Vascular surgery critical care: Perioperative cardiac optimization to improve survival

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Objective: **To review the literature on perioperative cardiac management of patients who are scheduled to undergo vascular surgery.**

Data Source: **MEDLINE- and PubMed-based review of literature published from 1965 to 2005.**

Conclusions: **Perioperative cardiac events (myocardial infarction, heart failure) remain the leading cause of morbidity and mortality in vascular surgery patients. Existing guidelines allow physicians to cost-effectively streamline preoperative cardiac risk assessment and stratification. Perioperative optimization of volume status and cardiac function and the routine use of perioperative beta-blockers can significantly improve outcomes after major vascular surgery. Perioperative addition of statins to beta-blockers in high-risk patients undergoing vascular surgery merits further evaluation. Preoperative coronary revascularization should be restricted to patients with unstable cardiac symptoms. (Crit Care Med 2006; 34[Suppl.]:S200–S207)**

Key Words: vascular surgery; perioperative myocardial infarction; perioperative cardiac risk; cardiac stress test; beta-blockers; statins; coronary revascularization

Vascular surgery patients present a formidable challenge to the practicing intensivist. These patients often are of advanced age and carry significant cardiac, respiratory, and renal co-morbidities. Major vascular surgical interventions also adversely affect their postoperative physiology and exacerbate preexisting conditions. These patients are hence considered high risk for any operative procedure. Therefore, a thorough preoperative risk assessment, optimal intraoperative management, careful postoperative monitoring, and early detection and management of complications are imperative to optimize patient outcomes. The cardiovascular management of these high-risk patients is of particular importance because perioperative cardiac events remain the leading contributor to postoperative morbidity and mortality. A large body of evidence now exists to guide the clinician in delivering optimal cardiac care. This article reviews the existing evidence and describes a practical approach to its application.

Among the different types of noncardiac surgery, peripheral vascular surgery likely has the highest cardiac morbidity and overall mortality. Coronary artery disease is present in 50–70% of patients undergoing vascular surgery (1, 2). The rate of perioperative myocardial infarction (MI) varies widely (4–34%) among patients undergoing vascular surgical procedures (3–5) and carries mortality rates as high as 25–40%. The economic burden associated with this complication is estimated to be $20 billion annually (4). The frequency and severity of these complications hence mandate detailed and comprehensive perioperative assessment and management.

Pathophysiology of Perioperative Cardiac Complications

A majority of perioperative MIs are asymptomatic and occur early in the postoperative period (6). Electrocardiography usually reveals a non–Q-wave MI pattern (6). Although the exact reasons are unclear, perioperative cardiac complications mainly result from prolonged (>20–30 mins) or recurrent (cumulative duration of ≥60 mins) periods of either absolute or relative myocardial ischemia (7, 8). Myocardial ischemia during the perioperative setting results either from increased myocardial oxygen demand, diminished supply, or both. Tachycardia of any cause (e.g., stress, anxiety, pain), uncontrolled hypertension, use of sympathomimetic agents (e.g., inotropes), and substance/drug withdrawal (e.g., alcohol, opiates, or beta-blockers) can all lead to increased myocardial oxygen demand. Decreased myocardial oxygen supply can result from systemic hypotension, severe hypoxia or anemia, coronary plaque rupture and hemorrhage, coronary vasospasm, surgery-induced procoagulant activity, or coronary thrombus formation.

Continuous electrocardiographic monitoring has demonstrated that postoperative cardiac events are often preceded by prolonged periods of new-onset ST depressions on the electrocardiogram (9–12). Similarly, multiple studies have also shown serum levels of cardiac troponin I to be elevated in patients with postoperative cardiac complications and have found it to be a very useful surveillance marker to detect and stratify postoperative MI after major vascular surgery (13, 14). Cardiac troponin I has also been found to be useful in predicting short-term mortality in vascular surgery patients (15).

Finally, pathologic analyses of coronary arteries of patients who died of postoperative MI after major vascular surgery demonstrate a high prevalence of unstable coronary arterial plaque on autopsy (16, 17). In addition, there is a high prevalence of transmural MI on histology, despite the preponderance of non–Q-wave MI seen clinically (16). Although not conclusive, collectively, these data support a role for myocardial ischemia in the pathophysiology of postoperative cardiac

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events. Hence, treatment strategies aimed at attenuating plaque rupture (e.g., statins) and restoring myocardial oxygen supply–demand balance (e.g., beta-blockers) may have a significant effect on reducing postoperative cardiac events in these high-risk patients.

Preoperative Cardiac Risk Assessment

Early preoperative risk assessment strategies used data derived from the routine history, physical examination, and electrocardiogram, either as individual risk factors or as a combined "risk index" (18–20). Of the clinical variables, history of recent MI and congestive heart failure seem to be the strongest predictors of postoperative cardiac complications. However, many studies have compared the various clinical risk assessment indices and have found them all to be insensitive (3, 21). Although some small studies demonstrate a positive relation between decreased preoperative left ventricular ejection fraction and postoperative cardiac events (22, 23), this finding has been shown to be very insensitive by larger studies and, hence, should not be used to predict risk of postoperative cardiac events (24). Subsequent risk assessment strategies have used specialized testing, including stress electrocardiography, echocardiography, and scintigraphy (25, 26). More recently, the American College of Cardiology (ACC) and the American Heart Association (AHA) have published comprehensive evidence-based guidelines for perioperative cardiovascular evaluation for noncardiac surgery (27, 28).

Preoperative Cardiac Testing: When and What Test(s) to Do?

The main purpose of performing preoperative cardiac risk assessment is to identify high-risk patients and determine which patients warrant further cardiac testing and treatment. Detailed cardiac assessment and treatment are not feasible in the emergent setting. However, in patients requiring elective vascular surgery, ACC/AHA guidelines propose a step-wise approach to cardiac testing (28). Patients who have had coronary revascularization within the previous 5 yrs or a favorable coronary evaluation (either noninvasive or invasive) within the previous 2 yrs, who report no interval change in the symptoms, do not require further cardiac testing. In the absence of these two criteria, factors such as co-morbidities and cardiac risk factors, functional status, and the risk of proposed surgery should all be integrated to risk stratify patients. Functional status of patients can be assessed using one of several validated activity scales (29, 30). Inability to perform activities requiring >4 metabolic equivalents without symptoms is categorized as poor functional status. All of the following are considered high-risk surgeries: any aortic or other vascular surgery, emergent major surgery in the elderly, and any surgery that leads to large volume shifts (major abdominal surgery). ACC/AHA guidelines recommend further cardiac testing in patients with: 1) at least one major clinical risk factor (unstable angina, decompensated heart failure, hemodynamically significant arrhythmias, or severe valvular heart disease), 2) an intermediate risk factor and high-risk surgery in the presence of moderate or poor functional capacity, and 3) minor or no clinical risk factors and high-risk surgery in patients with poor functional capacity. Several studies have demonstrated that the ACC/AHA guidelines are reasonably accurate in identifying high-risk patients and provide an excellent framework for cost-effective preoperative cardiac risk assessment and stratification (31–34).

When further testing is warranted, ACC/AHA guidelines recommend exercise electrocardiographic testing (treadmill) as the test of choice in ambulatory patients because this test is relatively safe, inexpensive, and can both provide an estimate of functional capacity and detect myocardial ischemia. However, ambulatory patients with significant abnormalities on their resting electrocardiogram (e.g., left bundle-branch block, left ventricular hypertrophy with "strain" pattern) may be best evaluated using exercise echocardiography or exercise myocardial perfusion imaging (28). Patients unable to perform adequate exercise can be evaluated with a nonexercise stress test such as dipyridamole myocardial perfusion imaging testing or dobutamine echocardiography. One meta-analysis compared dobutamine stress echocardiography, ambulatory electrocardiography, radionuclide ventriculography, and dipyridamole thallium scanning in predicting adverse cardiac outcome after vascular surgery and found all to have similar predictive value (35). Although dobutamine stress echocardiography seemed to be the best among these tests in this study, overlapping confidence intervals precluded definitive identification of the "optimal" test. A more recent meta-analysis again showed that dobutamine stress echocardiography had a trend toward higher positive predictive value in vascular surgery patients compared with other tests (36).

One could therefore argue that, in vascular surgery patients unable to perform exercise testing, dobutamine stress echocardiography is preferable because it has similar sensitivity, higher specificity, and slightly higher positive predictive value in comparison with the other tests and can provide additional information on ventricular and valvular function. However, because both dobutamine stress echocardiography and dipyridamole thallium imaging have poor positive predictive values (despite high negative predictive values), their value compared with conventional clinical variables (risk factors, functional status, and risk of surgery) to risk stratify patients has been debated (37, 38).

Preoperative Coronary Revascularization and Valvular Surgery

Practice patterns regarding preoperative coronary revascularization before vascular surgery are extremely variable (39). Conversely, untreated active coronary artery disease increases perioperative cardiac risk after vascular surgery. However, in some patients, the risk of coronary artery bypass surgery and the added risk of delaying the needed vascular surgery might outweigh the benefits of such an approach (40, 41). Therefore, most published guidelines recommend preoperative coronary revascularization only for high-risk patients with unstable cardiac symptoms (24, 28). Multiple studies have examined the effect of preoperative coronary revascularization (angioplasty or bypass surgery) on postoperative cardiac events after vascular surgery and have found conflicting results (42–46). These studies were all limited because they were small, nonrandomized, or lacked a control group.

A recent larger, multiple-center, randomized, controlled trial (the Coronary Artery Revascularization Prophylaxis or CARP Trial) evaluated the benefit of coronary revascularization before elective vascular surgery (47). Patients were eligible for the study if they were scheduled for an elective vascular operation for either an expanding abdominal aortic aneurysm or severe symptoms of arterial occlusive disease involving the lower limbs. Coronary angiography was recommended for eligible patients at increased risk for perioperative cardiac complications based on combined clinical risk factors and the presence of ischemia on a noninvasive stress imaging study. Patients were eligible for the study if one or more major coronary arteries had ≥70% stenosis on angiogram and were suitable for revascularization.

The investigators screened 5,859 patients and randomized 510 eligible patients to either coronary artery revascularization before surgery or no revascularization before surgery. Patients assigned to coronary artery revascularization received either percutaneous coronary intervention (59%) or bypass surgery (41%) at the discretion of the local investigator. The primary end point was long-term mortality and secondary end points included 30-day rates of MI, stroke, limb loss, and dialysis. The median time from randomization to vascular surgery was 54 days in the revascularization group and 18 days in the group not undergoing revascularization ($p < .001$). At 2.7 yrs after randomization, mortality was 22% in the revascularization group and 23% in the no-revascularization group (relative risk, 0.98; 95% confidence interval, 0.70–1.37; $p = .92$). Within 30 days after the vascular operation, a postoperative MI, defined by increased troponin levels, occurred in 12% of the revascularization group and 14% of the no-revascularization group ($p = .37$). No significant differences were found between the two groups with regard to the other secondary outcomes. This study provides strong evidence that prophylactic coronary revascularization before elective major vascular surgery in patients with stable coronary artery disease does not provide a survival benefit and does not reduce the risk of delayed MI as compared with optimal medical and preventive therapies.

There are very little data regarding the appropriateness of valvular repair or replacement before a vascular surgical procedure is undertaken. Common wisdom and clinical experience indicates that patients with valvular heart disease severe enough to warrant surgical treatment should have valve surgery before any elective noncardiac surgery.

Perioperative Hemodynamic Monitoring: The Pulmonary Artery Catheter Conundrum

Hemodynamic data obtained from pulmonary artery (PA) catheters have been widely used in critically ill patients, both diagnostically and to guide therapy. One large observational study concluded that PA catheter use was associated with an increased risk of mortality in a group of 5,735 mixed medical and surgical ICU patients (48). This finding has led to widespread controversy regarding the routine use of PA catheters. Therefore, the utility of a PA catheter in the perioperative setting must be balanced against the cost and risk of complications from insertion and use of the catheter.

Multiple small studies have prospectively evaluated the efficacy of preoperative PA catheter utilization in vascular surgery patients for optimization of hemodynamics, with cardiac complications as a major outcome, and have provided conflicting results (49–53). One meta-analysis combined the data from these small studies (four studies; n = 385) and concluded that in moderate-risk vascular surgery patients, routine preoperative PA catheterization is not associated with improved outcomes (54). Isaacson et al. (55) compared hemodynamic monitoring with a central venous catheter with management with a PA catheter in 102 patients undergoing abdominal aortic reconstructive surgery in a prospective randomized trial. They found no differences between the two groups with regard to mortality, morbidity (perioperative cardiac, pulmonary, or renal), duration of intensive care, postoperative hospital stay, or cost of hospitalization.

A recent large, randomized, controlled trial compared goal-directed therapy guided by a PA catheter with standard care without the use of a PA catheter in high-risk patients of ≥60 yrs of age, with American Society of Anesthesiologists (ASA) class III or IV risk, who were scheduled for urgent or elective major surgery (56). More than 50% of patients included in this study were scheduled to undergo major vascular surgery. The primary outcome was in-hospital mortality from any cause. A total of 7.7% of patients in the standard care group died in the hospital, as compared with 7.8% of patients in the PA catheter group. There was also a higher rate of pulmonary embolism in the catheter group than in the standard-care group (eight events vs. zero events, $p = .004$). Survival rates at 6 months were also not different between the groups (88.1% in the standard-care group vs. 87.4% in the PA catheter group).

Based on these studies, ACC/AHA guidelines do not support routine use of a PA catheter perioperatively. However, high-risk vascular surgery patients were excluded from most of these small studies, and PA catheters may be of some benefit in the high-risk group of patients (57). Second, the utility of the PA catheter presumably depends on how the data are interpreted and applied by caregivers. There is now good evidence that physicians' and nurses' understanding and interpretation of PA catheter data are variable and that erroneous determinations and decisions are often made (58–60). Given these caveats, based on current evidence, routine use of PA catheters in high-risk vascular surgery patients cannot be recommended. However, in very high-risk vascular surgery patients, risk of perioperative use of a PA catheter must be weighed against its benefit, and an individualized decision for each patient must be made.

Perioperative Use of Beta-Blockers

Beta-blockers have been clearly and consistently shown to reduce mortality after MI (61). Numerous studies have shown that perioperative beta-blocker use decreases the prevalence of postoperative myocardial ischemia after major noncardiac surgery, including vascular surgery (5, 62–66) (Table 1). However, only two of these studies have shown improvement in postoperative survival. The first of these evaluated the effect of beta-blockers on perioperative cardiac mortality after major noncardiac surgery (62). High-risk patients (n = 200, with more than two of the following five risk factors: age of >65 yrs, hypertension, diabetes mellitus, history of smoking, and total cholesterol of >240 mg/dL) were randomized to either atenolol or placebo. The first dose was administered 30 mins before surgery, and the drug was continued for 6 months after discharge. A total of 38% of patients in the atenolol group and 43% of patients in the placebo group underwent major vascular surgery. Overall mortality after discharge from the hospital was significantly lower among the atenolol-treated patients at 6 months (0% vs. 8%, $p < .001$), at 1 yr (3% vs. 14%, $p = .005$), and at 2 yrs (10% vs.

Table 1. Studies that demonstrated that β-blockers decreased perioperative cardiac risk

Study (Reference No.)	Patients (Study Drug)	Outcome Studied	Results
Mangano et al. (62)	200 high-risk patients undergoing noncardiac surgery (atenolol vs. placebo)	Postoperative mortality	Two-year postdischarge mortality significantly lower in the atenolol group compared with placebo (10% vs. 21%, $p = .019$)
Raby et al. (63)	26 high-risk vascular surgery patients (intravenous esmolol infusion vs. placebo)	Postoperative myocardial ischemia	Lower rate of persistent postoperative myocardial ischemia in the esmolol group compared with placebo (33% vs. 73%, $p < .05$)
Stone et al. (64)	128 patients with uncontrolled hypertension (single oral dose of labetalol, atenolol, or oxprenolol)	Intraoperative myocardial ischemia	2% rate of intraoperative myocardial ischemia in the treatment group vs. 28% in the control group ($p < .001$)
Urban et al. (65)	107 patients undergoing elective knee arthroplasty (esmolol infusion on the day of surgery and metoprolol for the next 48 hrs vs. placebo)	Postoperative myocardial ischemia	Postoperative myocardial ischemia less prevalent in the treatment group compared with the control group (0% vs. 7%, $p = .04$)
Torella et al. (66)	107 patients undergoing vascular surgery (atenolol vs. control)	Postoperative cardiac complications	One of 54 patients developed postoperative cardiac complications during beta-blocker therapy vs. 10 of 53 control group patients ($p = .01$)
Poldermans et al. (5)	112 high-risk patients undergoing vascular surgery (bisoprolol vs. placebo)	Death from cardiac causes or nonfatal MI	Lower rate of death from cardiac causes and nonfatal MI in the bisoprolol group compared with placebo (3.4% vs. 34%, $p < .001$)

MI, myocardial infarction.

21%, $p = .019$). Cardiac event–free survival throughout the 2-yr study period was 68% in the placebo group and 83% in the atenolol group ($p = .008$).

The second multiple-center, randomized, controlled trial evaluated the effect of bisoprolol on perioperative mortality and MI in high-risk patients undergoing vascular surgery (5). High-risk patients were identified by the presence of both clinical risk factors and positive results on dobutamine echocardiography. Eligible patients were then randomly assigned to receive standard perioperative care or standard care plus perioperative beta-blockade with bisoprolol. Study drug was initiated 1 wk before surgery and was continued for 1 month after surgery. The bisoprolol group had significantly lower 30-day rates of cardiac death (3.4% vs. 17%, $p = .02$) and nonfatal MI (0% vs. 17% in the placebo group, $p < .001$).

Subsequently, Boersma et al. (67) examined the relationship of clinical characteristics, dobutamine stress echocardiography results, beta-blocker therapy, and cardiac events in patients undergoing major vascular surgery. The majority of patients (83%) in this study were at low risk (fewer than three risk factors) for postoperative cardiac events based on revised cardiac risk index criteria (3). Despite this, the overall adjusted relative risk of postoperative cardiac events among all patients receiving beta-blockers was 0.3 (95% confidence interval, 0.1–0.7). This study also demonstrated that, in low-risk patients, dobutamine stress echocardiography was of little additional prognostic value compared with clinical criteria alone. However, in clinically intermediate- and high-risk patients receiving beta-blockers, dobutamine stress echocardiography had added value in identifying patients in whom surgery can still be performed and those for whom cardiac revascularization should be considered. It is important to note that discontinuing beta-blockers immediately after vascular surgery has been shown to increase postoperative cardiovascular morbidity and mortality (68).

Studies evaluating perioperative use of beta-blockers in unselected patients undergoing any noncardiac surgery have produced conflicting results. One recent systematic review included all randomized controlled trials that evaluated beta-blocker use in noncardiac surgery (69). Thirty-day perioperative outcomes, including total mortality, cardiac mortality, nonfatal MI, stroke, bradycardia requiring treatment, and hypotension requiring treatment, were evaluated. A total of 22 trials (n = 2,437) were included in the final analysis, and perioperative beta-blocker use was not associated with a beneficial effect on any outcome, except for the composite outcome of cardiovascular mortality, nonfatal MI, and nonfatal cardiac arrest (relative risk, 0.44; 95% confidence interval, 0.16–1.24). Patients treated with beta-blockers had higher rates of bradycardia requiring treatment. This study, however, evaluated a very heterogeneous group of patients, most of whom had low perioperative cardiac risk. Furthermore, beta-blockers have been shown to improve long-term survival rates, and 30-day event rates may not be truly reflective of the overall beneficial effects of beta-blockers in these patients.

A more recent large, multiple-center, retrospective cohort study of patients who underwent major noncardiac surgery and had no contraindications for beta-blocker therapy (n = 660,000) concluded that perioperative beta-blocker therapy was associated with a reduced risk of in-hospital death among high-risk patients (70). However, only 8% of the study patients underwent vascular surgical procedures. In summary, beta-blockers should be routinely used perioperatively in high-risk and possibly intermediate-risk vascular surgery patients to improve their survival. Beta-blockers should also be used in all patients scheduled to undergo vascular surgery who have inducible myocardial ischemia on noninvasive stress testing. However, in low-risk patients, safety concerns and cost should be balanced against the benefit of using beta-blockers in the perioperative period. Absolute contraindications of beta-blocker use include: high-degree conduction blocks, decompensated heart failure, acute bronchospasm, and severe vaso-occlusive disease with resting pain.

Beta-blockers likely exert their beneficial effect by multiple mechanisms. They reduce myocardial oxygen demand by decreasing heart rate, contractility, and afterload. Beta-blockers also exert anti-arrhythmic and anti-inflammatory effects, alter gene expression, and protect against apoptosis (71). The benefits seen with the use of perioperative beta-blockers seems to be a class effect because individual studies have shown similar results with different beta-blockers. However, all studies showing benefit of beta-blockade on mortality and myocardial ischemia have used beta$_1$-selective agents. Although the timing of initiation of beta-blockers has been debated, studies that have shown improvement in survival have generally achieved sympatholysis before induction of anesthesia in the operating room. Ideally, beta-blocker use should begin before surgery, with titration of the dose (for a resting heart rate of 60 beats/min or lowest heart rate tolerated) taking place as an outpatient procedure, and up to the induction of anesthesia. If the enteral route cannot be used, then beta-blockers should be administered intravenously during the immediate postoperative period. Therapy should then be continued at least through hospitalization and preferably for several months postoperatively and with appropriate follow-up.

Use of Statins to Improve Perioperative Outcome

Statins inhibit hydroxy-methylglutarate coenzyme A activity and decrease serum lipid levels. Statins also have been shown to decrease atherosclerosis and favorably alter vascular properties, independent of their serum lipid–lowering properties (72). Statins attenuate coronary artery inflammation, improve endothelial function, and stabilize atherosclerotic plaques (73). Statins have been shown to improve survival in patients with hypercholesterolemia and coronary artery disease (74), to decrease risk of stroke (75), and to lower limb claudication (76).

Table 2. Studies that demonstrated that statins decreased perioperative cardiac risk

Study (Reference No.)	Patients	Outcome Studied
Poldermans et al. (77)	2,816 patients who underwent major vascular surgery	Perioperative mortality
Durazzo et al. (78)	100 vascular surgery patients	Postoperative cardiac events (cardiac death, nonfatal MI, stroke, and unstable angina)
O'Neil-Callahan et al. (79)	997 vascular surgery patients	Perioperative cardiac complications (death, MI, ischemia, congestive heart failure, and ventricular tachyarrhythmias)
Kertai et al. (80)	570 patients undergoing elective abdominal aortic aneurysm surgery	Perioperative mortality and nonfatal MI

MI, myocardial infarction.

Several studies have evaluated the perioperative use of statins in vascular surgery patients (Table 2). Poldermans et al. (77) performed a case-controlled study of 2,816 patients and concluded that statin use reduces perioperative mortality in patients undergoing major vascular surgery (adjusted odds ratio, 0.22; 95% confidence interval, 0.10–0.47). In a subsequent randomized controlled trial, 100 patients were randomly assigned to receive 20 mg of atorvastatin or placebo once a day for 45 days, irrespective of their serum cholesterol concentration (78). Vascular surgery was performed, on average, 30 days after randomization, and patients were observed for 6 mos. Patients who received atorvastatin had a three-fold lower rate of cardiac events compared with the placebo group (8% vs. 26%, $p = .03$). Recently, a retrospective study also demonstrated that after adjusting for other significant predictors of perioperative complications, statins still conferred a highly significant protective effect (odds ratio, 0.52; 95% confidence interval, 0.35–0.77) (79). Finally, a combination of statin and beta-blocker use in patients with abdominal aortic aneurysm surgery has been shown to be associated with a reduced prevalence of perioperative mortality and nonfatal MI in high-risk patients (80).

Despite showing a consistent trend toward benefit, these studies do have important limitations. They are either retrospective or have studied small numbers of patients. It is also unclear if statins provide added benefit to beta-blockers in all vascular surgery patients. A large randomized trial comparing perioperative beta-blocker alone, vs. perioperative statin alone, vs. a combination of beta-blocker and statin in patients undergoing any noncardiac surgery is currently underway (81). Until these results are available, no definitive recommendations can be made. However, in patients scheduled for vascular surgery with history of coronary artery disease or at high risk for cardiac events, it may be prudent to add a statin to the perioperative medical regimen along with beta-blockers.

Other Agents

Several small studies have evaluated the roles of clonidine, nitroglycerin, and calcium channel blockers in the perioperative setting to improve survival and minimize cardiac events. Although clonidine provides safe sympatholysis during the perioperative period (82) and reduces postoperative myocardial ischemia, it has not been consistently shown to affect survival (83, 84). Studies have not found any reduction in perioperative cardiac events with use of prophylactic nitroglycerin (85) or diltiazem (86). Hence, these drugs cannot be recommended for routine use in vascular surgery patients to minimize perioperative cardiac risk.

Conclusions

Perioperative cardiac events contribute significantly to morbidity and mortality in patients undergoing vascular surgery. Although our understanding of the pathophysiology of these events is unclear, evidence exists that prolonged or recurrent myocardial ischemia is the predominant causative mechanism. Preoperative risk assessment and stratification using a step-wise approach coupled with optimal perioperative management should improve outcomes considerably and has the potential to reduce the economic burden associated with the excess morbidity and mortality. Noninvasive cardiac testing should be done only in selected patients based on their cardiac risk factors, functional status, and the risk of surgery. Beta-blockers should be routinely used perioperatively in all high- and intermediate-risk vascular surgery patients. When used, beta-blockers should be started before surgery and continued for several months after surgery for maximal benefit. Statin use may provide added benefit in high-risk patients scheduled to undergo vascular surgery. However, there is no role for routine coronary revascularization before elective vascular surgery. This procedure should be undertaken only in patients who have active or unstable coronary symptoms. Perioperative PA catheter use in vascular surgery patients remains controversial.

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