AMERICAN COLLEGE of CARDIOLOGY

American Heart Association℠
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**ACC/AHA Pocket Guidelines**

# Perioperative Cardiovascular Evaluation for Noncardiac Surgery

A Report of the American College of Cardiology/
American Heart Association
Task Force on Practice Guidelines

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# Perioperative Cardiovascular Evaluation for Noncardiac Surgery

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American Heart Association Task Force on Practice Guidelines)


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## Purpose of These Guidelines

These guidelines are intended for physicians involved in the preoperative, operative, and postoperative care of patients undergoing noncardiac surgery. They provide a framework for considering cardiac risk of noncardiac surgery in a variety of patient and operative situations. They strive to incorporate what is currently known about perioperative risk and how this knowledge can be used to treat individual patients. The methods used to develop these guidelines are described in the full text of the guidelines, published in the *Journal of the American College of Cardiology* and *Circulation.**

**JACC* 1996;27:910-948; *Circulation* 1996;93:1278-1317.

## General Approach

Successful perioperative evaluation and treatment of cardiac patients undergoing noncardiac surgery requires careful teamwork and communication between patient, primary care physician, anesthesiologist, surgeon, and the medical consultant. In general, indications for further cardiac testing and treatments are the same as those in the nonoperative setting, but their timing is dependent on such factors as the urgency of noncardiac surgery, the patient's risk factors, and specific surgical considerations. Coronary revascularization before noncardiac surgery to enable the patient to "get through" the noncardiac procedure is appropriate only for a small subset of patients at very high risk. Preoperative testing should be limited to circumstances in which the results will affect patient treatment and outcomes. A conservative approach to the use of expensive tests and treatments is recommended.



## Preoperative Clinical Evaluation

The initial history, physical examination, and electrocardiographic (ECG) assessment should focus on the identification of potentially serious cardiac disorders, including coronary artery disease (CAD) (eg, prior myocardial infarction [MI], angina pectoris), congestive heart failure (CHF), and electrical instability (symptomatic arrhythmias).

In addition to identifying the *presence* of preexisting manifested heart disease, it is essential to define disease *severity, stability,* and prior *treatment*. Other factors that help determine cardiac risk include

- functional capacity
- age
- comorbid conditions (eg, diabetes mellitus, peripheral vascular disease, renal dysfunction, chronic pulmonary disease)
- type of surgery (vascular procedures and prolonged complicated thoracic, abdominal, and head and neck procedures are considered higher risk)

## Further Preoperative Testing to Assess Coronary Risk

Coronary heart disease is the most frequent cause of perioperative cardiac mortality and morbidity after noncardiac surgery. A common question concerning noncardiac surgery is which patients are most likely to benefit from preoperative coronary assessment and treatment? The lack of adequately controlled or randomized clinical trials to define the optimal evaluation strategy has led to the proposed algorithm based on collected observational data and expert opinion. A step-wise Bayesian strategy that relies on assessment of clinical markers, prior coronary evaluation and treatment, functional capacity, and surgery-specific risk is outlined below and correlates with the information in Tables 1-4 and the Figure (page 32), which presents in algorithmic form a framework for determining which patients are candidates for cardiac testing. Table 1 outlines clinical predictors of perioperative risk. Table 2 presents a validated method for assessing functional capacity. Table 3 stratifies risk of various types of noncardiac surgeries. Table 4 lists the indications for coronary angiography. For clarity,



categories have been established as "black and white," but it is recognized that individual patient problems occur in "shades of gray." The clinician must consider several interacting variables and weight them appropriately. Furthermore, there are no adequate controlled or randomized clinical trials to help define the process.

The following steps correspond to the algorithm presented in the Figure (page 32).

- What is the urgency of noncardiac surgery? In many instances, patient or specific surgical factors dictate an obvious strategy (ie, immediate surgery) which may not allow further cardiac evaluation. In such cases, the consultant may function best by making recommendations for perioperative medical management and surveillance. Postoperative risk stratification may be appropriate for some patients who have not had such an assessment.

- Has the patient undergone coronary revascularization in the past 5 years? If so, and if clinical status has remained stable without recurrent symptoms/signs of ischemia, further cardiac testing is generally not necessary.

Has the patient had a coronary evaluation in the past 2 years? If coronary risk was adequately assessed and the findings were favorable, it is usually not necessary to repeat testing unless the patient has experienced a change or new symptoms of coronary ischemia since the previous evaluation.

Does the patient have an unstable coronary syndrome or a major clinical predictor of risk (Table 1)? When elective noncardiac surgery is being considered, the presence of unstable coronary disease, decompensated CHF, symptomatic arrhythmias, and/or severe valvular heart disease usually leads to cancellation or delay of surgery until the problem has been identified and treated. Examples of unstable coronary syndromes include recent MI with evidence of ischemic risk by clinical symptoms or noninvasive study, unstable or severe angina, and new or poorly controlled ischemia-mediated CHF. Many patients in these circumstances are referred for coronary angiography to further assess therapeutic options.



Does the patient have *intermediate clinical predictors of risk* (Table 1)? The presence or absence of prior MI by history or electrocardiogram, angina pectoris, compensated or prior CHF, and/or diabetes mellitus helps further stratify clinical risk for perioperative coronary events. Consideration of *functional capacity* and level of *surgery-specific risk* allows a rational approach to identifying patients most likely to benefit from further noninvasive testing.

*Functional capacity* can be expressed in metabolic equivalent (MET) levels; the oxygen consumption ($VO_2$) of a 70-kg, 40 year-old man in a resting state is 3.5 mL/kg per minute or 1 MET. Multiples of the baseline MET value can be used to express aerobic demands for specific activities. Perioperative cardiac and long-term risk is increased in patients who are unable to meet a 4-MET demand during most normal daily activities. The Duke Activity Status Index (Table 2) and other activity scales provide the clinician with a relatively easy set of questions to determine a patient's functional capacity as less than or greater than 4 METs.

*Surgery-specific cardiac risk* (Table 3) of noncardiac surgery is related to two important factors. First, the type of surgery itself may identify a patient with a greater likelihood of underlying heart disease, such as in vascular surgery, where underlying CAD is present in a substantial portion of patients. A second aspect is the degree of hemodynamic stress associated with surgery-specific procedures. Certain operations more predictably result in intraoperative or postoperative alterations in heart rate and blood pressure, fluid shifts, pain, bleeding, clotting tendencies, oxygenation, neurohumoral activation, and other perturbations. The duration and intensity of these coronary and myocardial stressors help estimate the likelihood of perioperative cardiac events. This likelihood is particularly evident for emergency surgery, in which the risk of cardiac complications is substantially elevated.

Examples of noncardiac surgery and their surgery-specific risks are provided in Table 3. Higher-risk surgery includes aortic surgery, peripheral vascular surgery, and anticipated prolonged procedures associated with major fluid shifts and/or blood loss involving the abdomen, thorax, head, and neck.



- Patients without major but with intermediate predictors of clinical risk (Table 1) and with moderate or excellent functional capacity can generally undergo intermediate-risk surgery with little likelihood of perioperative death or MI. Conversely, further noninvasive testing is often considered for patients with poor functional capacity or moderate functional capacity but higher-risk surgery and especially for patients with two or more intermediate predictors (ie, prior MI, prior or compensated CHF, angina, or diabetes mellitus).

- Noncardiac surgery is generally safe for patients with neither major nor intermediate predictors of clinical risk (Table 1) and moderate or excellent functional capacity (4 METs or greater). Further testing may be considered on an individual basis for patients without clinical markers but poor functional capacity who are facing higher-risk operations, particularly those with several minor clinical predictors of risk who are to undergo vascular surgery.

The results of noninvasive testing can be used to determine further preoperative management. Such management may include intensified medical therapy; cardiac catheterization, which may lead to coronary revascularization; or cancellation or delay of the elective noncardiac operation. Alternatively, the results may lead to a recommendation to proceed with surgery. In some patients the risk of intervention or corrective cardiac surgery may approach or even exceed the risk of the proposed noncardiac surgery. This approach may be appropriate, however, if it also significantly improves the patient's long-term prognosis.

For some patients, a careful consideration of clinical, surgery-specific, and functional status attributes leads to a decision to proceed to coronary angiography.



## Methods of Assessing Cardiac Risk

### Resting Left Ventricular Function

Several studies have shown that a left ventricular (LV) ejection fraction below 35% increases risk of noncardiac surgery. Patients with severe diastolic dysfunction are also at increased risk. The presence of current or poorly controlled CHF is an indication for evaluation of LV function. Possible indications include prior CHF or dyspnea of unknown etiology.

### Exercise Stress Testing

Preoperative exercise testing using treadmill or bicycle stress and ECG analysis with or without nuclear myocardial perfusion imaging echocardiography to identify ischemia provides substantial information about risk of perioperative MI and cardiac death. Poor functional capacity, particularly that associated with myocardial ischemia, identifies patients with a severalfold increased risk of untoward outcomes. A gradient of increasing ischemic risk is seen

in association with degree of functional incapacity, symptoms of ischemia, severity of ischemia (eg, depth, time of onset, and duration of ST-segment depression), and evidence of hemodynamic or electrical instability during or after stress. This gradient also correlates with increasing likelihood of severe and multivessel coronary disease.

### Pharmacological Stress Testing

For patients who are unable to exercise, selected use of pharmacological stress testing allows identification of patients with heightened risk of coronary events after noncardiac surgery. Dipyridamole or adenosine with thallium (or comparable radiopharmaceutical) myocardial perfusion imaging appears to have a high sensitivity and specificity for perioperative coronary events when used in patients with preexistent clinical predictors of risk, particularly angina pectoris, diabetes mellitus, prior MI, and prior CHF in patients undergoing vascular surgery. Quantitation of the degree of test abnormality may allow a means of establishing a gradient of risk much as is seen with exercise testing. Perioperative ischemic events appear to correlate with the magnitude of ischemia



such as presence of both ECG ischemia and thallium redistribution after pharmacological stress or multisegment redistribution, whereas long-term risk of death or MI may be better predicted by the presence of reversible and/or fixed thallium (or comparable radiopharmaceutical) defects.

Pharmacological stress testing involving echocardiography has also emerged as a promising method for stratifying coronary risk before noncardiac surgery. While the accumulated experience is less than that associated with myocardial perfusion imaging, dobutamine echocardiography appears to provide similar information and safety. The opportunity to assess LV and valvular dysfunction simultaneously offers advantages in some patients. As with all stress testing, proper identification of patients at medium and high risk and quantification of the degree of test abnormality may enhance predictive accuracy.

Although both exercise and pharmacological stress testing provide useful information for risk prediction, no prospective study has firmly established the cost-effectiveness or efficacy of either for improving perioperative

or long-term outcomes. Use of these tests to help identify patients with advanced left main or three-vessel coronary disease is justified, based upon overall knowledge of management of CAD. However, there is little or no current information to justify their use in broad populations at low risk.

### Ambulatory Electrocardiographic Monitoring

Several investigators have shown that detection of ischemia by preoperative 24- to 48-hour monitoring correlates with increased risk of both early postoperative and late ischemic cardiac events. However, higher-risk patients may have baseline ECG abnormalities that preclude analysis, and at present the technique does not allow for further quantification aimed at detecting those patients at greatest risk. Use of this technique should be limited to institutions in which preoperative monitoring of silent ischemia has been shown to be effective and in which a standardized monitoring protocol has been devised.



### Coronary Angiography

As indicated previously, it may be appropriate to proceed directly to coronary angiography in certain patients at high risk (Figure, page 32). Indications for coronary angiography in the preoperative setting generally are similar to those in the nonoperative setting (Table 4). First, it is essential to ensure that management with percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft (CABG) surgery is a viable option. Otherwise, coronary angiography may add to cost and risk without measurably benefitting outcome. Second, angiography should be reserved for patients at very high risk, including those with evidence of advanced ischemic risk or symptoms, and particularly those suspected of having left main or three-vessel CAD.

## Implications of Risk Assessment Strategies on Costs

The degree of variation in preoperative testing before noncardiac surgery is substantial, likely reflecting uncertainty about the most efficacious strategy or strategies and the lack of randomized clinical trials evaluating the impact of therapies on outcomes. Not surprisingly, formal cost-effectiveness analyses of various methods of preoperative testing and treatments have also yielded highly varied results. In many of these analyses, only short-term effects were evaluated; long-term benefits were ignored. Given this uncertainty, it is important for the clinician to consider the cost implications of screening strategies and, when possible, to rely on generally accepted strategies for treating nonsurgical patients.



## Management of Specific Preoperative Cardiovascular Conditions

### Hypertension

Severe hypertension (eg, diastolic blood pressure 110 mm Hg or greater) should be controlled before surgery when possible. The decision to delay surgery because of elevated blood pressure should take into account the urgency of surgery and the potential benefit of more intensive medical therapy. Continuation of preoperative antihypertensive treatment through the perioperative period is critical, particularly for agents such as ß-blockers or clonidine, to avoid severe postoperative hypertension.

### Valvular Heart Disease

Indications for evaluation and treatment of valvular heart disease are identical to those in the nonoperative setting. Symptomatic stenotic lesions such as mitral and aortic stenosis are associated with risk of perioperative severe CHF or shock and often

require percutaneous valvotomy or valve replacement before noncardiac surgery to lower cardiac risk. Conversely, symptomatic regurgitant valve disease (eg, aortic regurgitation and/or mitral regurgitation) is usually better tolerated perioperatively and may be stabilized before surgery with intensive medical therapy and monitoring. It is then treated definitively with valve repair or replacement after noncardiac surgery. This is appropriate when a wait of several weeks or months before noncardiac surgery may have severe consequences, for example, in patients with surgically curable malignant neoplasms. Exceptions may include patients with both severe valvular regurgitation and reduced LV function in whom overall hemodynamic reserve is so limited that destabilization during perioperative stresses is very likely.



### Myocardial Heart Disease

Dilated and hypertrophic cardiomyopathy are associated with an increased incidence of perioperative CHF. Management is directed toward maximizing preoperative hemodynamic status and providing intensive postoperative medical therapy and surveillance. An estimate of hemodynamic reserve is useful for anticipating potential complications arising from intraoperative and/or postoperative stress.

### Arrhythmias and Conduction Abnormalities

The presence of an arrhythmia or cardiac conduction disturbance should provoke a careful evaluation for underlying cardiopulmonary disease, drug toxicity, or metabolic abnormality. Therapy should be initiated for symptomatic or hemodynamically significant arrhythmias, first to reverse any underlying cause and second to treat the arrhythmia. Indications for antiarrhythmic therapy and cardiac pacing are identical to those in the nonoperative setting.

## Preoperative Coronary Revascularization

### Coronary Artery Bypass Graft Surgery

The indications for CABG before noncardiac surgery are identical to those reviewed in the ACC/AHA guidelines for CABG.* Because the cardiac risk of coronary bypass surgery itself often exceeds that of noncardiac surgery, CABG is rarely indicated to simply get a patient through the perioperative moment. However, for the patient with unstable coronary syndrome or the apparently stable patient who has advanced left main or three-vessel disease, CABG may lead to improved long-term survival. This long-term benefit may also be true for symptomatic patients with two-vessel disease with high-grade proximal left anterior descending (LAD) coronary artery stenosis and diminished LV dysfunction. In such circumstances, when the stress of elective noncardiac surgery is likely to exceed that encountered in daily life, it may be reasonable to consider CABG before noncardiac surgery. A number of observational studies have shown that patients with coronary heart disease who have successfully undergone CABG are at lower cardiac risk when they undergo noncardiac surgery.

* *JACC* 1991;17:543-589; *Circulation* 1991;83:1125-1173.

### Coronary Artery Angioplasty

As with CABG, there are no controlled trials comparing perioperative cardiac outcome after noncardiac surgery for patients treated with preoperative PTCA versus medical therapy. The results of several small observational series suggest that cardiac death is infrequent in patients who have coronary angioplasty before noncardiac surgery. Several studies have demonstrated a number of complications from angioplasty, including emergency CABG in some patients. Until further data are available, the indications for PTCA in the perioperative setting are similar to those in the ACC/AHA guidelines for use of PTCA in general.*

* *JACC* 1993;22:2033-2054; *Circulation* 1993;88:2987-3007.

## Medical Therapy for Coronary Artery Disease

There are very few randomized trials of perioperative medical therapy to lower cardiac risk in patients having noncardiac surgery, and the data are not sufficient to draw firm conclusions or recommendations. However, several points can be made on the basis of limited observational data. First, if patients require ß-blockers, calcium channel blockers, and/or nitrates before surgery to control or reduce angina or its ischemic equivalent, continuation of the preoperative medical regimen into the operative and postoperative period may also protect against ischemic tendencies caused by the unique stresses of the perioperative period. The same is true for therapies used to control symptoms of CHF. Second, observational studies suggest that ß-blockers reduce the frequency of postoperative ischemia and in one study reduced the incidence of perioperative MIs. Because postoperative ischemia is known to occur in a high percentage of patients who subsequently develop MI, protection against ischemia may also reduce risk of MI.



## Anesthetic Considerations and Intraoperative Management

### Anesthetic Agent

All anesthetic techniques and drugs are associated with known cardiac effects that should be considered in the perioperative plan. There appears to be no one best myocardial protective anesthetic technique. Therefore, the choice of anesthetic and intraoperative monitors is best left to the discretion of the anesthesia care team. Opioid-based anesthetics have become popular because of the cardiovascular stability associated with their use, but with high doses postoperative ventilation is needed. All inhalational agents have cardiovascular effects, including myocardial depression, which may be an important issue in patients with borderline LV reserve. Neuraxial techniques such as spinal and epidural anesthesia cause sympathetic blockade. Their use is frequently determined by the dermatomal level of the surgical procedure. Infrainguinal procedures may be accompanied by minimal hemodynamic changes if neuraxial blockade is limited to those dermatomes. Abdominal operations

requiring a high dermatomal level of anesthesia may result in more profound effects, including hypotension and reflex tachycardia if preload falls or hypotension without tachycardia if cardioaccelerators are inhibited by high-level blockade. Advocates of monitored anesthesia care, in which local anesthesia is supplemented by intravenous sedation/analgesia, have argued that this technique can eliminate the undesirable effects of general or neuraxial techniques, but no studies have established this. Furthermore, failure to produce complete local anesthesia/analgesia can lead to increased stress response, which may produce myocardial ischemia or depression.

### Perioperative Pain Management

Patient-controlled intravenous and/or epidural analgesia has become a popular method for reducing severity and duration of postoperative pain. Several studies suggest that effective pain management leads to a reduction in postoperative catecholamine surges and hypercoagulability, both of which can theoretically impact myocardial ischemia.



### Intraoperative Nitroglycerin

There are insufficient data to determine whether prophylactic intraoperative intravenous nitroglycerin is helpful or harmful in patients at high risk. Because the vasodilating properties of nitroglycerin are mimicked by several anesthetic agents, a combination of agents may lead to significant hypotension and even myocardial ischemia. When nitroglycerin is used, the hemodynamic effects of other agents used should be considered.

### Transesophageal Echocardiography (TEE)

There are few data on the value of TEE-detected transient wall motion abnormalities (presumed myocardial ischemia) to predict cardiac morbidity in noncardiac surgical patients. The largest experience to date suggests that the incremental value of this technique for risk prediction is small. Guidelines for the appropriate use of TEE to diagnose or guide therapy are being developed by the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists.*

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* *Anesthesiology* 1996;84:986-1006.

## Perioperative Surveillance

### Pulmonary Artery Catheters

Although a great deal of literature has evaluated the usefulness of pulmonary artery catheters in treating perioperative patients, very few studies have compared outcomes in patients treated with or without such monitoring. The American Society of Anesthesiologists recommends that the following three variables are particularly important in assessing benefit versus risk of pulmonary artery catheter use: disease severity, magnitude of anticipated surgical procedure, and practice setting. The extent of expected fluid shifts is a primary concern with regard to surgery. Current evidence indicates that patients most likely to benefit from use of pulmonary artery catheters in the perioperative period are those with a recent MI complicated by CHF, those with significant CAD who are undergoing procedures associated with significant hemodynamic stress, and those with systolic or diastolic LV dysfunction, cardiomyopathy, and valvular disease undergoing high-risk operations.



### Intraoperative and Postoperative ST-Segment Monitoring

Intraoperative and postoperative ST changes indicating myocardial ischemia have been found to be strong predictors of perioperative MI in patients at high clinical risk who undergo noncardiac surgery. Similarly, postoperative ischemia is a significant predictor of long-term MI and cardiac death. Conversely, ST depression may occur in patients at low risk who undergo noncardiac surgery. Often this is not associated with regional wall motion abnormalities, which raises the question whether this is ischemia or a nonspecific finding. Presently there are few data on the cost-effectiveness of ST-segment monitoring for the purposes of reducing perioperative morbidity in any patient population. Accumulating evidence suggests that proper use of computerized ST-segment analysis in appropriately selected patients at high risk may improve sensitivity for detection of myocardial ischemia, which could lead to improved perioperative and long-term risk assessment and treatment.

### Surveillance for Perioperative Myocardial Infarction

Very few studies have examined the optimal method for diagnosing perioperative MI. Clinical symptoms, postoperative ECG changes, and elevation of the MB fraction of creatine kinase (CK) have been most extensively studied. Newer myocardial-specific enzyme elevations such as troponin-I, troponin-T, or CK-MB isoforms may also have value. No single strategy or combination of strategies can be strongly advocated, given the paucity of current comparative evidence. In patients without known CAD, surveillance should probably be restricted to patients showing signs of cardiovascular dysfunction. In patients with known or suspected CAD undergoing high-risk procedures, obtaining electrocardiograms at baseline, immediately after the procedure, and for the first 2 postoperative days appears to be cost-effective. Use of cardiac enzymes is best reserved for patients with clinical, electrocardiographic, or hemodynamic evidence of cardiovascular dysfunction.

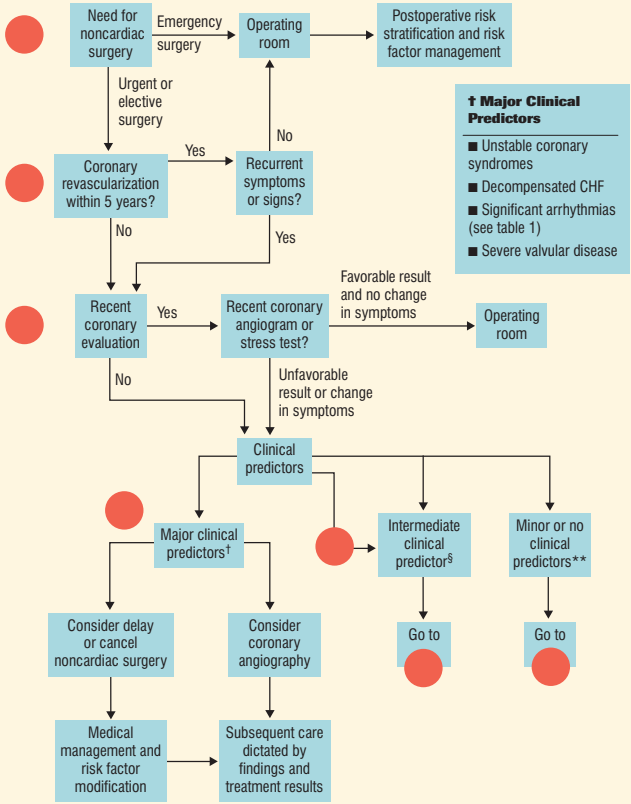


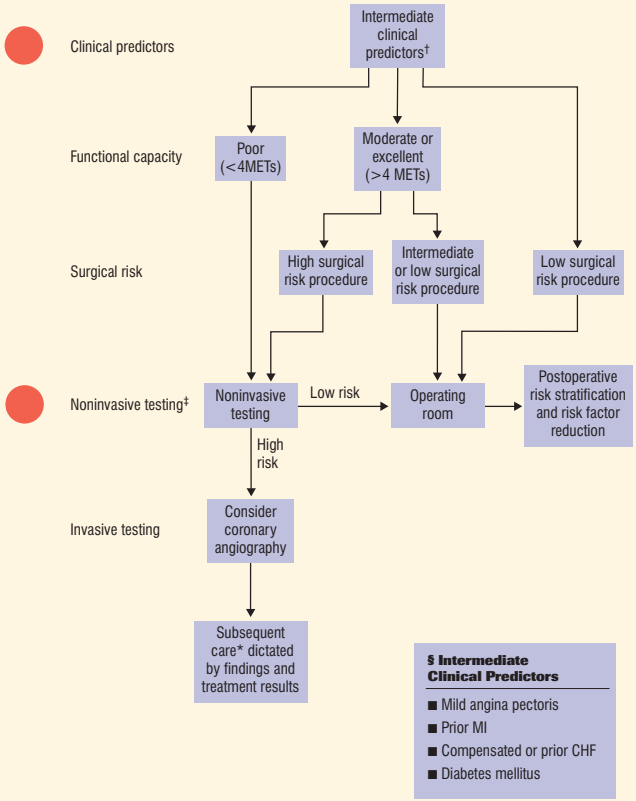
## Postoperative Therapy and Long-Term Management

When possible, postoperative management should include assessment and management of modifiable risk factors for CAD, heart failure, hypertension, stroke, and other cardiovascular diseases. For many patients, the need for noncardiac surgery may be their first opportunity for a systematic cardiovascular evaluation. Assessment for hypercholesterolemia, smoking, hypertension, diabetes, physical inactivity, peripheral vascular disease, cardiac murmur(s), arrhythmias, conduction abnormalities, perioperative ischemia, and postoperative MI may lead to evaluation and treatments that reduce future cardiovascular risk. In particular, patients who experience repetitive postoperative myocardial ischemia and/or sustain a perioperative MI are at substantially elevated risk for MI or cardiac death during long-term follow-up. These patients should be a particular focus for risk factor interventions and future risk stratification and therapy.

# Stepwise Approach to Preoperative Cardiac Assessment

Steps are discussed in text.



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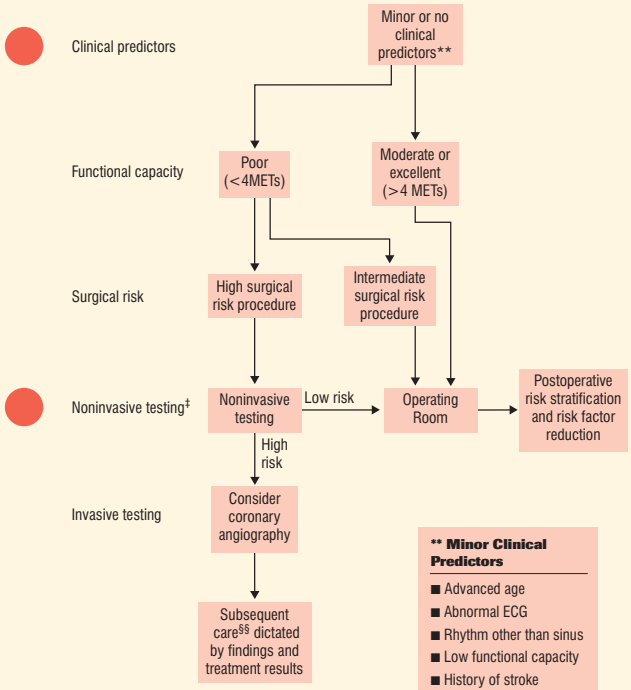


* *JACC* 1996; 27:910-948; *Circulation* 1996; 93:1278-1317.

‡ Myocardial perfusion imaging or stress echocardiography.

§§ Subsequent care may include cancellation or delay of surgery, coronary revascularization followed by noncardiac surgery, or intensified care.



**Table 1**

## Clinical Predictors of Increased Perioperative Cardiovascular Risk

(Myocardial Infarction, Congestive Heart Failure, Death)

### Major

Unstable coronary syndromes

- Recent myocardial infarction* with evidence of important ischemic risk by clinical symptoms or noninvasive study
- Unstable or severe† angina (Canadian Cardiovascular Society Class III or IV)‡

Decompensated congestive heart failure

Significant arrhythmias

- High-grade atrioventricular block
- Symptomatic ventricular arrhythmias in the presence of underlying heart disease
- Supraventricular arrhythmias with uncontrolled ventricular rate

Severe valvular disease

### Intermediate

Mild angina pectoris (Canadian Cardiovascular Society Class I or II)

Prior myocardial infarction by history or pathological waves

Compensated or prior congestive heart failure

Diabetes mellitus

### Minor

Advanced age

Abnormal electrocardiogram (left ventricular hypertrophy, left bundle branch block, ST-T abnormalities)

Rhythm other than sinus (eg, atrial fibrillation)

Low functional capacity (eg, unable to climb one flight of stairs with a bag of groceries)

History of stroke

Uncontrolled systemic hypertension

* The American College of Cardiology National Database Library defines *recent myocardial infarction* as greater than 7 days but less than or equal to 1 month (30 days).

† May include "stable" angina in patients who are unusually sedentary.

‡ Campeau L. Grading of angina pectoris. Circulation 1976;54:522-523.

**Table 2**

## Estimated Energy Requirements for Various Activities*

| | |
|---|---|
| 1 MET | Can you take care of yourself? |
| | Eat, dress, or use the toilet? |
| | Walk indoors around the house? |
| | Walk a block or two on level ground at 2-3 mph or 3.2-4.8 km/h? |
| 4 METs | Do light work around the house like dusting or washing dishes? |
| 4 METs | Climb a flight of stairs or walk up a hill? |
| | Walk on level ground at 4 mph or 6.4 km/h? |
| | Run a short distance? |
| | Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture? |
| | Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football? |
| >10 METs | Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing? |

MET indicates metabolic equivalent.

* Adapted from the Duke Activity Status Index (Hlatky MA, Boineau RE, Higginbotham MB, Lee KL, Mark DB, Califf RM, Cobb FR, Pryor DB. A brief self-administered questionnaire to determine functional capacity [the Duke Activity Status Index]. Am J Cardiol 1989;64:651-654.) and AHA Exercise Standards (Fletcher GF, Balady G, Froelicher VF, Hartley LH, Haskell WL, Pollock ML. Exercise standards: a statement for healthcare professionals from the American Heart Association. Circulation 1995;91:580-615.).



**Table 3**

## Cardiac Event Risk* Stratification for Noncardiac Surgical Procedures

### High

(Reported cardiac risk often >5%)

- Emergent major operations, particularly in the elderly
- Aortic and other major vascular
- Peripheral vascular
- Anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss

### Intermediate

(Reported cardiac risk generally <5%)

- Carotid endarterectomy
- Head and neck
- Intraperitoneal and intrathoracic
- Orthopedic
- Prostate

### Low†

(Reported cardiac risk generally <1%):

- Endoscopic procedures
- Superficial procedures
- Cataract
- Breast

* Combined incidence of cardiac death and nonfatal myocardial infarction.

† Further preoperative cardiac testing is not generally required.

**Table 4**

## Indications for Coronary Angiography* in Perioperative Evaluation Before (or After) Noncardiac Surgery

### Class I†: Patients with suspected or proven CAD:

- High-risk results during noninvasive testing
- Angina pectoris unresponsive to adequate medical therapy
- Most patients with unstable angina pectoris
- Nondiagnostic or equivocal noninvasive test in a high-risk patient (Table 1) undergoing a high-risk noncardiac surgical procedure (Table 3)

### Class II†:

- Intermediate-risk results during noninvasive testing
- Nondiagnostic or equivocal noninvasive test in a lower-risk patient (Table 1) undergoing a high-risk noncardiac surgical procedure (Table 3)
- Urgent noncardiac surgery in a patient convalescing from acute MI
- Perioperative MI

### Class III†:

- Low-risk noncardiac surgery (Table 3) in a patient with known CAD and low-risk results on noninvasive testing
- Screening for CAD without appropriate noninvasive testing.
- Asymptomatic after coronary revascularization, with excellent exercise capacity (≥ 7 METs)
- Mild stable angina in patients with good LV function, low-risk noninvasive test results
- Patient is not a candidate for coronary revascularization because of concomitant medical illness
- Prior technically adequate normal coronary angiogram within previous 5 years
- Severe LV dysfunction (eg, ejection fraction <20%) and patient not considered candidate for revascularization procedure
- Patient unwilling to consider coronary revascularization procedure

* If results will affect management.

† Class I: Conditions for which there is evidence for and/or general agreement that a procedure be performed or a treatment is of benefit. Class II: Conditions for which there is a divergence of evidence and/or opinion about the treatment. Class III: Conditions for which there is evidence and/or general agreement that the procedure is not necessary.

(CAD indicates coronary artery disease; MI, myocardial infarction; MET, metabolic equivalent; LV, left ventricular.)

Adapted from ACC/AHA Guidelines for Coronary Angiography. (JACC 1987:10:935-950; Circulation 1987; 76:963A-977A).