Lesson 269: PreAnesthetic Assessment of the Cardiac Patient for Noncardiac Surgery (Part 1)

LEARNING OBJECTIVES
At the end of this activity, the participant should be able to:
1. Stratify patients according to their risk for perioperative cardiovascular events by using appropriate risk factors.
2. Estimate the risk of surgical patients for perioperative cardiovascular events.
3. Stratify patients based on their functional status.
4. Use the ACC/AHA algorithm to determine which patients may require noninvasive testing before surgery.
5. Appropriately schedule patients for elective noncardiac surgery following the placement of bare-metal/drug-eluting stents.
6. Review the indications for coronary revascularization via percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) surgery.
7. Review the risks and benefits of coronary revascularization before noncardiac surgery.
8. Discuss current findings regarding cardiac outcomes after noninvasive stress testing versus preoperative evaluation.
9. Discuss why the assessment of cardiac patients may differ nationally.
10. Describe the pathophysiology of perioperative and nonsurgery-related cardiac ischemic events.

CASE HISTORY
A 63-year-old woman presented for left femoral-popliteal bypass surgery. Her medical history was significant for peripheral vascular disease, poorly controlled insulin-dependent diabetes, and end-stage renal disease requiring hemodialysis. Ambulation had been difficult for the past 3 months, and she was unable to climb stairs or walk more than half a block. A stress test 16 months earlier showed no ischemic changes and an absence of arrhythmias, in addition to normal wall motion with an ejection fraction of 74%. She denied symptoms of coronary ischemia. Results of preoperative laboratory tests included hemoglobin, 8.6 g/dL; hematocrit, 25.1%; potassium, 4.5 mEq/L; blood urea nitrogen, 22 mg/dL; creatinine, 5.9 mg/dL; and normal coagulation. She was receiving antibiotics, insulin (both regular and lente, dosed on a sliding scale), furosemide, and hydrochlorothiazide. Vital sign measurements were blood pressure, 139/60 mm Hg; pulse, 72 beats per minute; respiratory rate, 36 breaths per minute; and SpO2, 95% on room air. She weighed 94 kg; physical examination findings were otherwise unremarkable.

CALL FOR WRITERS
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Cardiac complications are major causes of morbidity and mortality for patients after noncardiac surgery. Researchers have assessed cardiac risk factors, algorithms for perioperative management, evaluation of cardiac status, and interventions to minimize the incidence of perioperative myocardial ischemia and infarction. Factors to be considered in the preoperative cardiac evaluation include the following: patient risk factors for perioperative cardiac events, patient functional status, surgical risk stratification, and integration of these to determine management. Management may include medical therapy, revascularization, delay of the procedure, or no intervention.

During a preoperative evaluation, the anesthesiologist characterizes the patient’s cardiovascular status and measures or estimates the degree of cardiovascular disease and function. The ACC/AHA guidelines attempt to estimate a patient’s risk for perioperative cardiac events more than the patient’s risk for cardiac disease. Understanding which patients are at highest risk for perioperative cardiac events and the mechanisms underlying the pathophysiology of myocardial ischemia and infarction can help clinicians stratify and then modify patients’ risk. Major morbidity and mortality after elective major noncardiac surgery in unselected populations have become rare. Goldman et al (N Engl J Med 1977;279(16):845-850) found that 1.9% of 1,001 patients died of cardiac causes, and Lee et al (Circulation 1999;100(10):1043-1049) found that 2% of patients undergoing elective major noncardiac surgery had serious cardiovascular complications.

Preoperative evaluations seek to identify the subset of the general population at greatest risk for perioperative cardiovascular events. It has been suggested that because of the low predictive value of positive test results in noninvasive cardiac testing, clinicians should shift their focus from stratifying risk factors to modifying a patient’s risk for perioperative events through medical management. In contrast to the risk for perioperative cardiac events in the general surgical population, the incidence in patients with known or suspected coronary artery disease (CAD) is significantly higher, ranging between 20% and 60%.

Ischemic events are about 3 times more likely to occur postoperatively and about 5 times more likely to occur intraoperatively than preoperatively. The incidence of postoperative myocardial infarction (MI) varies between 1.4% and 38%.

Perioperative events appear to have long-term consequences. Postoperative myocardial ischemia has been found to increase the odds for long-term cardiac events 2-20-fold. Postoperative MI increases the odds for long-term cardiac events such as nonfatal MI, unstable angina, congestive heart failure, and cardiac death 20-fold.

Cardiac ischemia is most likely to develop in high-risk patients within the first 2 days after surgery, typically at the end of the procedure and during the patient’s emergence from anesthesia. Most of these ischemic episodes are silent. ST-segment changes detected in patients undergoing noncardiac surgery are almost exclusively ST-segment depression rather than elevation. Most postoperative MIs occur after surgery and are of the non-Q-wave type preceded by episodes of ST-segment depression. A longer duration of ST-segment depression appears to correlate with adverse cardiac outcomes.

The mechanism of perioperative myocardial ischemia and MI–as distinct from nonperioperative MI–involves both thrombotic (from plaque rupture) and ischemic processes. Le Menach et al (Anesthesiology 2005;102(5):965-971) studied patients with MI at an average of 4% and proposed 2 distinct types of postoperative MI: early (≤24 hours) and late (>24 hours). Early MI was caused by “vulnerable plaques,” thrombosis-prone plaques, or plaques likely to undergo rapid progression. Late MI resulted after prolonged ischemic periods. The investigators recommended preoperative prevention with plaque stabilization, intensive β-blocker therapy, and analgesia for patients at risk for early MI, and monitoring for patients at risk for late MI.

Pathologic evidence indicates that intraoperative MIs are similar to nonoperative MIs. In autopsy specimens, 55% of fatal perioperative MIs were caused by plaque disruption and 45% by plaque hemorrhage. However, the significance of findings that fatal perioperative MIs have pathology similar to that of nonoperative MIs may be limited because only about 20% of perioperative MIs can be found by pathologic findings from a fatal MI may or may not represent those of a typical perioperative nonfatal MI.

Additionally troubling is the fact that when autopsy specimens were examined, the severity of the underlying fatal stenoses would not have predicted the fatal infarctions. There is the suggestion that stenoses that do not appear to be alarming perhaps should be alarming. On angiograms, patients who have a perioperative MI have evidence of extensive CAD. The cause commonly implicated in perioperative MIs is not high-grade stenosis, but rather the absence of adequate collateralization. Even when there is evidence of collateral flow around stenoses, the existence of adequate protection from perioperative MI by visible collaterals cannot be determined by angiography. In one-third of patients who experienced a perioperative cardiac event, no obvious coronary artery site could be identified on preoperative testing. Poldermans et al (Am J Cardiol 2001;88(12):1415-1414) found that in patients who died after elective vascular surgery, the pathologic evidence of infarction did not always correlate with wall motion abnormalities on preoperative dobutamine stress echocardiography. So, the absence of severe CAD does not predict a low cardiac risk, and the correlation between the degree of stenosis and risk for perioperative events is not definitive. In other words, a cardiac evaluation by anesthesiologists is multifactorial—no single factor defines a patient’s risk.

Medical History

Many risk indices have been developed for predicting patients’ risk for cardiac events. The ACC/AHA guidelines assign more weight to active conditions than to dormant conditions and identify major, intermediate, and minor predictors of increased risk for cardiac complications (Table 1).

Valvular Disease

Severe valvular disease may lead to a delay or cancella- tion of surgery, with possible further evaluation needed. The prevalence of critical aortic valve stenosis (valve area ≤0.8 cm² and velocity ratio ≤0.35) in a study of 75- to 86-year-olds was 2.9%. Generally, symptomatic patients require valve replacement surgery before nonemergent noncardiac surgery. A significantly higher incidence of nonfatal MI and perioperative death was reported in patients with aortic stenosis than in patients without aortic stenosis (14% vs 2%); the incidence was also higher in patients with severe aortic stenosis than in patients with moderate aortic stenosis (31% vs 11%). Depending on the surgical procedure, patients with severe aortic stenosis may tolerate noncardiac surgery provided they are given careful monitoring and management.

Acute or Recent Myocardial Infarction

What constitutes a prudent time period between an MI and elective noncardiac surgery is controversial. According to the ACC/AHA guidelines, an MI within 7 to 30 days before surgery is a major predictor of a perioperative cardiovascular event. Whether the myocardium is still at risk must be determined when patients who have had a recent MI are evaluated. If recent stress testing indicates that the myocardium is not at risk, the risk for reinfarction is low. Although available data are insufficient to recommend management either way, an interval of 4 to 6 weeks after an MI may be adequate before elective surgery is undertaken in the above scenario.

Previous Revascularization or Known Coronary Artery Disease

If a patient has undergone coronary artery bypass graft (CABG) surgery or percutaneous coronary interven- tion (PCI) within the preceding 5 years without a recur- rence of signs or symptoms of ischemia, no further test- ing is required. Likewise, if a patient has had a coronary evaluation within the preceding 2 years, no repeat testing is necessary unless the symptoms have changed or new symptoms of coronary ischemia have developed. However, if a patient has experienced at least 1 episode of unstable coronary syndrome (prior MI with symptoms or ischemic risk in a noninvasive study, unstable/severe angina, new/poorly controlled ischemic heart failure) or has major clinical predictors of risk (decompensated heart failure, significant arrhythmias, severe valvular disease; Table 1), surgery should be cancelled or delayed until the patient’s cardiovascular system has been evaluated and treatment administered.

Functional Status

According to the ACC/AHA guidelines, functional status is estimated by a metabolic equivalent of the task (MET), which measures exercise capacity. The MET is intended to be a marker of the ability of the myocardium to tolerate physiologic stress (by the presence or absence of cardiac symp- toms) and a long-term predictor of cardiac events. The test can be highly subjective, and the result depends on the reliability of patients and their interpretation of exertion. The absence of cardiac symptoms with exertion does not ensure that a patient’s myocardium is not at risk for ischemia or infarction because many patients have “silent” events. A MET of 1 is equivalent to the oxygen consumption of a 70-kg, 40-year-old man at rest. Functional capacity is classified as excellent (≥10 METs), good (7-10 METs), moderate (4-7 METs), or poor (<4 METs). The perioperative and long-term risks were found to increase in patients unable to perform routine tasks (requiring 4 METs) in their daily lives. An alternative to estimating a patient’s MET level may be cardiopulmonary exercise testing, which identifies elderly patients at greatest risk for postoperative death. Although used infrequently, cardiopulmonary exercise testing is an inexpensive and noninvasive way to evaluate cardiac and pulmonary function, and with it the clinician can gain insight into a patient’s reserve oxygen transport capacity.

Surgery-Specific Risk

An assessment of surgery-specific cardiac risk in patients undergoing noncardiac surgery comprises 2 components. Higher-risk patients are more likely to undergo certain types of surgery (eg, a significant number of patients undergoing vascular surgery have CAD), and a higher degree of hemodynamic cardiac stress is associated with certain surgical techniques (eg, certain procedures cause large changes in heart rate and blood pressure and significant bleeding). Various surgical procedures are stratified according to associated cardiac risk in Table 2. Other risks may be associated with specific institutions or surgeons because the volumes and outcomes of surgical procedures vary greatly by region and institution.
Noninvasive Stress Testing

According to the ACC/AHA guidelines, noninvasive testing is indicated for the following patients: those with a major clinical predictor; those with an intermediate clinical predictor who either have poor functional status or are undergoing a high-risk procedure; and those with poor functional status who are undergoing a high-risk procedure.

Identification of Appropriate Stress Tests

The goals of noninvasive testing are to identify the extent of myocardium at risk, quantify the ischemic threshold (i.e., determine the amount of stress that induces myocardial ischemia), and estimate ventricular function. When Kertai et al (Heart 2003;89[11]:1327-1334) compared 6 diagnostic tests as predictors of cardiac risk, the sensitivity rates of ambulatory and exercise electrocardiography (ECG) were low (52% and 74%, respectively), and the specificity rates were also low (70% and 69%, respectively). Patients suspected of being at high risk for a perioperative cardiac event were not able to perform either of the tests. Although exercise ECG may be considered the most physiologic type of testing, many high-risk patients are unable to adequately exert themselves and have ECG abnormalities. The presence of resting ECG changes (bundle branch block, left ventricular hypertrophy) may interfere with a reliable analysis of the ST segment. Exercise ECG had a low sensitivity (75%) and also a low specificity (83%) for predicting cardiac death and nonfatal infarction.

Radionuclide ventriculography for patients with a low ejection fraction (<35%) at baseline has been found to have a poor sensitivity (50%) but a high specificity (91%). Dipyridamole stress echocardiography has been reported to have a low sensitivity (74%) but a high specificity (86%). A sensitive test has been deemed more valuable for identifying patients at increased risk for perioperative cardiac events. The sensitivities of dobutamine stress echocardiography and myocardial perfusion scintigraphy have been found to be similar (85% and 83%, respectively), with dobutamine stress echocardiography having a higher specificity (70%) than that of myocardial perfusion scintigraphy (49%) and a better overall predictive performance. Echocardiography also adds information regarding abnormalities of valvular and ventricular function.

An earlier study by Mantha et al (Anesth Analg 1994;79[3]:422-433) reported the results of a meta-analysis of the effectiveness of 4 tests to predict cardiac outcomes in vascular surgery; the study yielded no data for recommending an optimal test. What the clinician should take from this is that, perhaps, appropriate noninvasive testing should be considered on an individual basis in the context of the medical history, the results of surgical pathology, and the institution.

Myocardial Revascularization

The benefit of prophylactic revascularization before noncardiac surgery is controversial. In a retrospective study by Eagle et al (Circulation 1997;96[6]:1982-1987), the rates of MI and mortality were lower in high-risk noncardiac surgical patients who had previously undergone surgical revascularization than those of patients who had undergone only medical therapy. Previous percutaneous transluminal coronary angioplasty (PTCA) may also be cardioprotective during subsequent noncardiac surgery.

It appears that a history of revascularization may be associated with reduced morbidity and mortality in patients who subsequently undergo noncardiac surgery. The practice of routine revascularization as part of a preoperative workup, however, is questionable. In a patient with known CAD, the clinician must question whether the risks associated with revascularization (CABG or PCI) are outweighed by...
the benefits, and whether a surgical procedure can be delayed to allow adequate time after CABG or PCI procedures. Patients with CAD who are scheduled to undergo a low-risk noncardiac procedure may not benefit; they represent a different patient population than that in the Coronary Artery Surgery Study (high-risk patients, high-risk procedures). All patients (revascularized or not) undergoing a low-risk procedure have a mortality rate of less than 1%. Therefore, in patients with CAD about to undergo a low-risk procedure, the utility of noninvasive testing is questionable because it does not appear to influence outcome.

After PTCA with bare-metal stenting, antplatelet therapy continues for 14 to 30 days, increasing the risk for perioperative bleeding. Because the risk associated with occlusion of a bare-metal stent decreases after 30 days as endothelialization occurs, it is wise to delay elective procedures for at least 30 to 40 days after PTCA and the placement of a bare-metal stent. For those patients who receive drug-eluting stents, dual antplatelet therapy (aspirin and clopidogrel) is prescribed for a minimum of 12 months. Stopping antplatelet therapy before the end of 12 months increases the risk for stent thrombosis. The discontinuation of clopidogrel alone before 12 months has been associated with increased rates of nonfatal MI, mortality, and late stent thrombosis in the nonoperative setting.

What happens if a patient’s stress test result is markedly abnormal? Should the patient undergo a coronary revascularization procedure before elective surgery? Consultation with a cardiologist is prudent before a patient with an abnormal stress test proceeds with any elective surgery, to assist with both short- and long-term management. The ACC and AHA have published evidence-based guidelines to assist cardiologists and cardiac surgeons in determining which patients are appropriate candidates for nonemergent coronary revascularization. Indications for CABG include the following: significant left main CAD or the equivalent of left main CAD; 1- or 2-vessel disease that includes stenosis of the proximal left anterior descending artery; and 3-vessel disease, especially in patients with an ejection fraction of less than 50% because CABG appears to increase their survival.

Percutaneous intervention is indicated in nondiabetic patients with significant disease in 1 or 2 vessels who are either asymptomatic or have mild angina; patients with Canadian Cardiovascular Society (CCS) class III angina with 1 or more lesions in 1 or more vessels; patients with CCS class III angina with significant left main CAD who are not candidates for CABG, and patients with CCS class III angina and a history of CABG with focal saphenous venous graft lesions or multiple stenoses who are poor candidates for reoperation (Table 3).

The long-term benefit of revascularization is somewhat controversial. Early retrospective studies showed better outcomes among patients who underwent CABG before elective noncardiac surgery. Subsequent studies also demonstrated a potential benefit in the outcomes of patients who underwent PCI before noncardiac surgery. In contrast to studies that looked at the effect of a single cardiac intervention (ie, PTCA only or CABG only), BARI (Bypass Angioplasty Revascularization Investigation) prospectively investigated the outcome of patients who underwent either PTCA or CABG before noncardiac surgery. Both interventions were associated with a low risk for procedural complications and yielded similar outcomes.

The conclusion from the studies previously mentioned is that coronary intervention, either PCI or CABG, decreases morbidity and mortality when performed before elective noncardiac surgery. The results of BARI suggest that the 2 interventions are equally efficacious, at least in the short term. However, in the nonsurgical setting, other BARI findings suggest that CABG is superior to PCI in patients with diabetes. Publication of the CARP (Coronary Artery Revascularization Prophylaxis) trial, however, has brought into question the benefits of prophylactic preoperative cardiac revascularization (N Engl J Med 2004;351[27]:2795-2804). This prospective multicenter randomized trial included 510 veterans in US Veterans Administration hospitals who were scheduled to undergo elective vascular surgery for either an expanding abdominal aortic aneurysm or severe peripheral vascular occlusive disease of the lower extremities. Patients were excluded if they required emergency surgery or if they had a severe coexisting illness, a history of revascularization without recurrent ischemia, a low ejection fraction, or left main CAD. Patients were assigned to undergo either cardiac revascularization (PTCA or CABG) or the planned vascular surgery without cardiac intervention. Mortality rates increased before the planned vascular procedure in patients who had received CABG/PCI, reflecting the inherent risks associated with those interventions. No short- or long-term benefits were discovered in the revascularization group compared with the control group, even within a subgroup of high-risk patients who had been expected to benefit from cardiac intervention.

The CARP trial not only challenges the dogma that preoperative cardiac revascularization reduces cardiac events after elective surgery, but also calls into question the need for a preoperative cardiac evaluation as long as medical management is adequate. The extensive perioperative use of β-blockers (~85%), antiplatelet agents (~75%), statins (~5%), and angiotensin-converting enzyme inhibitors in the study patients may have diminished any differences in outcome between the 2 groups.

A recent randomized study by Poldermans et al (J Am Coll Cardiol. 2006;48[5]:964-969) suggested that in vascular surgery, intermediate-risk patients who received a β-blocker (heart rate <65 beats per minute) had cardiovascular outcomes similar to those of intermediate-risk patients who had undergone stress testing and subsequent coronary revascularization when deemed appropriate. Therefore, it is ultimately up to the individual clinician to make educated decisions about the appropriate perioperative management of each patient, taking into account available scientific evidence, practice guidelines, appropriate pharmaco logical prophylaxis, and the patient’s wishes.

Selected Bibliography


