, or hemodynamically significant valvular heart disease, such as aortic stenosis. These patients are at increased risk for perioperative major adverse cardiac events (MACE), including MI, HF, cardiac arrest, conduction abnormalities, and sudden cardiac death. Certainly, the emergent or urgent status of some surgery plays a large role in estimating risk due to the absence of time for risk assessment and modification. Patients with the high-risk conditions listed are at increased risk of a perioperative cardiovascular event compared with normal, age-matched control participants; however, in most emergent cases, the benefit of proceeding with surgery outweighs the risk of delay to perform additional testing.

The initial preoperative evaluation is typically performed by either a primary care physician or an anesthesiologist, and referral to a cardiologist is warranted if specialized procedures are indicated for life-threatening conditions. Intermediate- or high-risk patients may have angina, dyspnea, syncope, and palpitations, as well as history of heart disease (ischemic, valvular, structural myocardial disease), hypertension, diabetes, chronic kidney disease, and cerebrovascular or peripheral arterial disease. Cardiac functional status may be expressed in metabolic equivalents (METs), as initially determined by the Duke Activity Status Index (Table 1.1). One MET is equivalent to the adult resting oxygen utilization, and an important indicator for MACE after major noncardiac surgery is the preoperative inability to achieve 4 METs or greater, such

Table 1.1 Duke Activity Status Index

Can You...	Weight (in METs)
1. Take care of yourself, i.e., eating, dressing, bathing, or using the toilet?	2.75
2. Walk indoors, such as around your house?	1.75
3. Walk a block or two on level ground?	2.75
4. Climb a flight of stairs or walk up a hill?	5.50
5. Run a short distance?	8.00
6. Do light work around the house such as dusting or washing dishes?	2.70
7. Do moderate work around the house such as vacuuming, sweeping floors, or carrying groceries?	3.50
8. Do heavy work around the house such as scrubbing floors or lifting or moving heavy furniture?	8.00
9. Do yardwork such as raking leaves, weeding, or pushing a power mower?	4.50
10. Have sexual relations?	5.25
11. Participate in moderate recreational activities such as golf, bowling, dancing, doubles tennis, or throwing a baseball or football?	6.00
12. Participate in strenuous sports such as swimming, singles tennis, football, basketball, or skiing?	7.50

MET, Metabolic equivalents where 1 MET is the equivalent of resting oxygen consumption.
From Hlatky MA, Boineau RE, Higginbotham MB, et al. A brief self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). *Am J Cardiol.* 1989;64:651–654.

as by climbing two flights of stairs or walking four city blocks. The decision to pursue cardiovascular or pulmonary testing should be considered only if the results would impact surgical decision making or would likely identify an immediately life-threatening condition requiring timely management.

PREOPERATIVE CARDIAC ASSESSMENT USING RISK MODELING CALCULATORS

Risk model calculators estimate the probability of a perioperative event based on information obtained from the history, physical examination, and surgery type. These models are more applicable for patients at intermediate or high perioperative cardiac risk during noncardiac surgery. Patients at low risk for MACEs should proceed to surgery without further evaluation.

Specific information pertaining to both the patient and the surgery must be provided to appropriately identify individualized risk using a risk calculator. Perioperative information is entered into one or both of two commonly used perioperative risk indices: the Revised Cardiac Risk Index (RCRI) (Fig. 1.1) (http://www.mdcalc.com/revised-cardiac-risk-index-for-pre-operative-risk) or the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) (Fig. 1.2) surgical risk calculators (http://site.acsnsqip.org). The RCRI determines preoperative risk based on risk of surgery, history of ischemic heart disease, congestive heart failure (CHF), cerebrovascular disease, preoperative use of insulin, and creatinine greater than 2.0 mg/dL. The ACS-NSQIP calculator incorporates 20 patient risk factors in addition to the

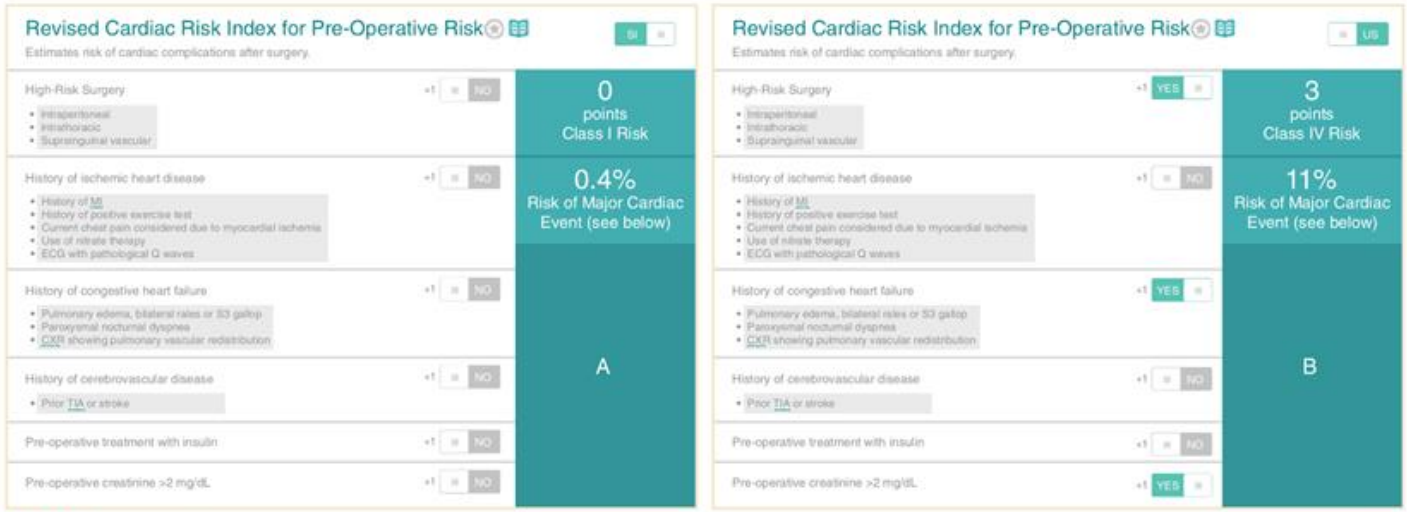

Fig. 1.1 Revised Cardiac Risk Index calculator depicted for two patients entered into the risk calculator. Patient A has no risk factors and a calculated risk for major cardiac event equal to 0.4%. Patient B has several risk factors and a calculated risk for major cardiac event equal to 11%. (From http://www.mdcalc.com/revised-cardiac-risk-index-for-pre-operative-risk/.)

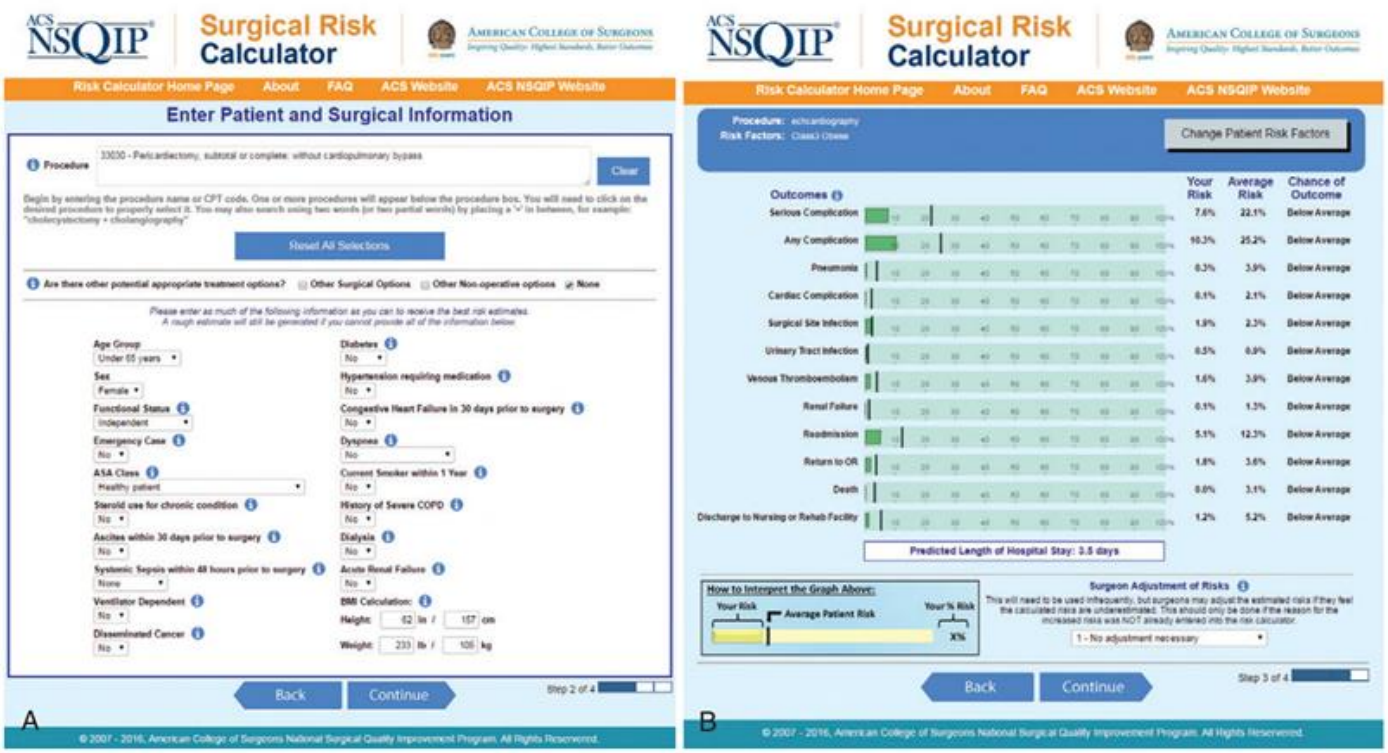

Fig. 1.2 National Surgical Quality Improvement Program (NSQIP) risk calculator. (A) The online site displays where patient and surgical features may be input into the data calculator. (B) As an example, the surgical risk calculation has been performed for a patient undergoing echocardiography with specific risk factors. The resulting surgical risk calculation, including negative outcomes, percent risk of these outcomes occurring, and the chance of the outcome (e.g., average, above average) are displayed. Note in the lower right corner that the surgeon may adjust this risk calculation. In this example, no adjustment has been made. (From http://site.acsnsqip.org.)