AANA Journal Course 4

Update for nurse anesthetists

*6 CE Credits

Preoperative cardiac evaluation

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This AANA Journal *course discusses the American College of Cardiology (ACC) and American Heart Association (AHA) guideline on perioperative cardiovascular evaluation for noncardiac surgery. The intent of the ACC/AHA guideline is to assist clinicians in clinical decision making by describing a range of generally acceptable approaches for the diagnosis, management, and prevention of cardiac diseases.*

Optimizing the anesthetic management of the cardiac patient undergoing noncardiac surgery is becoming increasingly important: as the percentage of Americans older than 65 years continues to grow, so does the prevalence of cardiac disease in this population. Simply accepting a preoperative cardiology clearance for the cardiac patient undergoing noncardiac surgery provides little information that can be used for risk assessment and management of anesthesia. While national practice patterns vary significantly, there is an important need to standardize cost-effective preoperative cardiac evaluation. By using evidence-based studies, the ACC/AHA guideline delineates methods to objectively categorize cardiovascular risk and use data from the cardiology consultation to refine anesthetic management. Use of the guideline can lead to more efficient evaluation of the noncardiac patient with cardiac disease, which can decrease morbidity, mortality, and cost.

Key words: Cardiac, noncardiac surgery, risk.

Objectives

At the completion of the course, the reader should be able to:

1. Discuss the prevalence and incidence of coronary artery disease.
2. Discuss the use of cardiac risk indexes.
3. Describe the use of the ACC/AHA guideline to determine the need for a cardiology consultation.
4. Describe noninvasive testing and invasive testing for the noncardiac surgical patient.
5. Discuss the anesthetic implications of prophylactic invasive procedures to include percutaneous transluminal coronary angiography and coronary bypass grafting.

Epidemiology

The average age of the United States population is steadily increasing. In 2000, the number of people 65 years old or older was 34.7 million, or 12.6% of the population. By the year 2050, there will be approximately 79 million people older than 65 years, representing 20% of the population.[1]

An epidemic of coronary artery disease (CAD) began during the 20th century and continues to be a leading cause of death in most industrialized countries. Improvements in diagnostic testing, increased professional knowledge of the pathological changes caused by cardiac disease, and heightened public awareness of the symptoms have resulted in greater survival rates for patients hospitalized with myocardial infarction, while increasing the prevalence of CAD.[2] It also is known that the largest number of surgical procedures is performed on people older than 65 years.[3] It is conceivable, therefore, that the number of surgical procedures performed in older persons will continue to increase, and the prevalence of CAD will continue to rise. Nearly a fourth of all surgical procedures in this cohort involve major intra-abdominal, thoracic, vascular, and orthopedic procedures, which are associated with significant risk of perioperative cardiovascular morbidity and mortality.[4]

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Although the prevalence of CAD is increasing, the incidence rate is difficult to accurately measure. Many people have silent or asymptomatic CAD and are not included in studies designed to measure the incidence of CAD. Silent cardiac ischemia documented by ambulatory electrocardiogram (ECG), Holter monitoring, or exercise ECG occurs in 2.5% to 10% of middle-aged men who have not reported signs or symptoms of CAD.[5,6]

While the incidence rate of CAD in middle-aged men is underestimated because of silent ischemia, the incidence in middle-aged women is also ambiguous. Chest pain is a less reliable indicator of CAD in women than in men. The prevalence of nonatherosclerotic causes of chest pain such as mitral valve prolapse and coronary artery spasm are higher in women than in men.[7,8] Women are approximately 3 times as likely as men to have a negative angiogram when evaluated for chest pain.[8] Although the risk of CAD is higher in African American women than in white women, African American women receive less preventive therapy and risk-factor control.[9] Hence for nearly 2 decades, studies have demonstrated the incidence rate of CAD in the middle-aged population is elusive because scientific methods fail to accurately quantify the disease irrespective of sex.

Multifactorial cardiac risk indexes

Cardiac risk indexes have been developed and integrated into clinical practice, but their validity has been questioned. Goldman and colleagues[10] published their seminal article in 1977, which resulted in the Goldman cardiac risk index (GCRI). They identified 9 risk factors and assigned each factor a certain number of points. After adding the points, patients were placed into 1 of 4 categories that have been used to estimate surgical risk. Multiple factors are associated with increased cardiac morbidity, including age, previous myocardial infarction (MI), cigarette smoking, congestive heart failure (CHF), valvular disease, angina pectoris, dysrhythmias, diabetes mellitus, peripheral vascular disease, and the type of operative procedure.[11,12]

The GCRI has been validated in other cohorts of patients, but it has not been found to be predictive in patients undergoing major vascular surgery.[10,12] Moreover, the GCRI is based on data from the 1970s and 1980s. Most patients undergoing surgery in today's operating rooms have a lower risk score, thus limiting the usefulness of the original GCRI. Additional attempts to develop or validate cardiac risk indexes have been made by Cooperman, Detsky, Eagle, Lee, and Yeager with conflicting results.[10,13] Unfortunately, there is no agreement on the usefulness of a preoperative risk index to predict risk for major peripheral vascular procedures.[10] Despite the lack of consensus, experts in the field of vascular surgery recommend additional studies to validate indexes such as the GCRI that can be used to accurately stratify patients undergoing noncardiac surgery based on their risk factors.

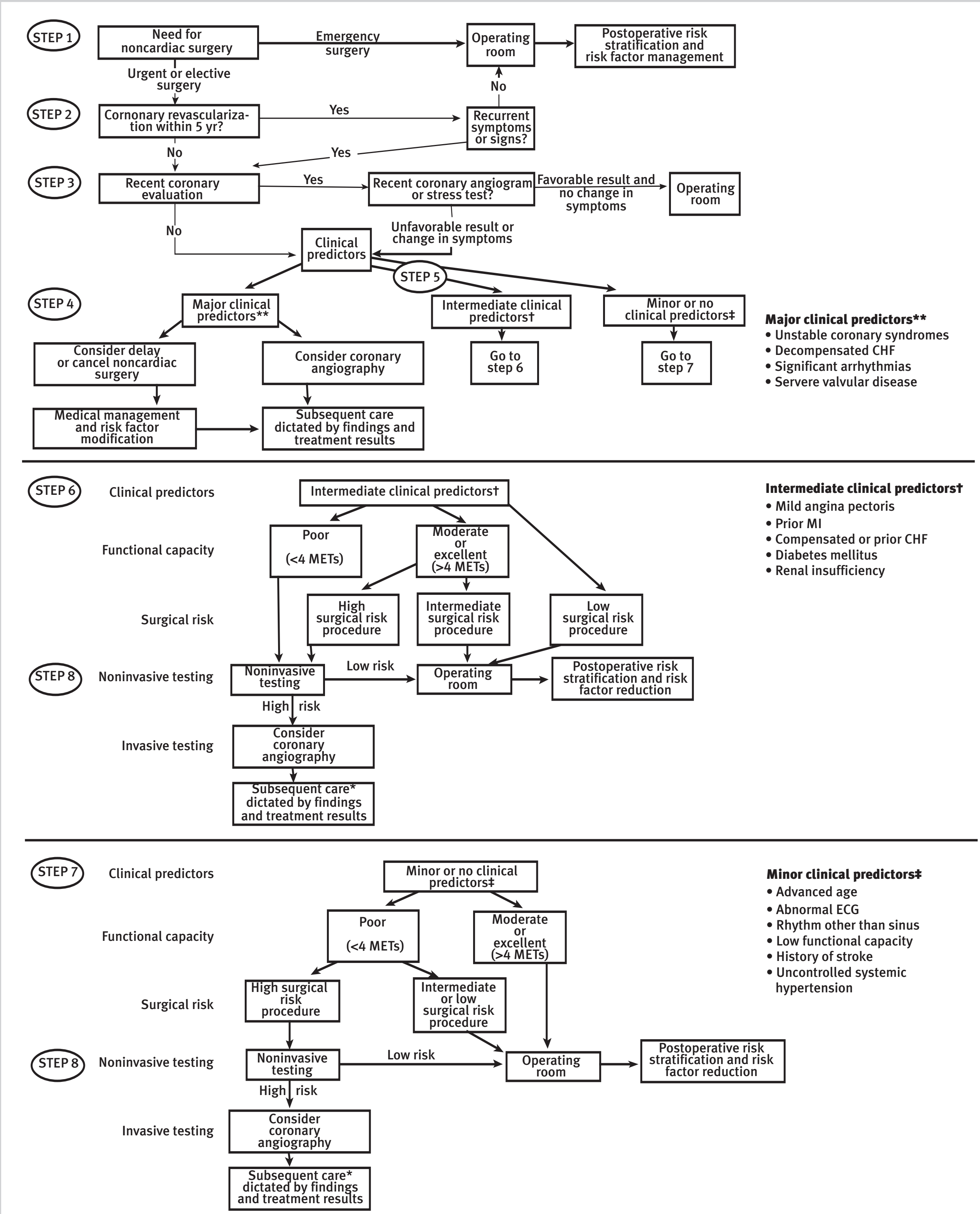
ACC/AHA guideline for cardiac evaluation and risk stratification for noncardiac surgical patients

Because epidemiological data are inconclusive and risk indexes fail to accurately stratify patients with peripheral vascular disease, clinicians must use cardiology consultations to accurately identify risk factors. Simply accepting a cardiology consultation to obtain medical clearance for surgery provides little information that can be used for anesthetic management. Studies have demonstrated that the usefulness or yield of a cardiology consultation in terms of new therapy or significant effect on patient management before surgery ranges from 10% to 70%.[14,15] There are multiple reasons for this range. For example, 1 review of 202 cardiology consultations found that 108 anesthesiologists asked for evaluation, 79 asked for a clearance, and 9 did not specifically request anything.[14] Studies designed to determine the usefulness of a cardiology consultation have been published, yet no studies document the expectations of the anesthesiologists and surgeons who request cardiology consultations.[16] Hence, there is considerable ambiguity between anesthesiologists and cardiologists regarding the intent of a cardiology consultation and about the usefulness of the consultation.

Published evidence of efforts to clarify the ambiguity surrounding the cardiology consultation process can be found. One of the most extensive publications is a guideline for cardiovascular evaluation that initially was published by the American College of Cardiology (ACC) and the American Heart Association (AHA) in 1996 with an updated version published in 2002.[4] The intent of the updated ACC/AHA guideline is to assist clinicians in clinical decision making by describing a range of generally acceptable approaches for the diagnosis, management, and prevention of specific cardiac diseases or conditions.[4]

The first 3 steps of the ACC/AHA guideline, outlined in the Figure, require evaluation of the urgency of the operation and recent cardiac interventions. If the operation is not emergent and there has not been a recent cardiac evaluation or intervention, then steps 4 through 7 are taken to assess the patient's clinical predictors of cardiac risk, the functional status of the patient, and the risk of the proposed surgical procedure. The anesthesia provider's decision to seek a cardiology consultation for noninvasive and/or invasive testing, step 8, is based on the following 2 questions, which are outlined in steps 4 to 7 in the Figure.

Figure. Stepwise approach to preoperative cardiac assessment



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

CHF indicates congestive heart failure; ECG, electrocardiogram; MET, metabolic equivalent; MI, myocardial infarction.

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The first question, found in steps 4 and 5, focuses on the identification of any major or intermediate clinical predictors of cardiac risk. The second question, outlined in steps 6 and 7, requires assessment of the patient's functional capacity and identification of specific cardiac risk associated with the surgical procedure. A routine preoperative history and physical assessment should provide answers to these questions, which become the basis for requesting the preoperative cardiac consultation, step 8.

The ACC/AHA guideline defines major predictors of clinical cardiac risk as unstable coronary syndrome, decompensated CHF, significant arrhythmias, symptomatic ventricular arrhythmias, and severe valve disease. Intermediate clinical predictors of cardiac risk are mild angina pectoris, history of MI, previous or compensated CHF, diabetes mellitus, and chronic renal insufficiency with a serum creatinine level greater than 2 mg/dL. Minor clinical predictors of cardiac risk are advanced age, abnormal ECG, rhythm other than sinus, low functional status, history of stroke, and uncontrolled systemic hypertension.[4]

The answer to the second question, outlined in steps 6 and 7 in the Figure, requires evaluation and categorization of the patient's functional capacity. Because functional capacity has been shown to be a reliable predictor of perioperative long-term cardiac morbidity, assessment of the patient's ability to perform various levels of physical activities is important to determine which patients might benefit from additional testing.[4] The guideline defines functional capacity in terms of metabolic equivalent (MET) levels. The oxygen consumption of a 70-kg, 40-year-old man in the resting state is 3.5 mL/kg per minute, or 1 MET. A man with excellent functional capacity can perform activities requiring greater than 10 METs. Activities in the 7 to 10 MET range define good functional capacity. Moderate functional capacity is defined by activities in the 4 to 7 MET range, and poor functional capacity is defined as inability to perform activities of greater than 4 METs. Activities requiring more than 4 METs include moderate cycling, climbing hills, ice skating, roller blading, skiing, jogging, and singles tennis.[4] Examples of leisure activities associated with fewer than 4 METs are baking, slow ballroom dancing, golfing with a cart, playing a musical instrument, and walking at a speed of approximately 2 to 3 miles per hour.[4] At activity levels of less than 4 METs, specific questions to establish risk gradients are less reliable. Accurate categorization of functional capacity can be difficult if the patient's ability to perform physical activities is limited because of physical limitations that are unrelated to the existence or severity of CAD.

In addition to identifying functional capacity, question 2 requires identification of the surgical-specific cardiac risk of perioperative MI and/or death, outlined in step 6 of the Figure. The degree of surgical-specific risk is associated with 2 factors: (1) the type of surgery itself and (2) the degree of hemodynamic cardiac stress associated with the surgical procedure. High-risk surgical procedures, with a perioperative risk of 5% or more of MI and/or death, include emergent major operations, aortic and other major vascular procedures, peripheral vascular bypass procedures, and procedures in which large fluid shifts and/or blood loss are expected.[4] Intermediate-risk surgical procedures are associated with a 1% to 5% perioperative risk of MI and/or death. These procedures include carotid endarterectomies and intraperitoneal and intrathoracic, orthopedic, head and neck, and prostate surgical procedures, excluding transurethral resection of the prostate. The surgical procedures associated with the lowest cardiac risk include endoscopies, cataract implants, and related superficial procedures with a cardiac risk of less than 1%.[4] After analyzing the responses to the questions discussed thus far in steps 1 through 7, the anesthesia provider has a rationale on which to proceed with a cardiology consultation.

While the ACC/AHA guideline was developed using evidence-based methods to ensure scientific rigor, it must be followed with an appreciation of the effects of confounding. By definition, *confounding* occurs when the apparent association between a risk factor and an outcome is affected by the relationship of a third variable to the risk factor and the outcome.[17] One confounding variable associated with the risk of MI and/or death that has been the topic of substantial scientific debate is the perioperative pharmacologic protection of the myocardium related to the use of beta blockers. Hence, the use of beta blockade is another variable or confounder that affects the risk of perioperative cardiac morbidity in the patient with CAD. For example, the 2002 guideline was developed before recent studies demonstrated the benefits of perioperative beta-adrenergic blockade.[18,19] Therefore, the beneficial effects of beta-adrenergic blockade in patients undergoing noncardiac surgery may not have been evaluated accurately, which could skew the outcome data in the guideline. In quantitative terms, recent data indicated that for every 100 patients receiving a beta blocker, approximately 13 will be prevented from having intraoperative or postoperative ischemia, 4 will not have an MI, and 3 deaths will be prevented.[18,19] These data were derived from a systematic review and, therefore, represent 11 trials involving 866 patients.[19] Which beta blocker to use and when to administer the beta blocker are questions that have not been resolved, yet recent evidence continues to demonstrate significant reductions in cardiac morbidity and mortality when beta blockers are administered.[20] As more data become available that demonstrate the reduction of ischemia, MI, and death, the perioperative administration of beta blockers will continue to gain acceptance as a valid method to reduce cardiac morbidity and mortality.

Additional confounders affecting the risk-stratification process described in the guideline include institutional surgical morbidity and the volume of surgical procedures. Because institutional procedure–specific rates of morbidity for each surgeon may not be recorded, the documented morbidity variance from one hospital to the next may not be the same as the data reported in the guideline. For example, 1 survey revealed a less than 3% stroke rate after carotid endarterectomy in hospitals in which 50 or more carotid endarterectomies were performed annually.[21] Based on these data, if your hospital does not exceed a threshold of 50 carotid endarterectomies annually, then the 1% to 5% cardiac morbidity in the guideline may not be the same. In summary, steps 1 through 7 of the ACC/AHA guideline describe a process that can be used to estimate morbidity and mortality for cardiac patients undergoing noncardiac surgery. Moreover, the guideline can be used to guide decisions related to obtaining cardiac consultation.

Step 8: Use of noninvasive and invasive testing for noncardiac surgical patients

Step 8 in the guideline involves noninvasive and invasive testing that is performed by the cardiologist. Evaluating the functional capacity in patients with symptoms of peripheral vascular, pulmonary, and/or skeletal muscle diseases that cause physical limitations unrelated to the cardiovascular system may require additional testing by the cardiologist. The guideline suggests additional testing if any 2 of the following factors have been identified: (1) angina, previous MI, compensated CHF, or diabetes; (2) poor functional capacity defined as the inability to perform activities requiring 4 METs; or (3) a high-surgical-risk procedure.[4] A major goal of additional testing and consultation with a cardiologist is to identify high-risk patients whose long-term outcome would be improved with additional medical therapy or preoperative coronary revascularization.

Because the sensitivity and specificity of certain preoperative studies is known to be low, the cardiologist may use more than one method to evaluate the patient's cardiac disease. For example, the 12-lead ECG provides important information on the status of the patient's myocardium and coronary circulation. Numerous studies demonstrate an abnormal preoperative ECG result as a statistically significant predictor of adverse cardiac outcomes. While an abnormal ECG result suggests underlying CAD, a normal resting ECG result may be misleading. From 25% to 50% of previous MIs are missed on ECG because the test is misread or lacks the pathognomonic findings indicative of an old MI.[2] The guideline identifies horizontal or down-sloping ST-segment depression greater than 0.5 mm, left ventricular hypertrophy with a strain pattern, and left bundle branch block in patients with known CAD as risk factors associated with a decreased life expectancy.[4] The ACC/AHA guideline recommends a 12-lead resting ECG for patients with chest pain in intermediate- and high-risk categories who are scheduled for intermediate- or high-risk procedures. In addition, a 12-lead ECG should be obtained for asymptomatic diabetics, patients who have undergone previous coronary revascularization, asymptomatic men 45 years old or older and women 55 years old or older with 2 or more atherosclerotic risk factors, and patients with previous hospitalization for cardiac causes.[4]

The primary goals and the recommendations for noninvasive or exercise and invasive or pharmacologic stress testing are discussed in the guideline. Exercise stress testing is an inexpensive, noninvasive method of predicting postoperative cardiac morbidity. The incidence of perioperative MI is as high as 37% in patients with positive results on a stress exercise ECG compared with an incidence of 1.5% in patients with normal results.[4] The mean sensitivity and specificity of exercise testing are 68% and 77%, respectively.[4] The sensitivity and specificity change in patients with multivessel CAD to 81% and 66%, respectively, and for left main coronary disease, the sensitivity is 86%, and the specificity declines to 53%.[4] False-negative exercise stress test results are common. Failure to reach the age-predicted peak exercise heart rate is one reason for a false-negative result. Patients with peripheral vascular disease represent one population in which failure to reach a predicted heart rate could be caused by claudication, which may be independent of the functional status of the myocardium. Therefore, in a patient with peripheral vascular disease, the exercise stress test has limited application. This limitation also applies to patients with pulmonary and/or skeletal muscle limitations.

To evaluate these patients, cardiologists use pharmacologic stress and myocardial perfusion imaging methods to study and categorize the functional status of the patient undergoing noncardiac surgery. Pharmacologic stressors for the detection of CAD can be divided into 2 categories: (1) those that result in coronary artery vasodilatation, such as dipyridamole, and (2) those that increase myocardial oxygen demand, such as dobutamine. The guideline cites the use of dobutamine stress echocardiography for preoperative risk assessment. Dobutamine is a beta receptor agonist that causes increased heart rate and contractility. After an infusion of dobutamine, 2-dimensional echocardiography is used to detect regional wall motion abnormalities resulting from myocardial ischemia that is caused by dobutamine and, therefore, to identify CAD. The predictive value of a positive test result ranged from 7% to 25% for MI and/or death.[4] The predictive value of a negative test result ranged from 93% to 100%.[4] In another analysis comparing dobutamine stress testing with coronary angiography for diagnosing CAD, the sensitivity and specificity ranged from 54% to 96% and from 57% to 95%, respectively.[10] These data indicate that dobutamine can be used to diagnose CAD with a specificity of 95%, while the specificity of a negative test result ranges from 93% to 100%.

The coronary artery vasodilators work by producing differential flows in normal coronary arteries compared with those with stenosis. Several studies have shown that the presence of a redistribution defect on dipyridamole thallium imaging in patients undergoing peripheral vascular surgery is predictive of postoperative cardiac morbidity.[4] These studies have been extended to include patients undergoing nonvascular surgery. Data in the guideline indicate that quantification of abnormalities had a significant impact on risk assessment. These data suggest that as the size of the reperfusion defect increases to 20% to 25% of the left ventricular mass, the degree of cardiac risk significantly increases.[4] While the positive predictive value of a thallium redistribution study ranges from 23% to 69%, the negative predictive value of a normal scan is uniformly high, at approximately 99%.[4]

Preoperative prophylactic interventions

Some high-risk patients may benefit from prophylactic preoperative coronary interventions. The criteria to determine which high-risk patients will benefit from prophylactic preoperative coronary intervention has not been established because we do not have randomized controlled trials designed to evaluate the overall benefit of prophylactic coronary artery bypass grafting (CABG). Eagle et al[4] analyzed 3,368 cases in the Coronary Artery Surgery Study and found that the mortality rate for patients undergoing urologic, orthopedic, breast, and skin procedures was very low, regardless of weather they had undergone prior CABG for CAD. However, patients undergoing thoracic, abdominal, vascular, and major otolaryngeal procedures who had undergone previous CABG had a lower risk of death and nonfatal MI than did patients without a previous MI.[4] The current recommendations for CABG before high- or intermediate-risk surgical procedures are based on conclusions from data published by the ACC/AHA in 1991.[4] Based on the paucity of data related to the selection of patients who would benefit from prophylactic CABG, these decisions often are made on a case-by-case basis.

Randomized, controlled trials evaluating the long-term survival rate for patients undergoing prophylactic percutaneous transluminal coronary angioplasty (PTCA) with or without stenting before high-risk surgical procedures are underway. While the risks and benefits of PTCA before major noncardiac surgery have yet to be established firmly, there is an additional element of uncertainty regarding how much time should pass before the noncardiac surgical procedure is performed. Arterial recoil and/or acute thrombosis at the site of balloon angioplasty is most likely to occur within hours to days after PTCA.[4] Stent thrombosis is most common during the first few weeks after placement. Because stent thrombosis is a very morbid event and because the risk of thrombosis diminishes after endothelialization of the stent has occurred, it is reasonable to delay elective noncardiac surgery for 2 weeks, ideally for 4 weeks, to allow for partial endothelialization of the stent.[4]

Another variable that has a significant effect on the post-PTCA surgical patient is associated with antiplatelet therapy. Typically, ticlopidine and aspirin are started 3 to 5 days before elective PTCA with stenting, and these drugs are continued for 14 to 30 days.[4] The risk of stent occlusion declines significantly after the initial 30-day post-PTCA interval. Thus, performing elective surgery on a patient during the early post-stenting period poses a significant dilemma because discontinuation of the antiplatelet therapy increases the risk of stent thrombosis and MI, but continuation will increase the risk of bleeding. The available data suggest that if the proposed surgical procedure cannot be delayed for 30 to 40 days after PTCA, then prophylactic revascularization by PTCA may not be recommended to reduce the cardiac risk.[4]

Summary

Cardiac events such as MI are well-documented complications of surgery. Prevention of these events is a major goal of perioperative anesthetic management. Effectively using data from the cardiology consultation is critical to the process of risk categorization and anesthetic management of the noncardiac patient. The final goal is to provide anesthetic management that increases the probability of a good outcome.

REFERENCES

1. Day JC. *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050.* US Bureau of the Census, Current Population Reports. Washington, DC: US Bureau of the Census; 1996:23-197.
2. Luepker RV, Apple FS, Christenson RH, et al. Case definitions for acute coronary heart disease in epidemiology and clinical research studies. *Circulation.* 2003;108:2543-2549.
3. Fleisher LA, Eagle KA. Lowering cardiac risk in noncardiac surgery. *N Engl J Med.* 2001;345:1677-1682.

4. Eagle KA, Berger PB, Calkins H, et al. ACC/AHA guideline update for perioperative cardiovascular evaluation for noncardiac surgery—executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1996 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). *J Am Coll Cardiol.* 2002:39:542-553.
5. Cohen PF. Silent myocardial ischemia. *Ann Intern Med.* 1988;109:312-319.
6. Lee TH. Reducing cardiac risk in noncardiac surgery. *N Engl J Med.* 1999;341:1838-1840.
7. The National Heart, Lung, and Blood Institute Coronary Artery Surgery Study. *Circulation.* 1981;63:1-8.
8. Welch CC. Proudfit WL, Sheldon WC. Coronary arteriographic findings in 1,000 women under age 50. *Am J Cardiol.* 1975;35:211-215.
9. Jha AK, Varosy PD, Kanaya AM, et al. Differences in medical care and disease outcomes among black and white women with heart disease. *Circulation.* 2003;108:1089-1094.
10. Goldman L. Multifactorial index of cardiac risk in noncardiac surgery: ten year status report. *J Cardiothorac Anesth.* 1987;1:237-244.
11. Nehler MR, Krupski WC. Cardiac complications and screening. In: Rutherford RB. *Vascular Surgery.* Philadelphia, PA: WB Saunders Co; 2000:626-646.
12. Mangano DT. Perioperative cardiac morbidity. *Anesthesiology.* 1990;72:153-157.
13. Goldman L. Adler J. General anesthesia and noncardiac surgery in patients with heart disease. In: Brunwald E, Zipes DP. *Heart Disease.* Philadelphia, PA: WB Saunders Co; 2001:2084-2097.
14. Katz RI, Barnhart JM, Ho G, et al. A survey on the intended purposes and perceived utility of preoperative cardiology consultations. *Anesth Analg.* 1998;3:682-687.
15. Kleinmann B, Czinn E, Shak K, Sobotka PA, Rao TK. The value of the anesthesia-surgical care team on the preoperative cardiac consultation. *J Cardiothor Anesth.* 1989;3:682-687.
16. Park KW. Preoperative cardiology consultation. *Anesthesiology.* 2003;138:754-762.
17. Katz MH. Multivariable analysis: a primer for readers of medical research. *Ann Intern Med.* 2003;138:644-650.
18. Butterworth J, Furberg CD. Improving cardiac outcomes after noncardiac surgery. *Anesth Analg.* 2003;97:613-615.
19. Stevens RD, Burri H, Tramer MR. Pharmacologic myocardial protection in patients undergoing noncardiac surgery: a quantitative systematic review. *Anesth Analg.* 2003;97:623-633.
20. Auerbach A, Goldman L. beta-Blockers and reduction of cardiac events in noncardiac surgery. *JAMA.* 2002;287:1435-1444.
21. Karp HR, Flanders WD, Shipp CC, Taylor B, Martin D. Carotid endarterectomies among Medicare beneficiaries: a statewide evaluation of appropriateness and outcome. *Stroke.* 1998;29:46-52.

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