

arrhythmia, and severe valvular disease (including severe aortic stenosis and symptomatic mitral stenosis).

Assessment of exercise tolerance in preoperative risk stratification and precise prediction of in-hospital perioperative risk is most applicable in patients who self-report worsening exercise-induced cardiopulmonary symptoms, patients who may benefit from noninvasive or invasive cardiac testing regardless of the scheduled surgical procedure, and patients with known CAD or with multiple risk factors and the ability to exercise. For the prediction of perioperative events, “poor” exercise tolerance has been defined as inability to walk four blocks and climb two flights of stairs or as inability to meet a metabolic equivalent (MET) level of 4 (Table 24-2). Highly functional symptomatic patients (i.e., those who are able to achieve a functional capacity ≥ 4 METS without symptoms, as when climbing a flight of stairs or running a short distance) rarely require noninvasive testing or intervention to lower the risk of noncardiac surgery.

If the patient has poor functional capacity or is symptomatic, physicians often use risk indices derived from empirical multivariable predictive models based on clinical assessment of risk factors to identify patients with elevated perioperative cardiac risk. Based on prospective comparison studies, the Revised Cardiac Risk Index (RCRI) is favored by many given its accuracy and simplicity (Table 24-3). A newer predictive model is the National Surgical Quality Improvement Program (NSQIP) risk calculator and is based on multiple clinical predictors. The RCRI relies on the presence or absence of six identifiable predictive factors: high-risk surgery (suprainguinal vascular, intrathoracic, or intraperitoneal surgery), ischemic heart disease, congestive heart failure (CHF), cerebrovascular disease, diabetes mellitus (requiring insulin therapy), and renal failure (with a serum creatinine concentration >2.0 mg/dL). Each of the RCRI clinical predictors, if present, is assigned 1 point. The risk for cardiac events (i.e., MI, pulmonary edema, ventricular fibrillation or primary cardiac arrest, and complete heart block) can then be predicted. A patient with an RCRI score of 0 has an estimated risk of 0.4% to 0.5% for major cardiac complications; the risk is 0.9% to 1.3% for someone with a score of 1, 4% to 6.6% with a score of 2, and 9% to 11% with a score of 3 (Fig. 24-1). Cardiac

risk particularly increases with the presence of two or more predictors and is greatest with three or more. The clinical utility of the RCRI is that it identifies patients who are at higher risk for cardiac complications and helps determine whether they may benefit from further risk stratification with noninvasive cardiac testing or from initiation of preoperative preventive medical management.

Preoperative Noninvasive Cardiac Testing for Risk Stratification

Evidence discourages widespread application of preoperative noninvasive cardiac testing for all patients. Rather, a selective approach based on clinical risk categorization appears to be both effective and cost-effective. No testing is recommended if it might delay surgical intervention for urgent or emergent conditions.

Coronary revascularization offers the potential benefit of identifying asymptomatic but high-risk patients—that is, patients

TABLE 24-3 REVISED CARDIAC RISK INDEX: CLINICAL MARKERS

1. High-risk surgical procedures
2. Ischemic heart disease
 - a. History of myocardial infarction
 - b. Current angina considered to be ischemic
 - c. Requirement for sublingual nitroglycerin
 - d. Positive exercise test
 - e. Pathologic Q waves on ECG
 - f. History of PTCA and/or CABG with current angina considered to be ischemic
3. Congestive heart failure
 - a. Left ventricular failure by physical examination
 - b. History of paroxysmal nocturnal dyspnea
 - c. History of pulmonary edema
 - d. S_3 gallop on cardiac auscultation
 - e. Bilateral rales on pulmonary auscultation
 - f. Pulmonary edema on chest radiography
4. Cerebrovascular disease
 - a. History of transient ischemic attack
 - b. History of cerebrovascular accident
5. Diabetes mellitus
 - a. Treatment with insulin
6. Chronic renal insufficiency
 - a. Serum creatinine concentration >2 mg/dL

Modified from Lee TH, Marcantonio ER, Mangione CM, et al: Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery, *Circulation* 100:1043–1049, 1999.

CABG, Coronary artery bypass grafting; ECG, electrocardiogram; PTCA, percutaneous transluminal coronary angioplasty.

TABLE 24-2 FUNCTIONAL STATUS

EXCELLENT (ACTIVITIES REQUIRING >7 METS)

Carry 24 lb up eight steps
Carry objects that weigh 80 lb
Outdoor work (shovel snow, spade soil)
Recreation (ski, basketball, squash, handball, jog or walk 5 mph)

MODERATE (ACTIVITIES REQUIRING >4 BUT <7 METS)

Have sexual intercourse without stopping
Walk at 4 mph on level ground
Outdoor work (garden, rake, weed)
Recreation (roller-skate, dance, foxtrot)

POOR (ACTIVITIES REQUIRING <4 METS)

Shower/dress without stopping, strip and make bed, dust, wash dishes
Walk at 2.5 mph on level ground
Outdoor work (clean windows)
Recreation (golf, bowl)

Modified 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* 64:651–654, 1989.

MET, Metabolic equivalent.

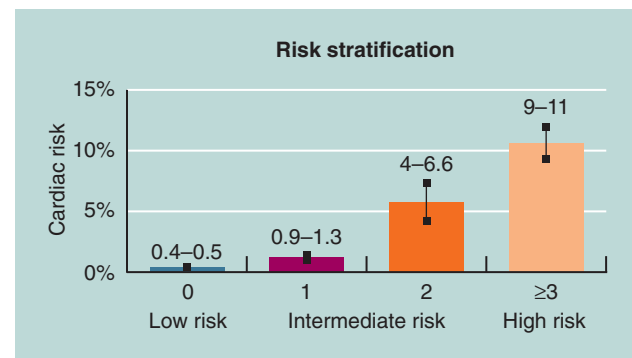


FIGURE 24-1 Bar graph shows the predicted risk for cardiac events during surgery according to a patient’s Revised Cardiac Risk Index score.