Are the current perioperative risk management strategies for myocardial infarction flawed?

Current Guideline-Based Preoperative Evaluation Provides the Best Management of Patients Undergoing Noncardiac Surgery

Gabriel Gregoratos, AB, MD

This report will review the 2007 revision of the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery, examine the rationale of the recommendations put forth, and attempt to clarify certain recommendations in the context of optimal patient care.

Response by Brett p 3144

The Problem

The volume of noncardiac surgery has progressively increased over the past 2 decades to levels exceeding prior predictions, with elderly patients undergoing at least 4 million major noncardiac operations annually. Given the high prevalence of coronary heart disease (CHD), it is not surprising that cardiac complications are a major cause of perioperative morbidity and mortality. Cardiac complications occur in 1% to 5% of unselected patients undergoing vascular surgery. Of the 27 million patients undergoing anesthesia annually, 50 000 suffer a perioperative myocardial infarction (MI). The recently published universal definition of MI has broadened the definition of MI and will likely result in a further increase of perioperatively diagnosed MIs and affect long-term management and prognosis. As a result, consultations for preoperative evaluation and assistance in perioperative management are frequently requested of cardiologists, internists, and generalists by surgeons and anesthesiologists. The guidelines emphasize that the consultant should not only offer opinions regarding the operative risk and advice on perioperative management but should use this opportunity to recommend treatments that will affect long-term patient outcomes.

This report will focus entirely on preoperative risk assessment and management of patients with known or potential CHD, the major cause of perioperative cardiac morbidity and mortality. Although valvular disease, cardiomyopathy, and other forms of heart disease contribute to surgical morbidity and mortality and warrant consideration in preoperative risk determination, they will not be addressed because of space constraints.

Preoperative Clinical Risk Assessment

Over the past 25 years, a number of risk indices have been developed for preoperative risk assessment of patients undergoing noncardiac surgery. In a prospective evaluation of these indices, Gilbert et al showed that each performed better than chance in predicting cardiac complications, but no
The intermediate risk predictors have been renamed the highest risk category have been renamed "active cardiac conditions." The intermediate risk predictors have been replaced by 5 of the 6 variables of the revised cardiac risk index "w 이후명" together vascular, intra-abdominal, and intrathoracic surgery as high risk, the guidelines appropriately assign the highest level of risk to elective vascular surgery, which has major implications for risk stratification and risk reduction therapies. The guidelines note that low-risk surgery and especially ambulatory surgery carry very low cardiac event risk even in high-risk patients who may therefore proceed to surgery with appropriate medical management and without further testing. However, the guidelines fail to mention that laparoscopic surgery has significantly lower perioperative mortality than similar "open" surgery and therefore may represent, along with other less invasive procedures, a potential alternative for high-risk patients.

The guidelines integrate in a stepwise fashion all the elements of the clinical preoperative assessment: type of surgery, presence/absence of active cardiac conditions (high-risk clinical predictors), the patient’s functional capacity, and the number of clinical risk variables from the revised cardiac risk index. This process is presented in a straightforward 5-step algorithm (Figure 1) that is a definite improvement over the 3-part, 8-step complex presentation of the same process in the 2002 version of the guidelines. After risk assessment, the algorithm provides recommendations for further testing, if it will change management, and treatment with β-blockers for selected groups of patients. This algorithm can be applied effectively to most patients and provides

### Table 1. Perioperative Risk Predictors

<table>
<thead>
<tr>
<th>I. Active cardiac conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute coronary syndromes</td>
</tr>
<tr>
<td>Decompensated heart failure</td>
</tr>
<tr>
<td>Significant arrhythmias</td>
</tr>
<tr>
<td>Severe valvular disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Clinical risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of ischemic heart disease</td>
</tr>
<tr>
<td>History of compensated or prior heart failure</td>
</tr>
<tr>
<td>History of cerebrovascular disease</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
</tr>
<tr>
<td>Renal insufficiency (serum creatinine &gt;2 mg/dL)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III. Minor risk predictors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt;70 years</td>
</tr>
<tr>
<td>Abnormal ECG</td>
</tr>
<tr>
<td>Rhythm other than sinus</td>
</tr>
<tr>
<td>Uncontrolled hypertension</td>
</tr>
</tbody>
</table>

Adapted from the guideline text.1

**Single index was superior. Most of these indices involve a scoring system that assigns different weights to different factors and sums the score to arrive at a composite risk, arguably an unwieldy process.**

In 1999, Lee at al1 reported that when the Goldman Index was modified, simplified, and prospectively validated, its predictive value was improved substantially. These investigators identified 6 independent variables for risk stratification of stable patients undergoing major elective noncardiac surgery. This revised cardiac risk index was validated by Boersma et al14 in their retrospective evaluation of >108,000 noncardiac surgical procedures and has become the preferred clinical tool for the preoperative risk assessment of patients before noncardiac surgery.

In the 2007 revision1 of the 2002 version of the guidelines,15 the major clinical risk factors that place the patient in the highest risk category have been renamed active cardiac conditions. The intermediate risk predictors have been replaced by 5 of the 6 variables of the revised cardiac risk index (type of surgery is addressed separately) and are now called clinical risk factors. The minor risk predictors that have not been shown to independently increase perioperative risk remain unchanged (Table 1).

In addition to these clinical variables, the guidelines emphasize that a patient’s exercise capacity is an important determinant of perioperative risk. Adequate exercise supports the view that good exercise capacity predicts both good perioperative and good long-term outcomes16,17 and that sedentary patients with additional risk factors are at increased risk and could benefit from more extensive evaluation preoperatively.18

The guidelines review in depth the evidence available regarding the high perioperative risk of cardiac complications of emergency3 and major vascular, abdominal, and thoracic surgery19 and the low risk of superficial and other ambulatory procedures.20 The various surgical procedures are stratified by risk category (Table 2). Although the revised cardiac risk index “lumps” together vascular, intra-abdominal, and intrathoracic surgery as high risk, the guidelines appropriately assign the highest level of risk to elective vascular surgery, which has major implications for risk stratification and risk reduction therapies. The guidelines note that low-risk surgery and especially ambulatory surgery carry very low cardiac event risk even in high-risk patients who may therefore proceed to surgery with appropriate medical management and without further testing. However, the guidelines fail to mention that laparoscopic surgery has significantly lower perioperative mortality than similar “open” surgery and therefore may represent, along with other less invasive procedures, a potential alternative for high-risk patients.

The guidelines integrate in a stepwise fashion all the elements of the clinical preoperative assessment: type of surgery, presence/absence of active cardiac conditions (high-risk clinical predictors), the patient’s functional capacity, and the number of clinical risk variables from the revised cardiac risk index. This process is presented in a straightforward 5-step algorithm (Figure 1) that is a definite improvement over the 3-part, 8-step complex presentation of the same process in the 2002 version of the guidelines. After risk assessment, the algorithm provides recommendations for further testing, if it will change management, and treatment with β-blockers for selected groups of patients. This algorithm can be applied effectively to most patients and provides

### Table 2. Cardiac Risk* of Noncardiac Surgical Procedures

<table>
<thead>
<tr>
<th>Risk Stratification</th>
<th>Procedure Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular (reported cardiac risk often &gt;5%)</td>
<td>Aortic and other major vascular surgery</td>
</tr>
<tr>
<td>Intermediate (reported cardiac risk generally 1% to 5%)</td>
<td>Intraperitoneal and intrathoracic surgery</td>
</tr>
<tr>
<td>Low† (reported cardiac risk generally &lt;1%)</td>
<td>Endoscopic procedures</td>
</tr>
</tbody>
</table>

*Combined incidence of cardiac death and nonfatal MI.†These procedures do not generally require further preoperative cardiac testing.
the clinician with a workable framework on how to proceed with patient evaluation.

**Preoperative Noninvasive Assessment**

**Left Ventricular Function**

Studies that examined the role of left ventricular (LV) function in relation to perioperative risk found that LV dysfunction had poor sensitivity and a low positive predictive value for perioperative cardiac events. In a meta-analysis of 8 studies, LV ejection fraction <35% under resting conditions had a sensitivity of 50% and specificity of 91% in predicting major perioperative cardiac events,21 mainly postoperative heart failure. Impaired LV function also did not reliably predict perioperative ischemic events. The current guidelines recommendations for perioperative assessment of LV function are set in class IIa (is reasonable) for patients with dyspnea of unknown origin and for patients with heart failure and worsening dyspnea. The class I recommendation of the 2002 version has been eliminated. The guidelines do not recommend routine preoperative evaluation of LV function.

**Assessment of Risk of CHD and the Presence of Ischemia**

The guidelines address the use of a preoperative resting 12-lead ECG. Because this test is nearly universally performed preoperatively, the 2 most important recommendations in the guidelines consider when a preoperative ECG may not be indicated. Thus, there is a class IIb recommendation (evidence not well established) for a preoperative ECG in patients with at least 1 clinical risk factor who are undergoing intermediate risk procedures. More to the point is a class III recommendation that preoperative and postoperative resting ECGs are not indicated in asymptomatic individuals undergoing low-risk surgery. These recommendations are based on studies that have shown resting ECG abnormalities not to be predictive of outcomes,22 especially in patients undergoing low-risk (for example, cataract) surgery.23

The use of preoperative noninvasive stress testing to detect myocardial ischemia, both exercise and pharmacological, with and without imaging is discussed extensively. The positive and negative predictive values of the various stress

---

Figure 1. Cardiac evaluation and care algorithm for noncardiac surgery based on active clinical conditions (high-risk indicators), known cardiovascular disease, or cardiac risk factors for patients aged ≥50 years. HR indicates heart rate; LOE, level of evidence; and MET, metabolic equivalent. Reproduced from Fleisher et al. *Circulation*. 2007;116:1971–1996, with permission from Lippincott Williams and Wilkins. Copyright 2007, American Heart Association.
Table 3. Recommendations for Noninvasive Stress Testing Before Noncardiac Surgery

Class I

Patients with active cardiac conditions* in whom noncardiac surgery is planned should be evaluated and treated in accordance with other relevant ACC/AHA guidelines before noncardiac surgery

Class IIa

Noninvasive stress testing of patients with ≥3 clinical risk factors* and poor functional capacity (<4 METs) who require vascular surgery is reasonable if it will change management

Class IIb

Noninvasive stress testing may be considered:

1. For patients with at least 1 or 2 clinical risk factors* and poor functional capacity (<4 METs) who require intermediate-risk noncardiac surgery if it will change management

2. For patients with at least 1 or 2 clinical risk factors* and good functional capacity who are to undergo vascular surgery

Class III

Noninvasive testing is not useful for patients undergoing low-risk noncardiac surgery and patients with no clinical risk factors undergoing intermediate-risk noncardiac surgery

MET indicates metabolic equivalent. Adapted from the guideline text.1

*See Table 1 for definition of active cardiac conditions and clinical risk factors.

Tests as reported in the literature are listed in 2 exhaustive tables contained in the guidelines, and the section ends with a discussion of which test is appropriate if a test is indeed indicated. The recent meta-analysis by Beattie et al24 of 25 echocardiographic and 15 nuclear perfusion pharmacological stress studies is reviewed in detail. In this meta-analysis, the likelihood of perioperative MI or death in patients with a positive stress echocardiogram was more than twice that of a positive stress nuclear perfusion study. The importance of exercise testing in preference to pharmacological stress (if the patient can exercise) is again emphasized because exercise stress testing can both provide an estimate of the patient’s functional capacity and detect myocardial ischemia.

The recommendations for preoperative stress testing (Table 3) have changed substantially in the 2007 revision of the guidelines in light of recent evidence that preoperative coronary revascularization may not decrease perioperative cardiac events (see revascularization section below) and that heart rate control with β-blockers provides significant perioperative protection in selected patients. However, these studies report the lack of revascularization benefit in patients who were extensively risk stratified noninvasively and invasively and were revascularized because of evidence of ischemia, but with no other indication. Therefore, these studies should not be interpreted a priori to preclude preoperative testing. The stipulation “if it will change management” that accompanies several of the guidelines recommendations takes into account not only the limited role of preoperative revascularization but also individual patient circumstances (patient unwilling or is a poor candidate for revascularization, for example). Integrating these recommendations with the clinical evaluation algorithm (Figure 1) suggests to the author that the following patient groups may benefit from preoperative stress testing:

1. Patients with symptomatic CHD who require vascular or intermediate-risk surgery. Many of these patients will have required stress testing under circumstances other than preoperative assessment.

2. Asymptomatic patients with known CHD and poor functional capacity or diabetes mellitus who require vascular or intermediate-risk surgery because clinical assessment alone cannot provide adequate risk prediction.

3. Patients with poor or unknown functional capacity and ≥3 clinical risk factors who require vascular surgery. Many of these patients will have significant unsuspected CHD and may be candidates for revascularization irrespective of preoperative status.

4. Most patients with 1 or 2 clinical risk factors and either poor functional capacity undergoing intermediate-risk surgery or good functional capacity undergoing vascular surgery are unlikely to require or benefit from preoperative revascularization. Preoperative stress testing for these patients may be considered only if unusual individual circumstances exist.

5. Most patients with known or suspected CHD who are clearly not candidates for revascularization will also not benefit from preoperative stress testing. However, in some such patients, preoperative testing may help the clinician to better define the extent of myocardial ischemia and arrive at a decision to proceed with or cancel elective surgery or substitute a procedure of lesser magnitude (eg, endoscopic repair of an abdominal aortic aneurysm).

Implementations of the current recommendations will likely result in a significant reduction of preoperative testing, result in a significant reduction of costs,25 and reduce delays in the performance of elective surgery by eliminating fruitless testing.26

Risk Reduction Strategies

Preoperative Coronary Revascularization

The role of preoperative coronary revascularization to reduce the risk of perioperative cardiac morbidity and mortality has been controversial since the advent of revascularization surgery.27 In part this is due to the finding that the pathophysiology of a perioperative MI is different than that of a nonoperative MI. Pathological studies have shown that the majority of nonoperative MIs are due to plaque rupture and coronary thrombosis, whereas this mechanism is responsible for only approximately half of the perioperative MIs, with the remaining half resulting from a prolonged imbalance between myocardial oxygen supply and demand generated by the stresses of surgery in the setting of obstructive coronary artery disease.28,29 Clinical studies have reported that perioperative MIs are commonly associated with ST depression,
whereas ST elevation and development of Q waves are uncommon. In a small angiographic study, most perioperative MIs were found to be due to inadequate collateralization of previously totally occluded coronaries, with a smaller number occurring without significant coronary obstruction. Contributing to the uncertainty regarding the usefulness of preoperative revascularization has been the absence, until recently, of evidence based on prospective randomized outcome studies and reliance mainly on retrospective observational cohort studies.

The recent publication of 3 prospective randomized trials has helped to dispel some of this uncertainty as all 3 suggest that in many (but not all) instances coronary revascularization preoperatively does not significantly improve perioperative and long-term outcomes. All 3 trials have significant limitations: In the Coronary Artery Revascularization Before Elective Major Vascular Surgery (CARP) trial, patients with a ≤50% stenosis of the left main coronary artery, those with an LV ejection fraction <20%, and those with severe aortic stenosis were excluded from randomization, and the study was underpowered to detect outcome differences in high-risk subgroups. The Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography (DECREASE)-II study was designed to evaluate the utility of preoperative testing and adequate β-blockade in intermediate-risk patients undergoing vascular surgery. Although the authors concluded that 30-day and long-term cardiac events in these patients were sufficiently low to make preoperative testing unnecessary, the effect of coronary revascularization in the subgroup of patients with extensive stress-induced ischemia could not be assessed because of the small number of such patients. The DECREASE-V pilot study also was not adequately powered to definitively assess the value of preoperative revascularization in high-risk patients, but the results are consistent with those of the other 2 trials suggesting a lack of benefit. It must also be noted that in all 3 trials, the type of revascularization was left to the discretion of the primary physician and was a mix of coronary artery bypass graft (CABG) surgery and percutaneous coronary intervention (PCI). These limitations must be taken into account when the guidelines recommendations are interpreted. For example, the CARP results do not apply to patients similar to those excluded from the trial who may well have benefited from revascularization.

The guidelines recommendations on preoperative revascularization, as shown in Table 4, should be read in conjunction with the extensive narrative portion of this section. Although prophylactic revascularization in patients with stable CHD simply to lower the risk of surgery is explicitly discouraged, there are specific clinical and anatomic patient subsets that may derive long-term survival benefit from revascularization irrespective of their preoperative status. These are the patients listed under class I recommendations. Patients with coexistent severe aortic stenosis and CHD should be considered individually and in accordance with the ACC/AHA valvular disease guidelines. Many of these patients will benefit from preoperative valve surgery and coronary revascularization. Notwithstanding the results of the DECREASE-V trial, selected high-risk patients with extensive myocardial ischemia on preoperative stress testing who are to undergo high-risk surgery may benefit from revascularization even if stable. There is convincing evidence from cohort studies that the risk of perioperative cardiac events increases as the extent of myocardial ischemia increases.

The guidelines address at length the relative merits of CABG compared with PCI in selected patients. No recommendation is made regarding the timing of noncardiac surgery after CABG, but the guidelines authors refer to the DECREASE-V study in which vascular surgery took place at a median of 29 days after CABG.

For patients who undergo preoperative PCI, the choice of bare metal stents, drug-eluting stents, or balloon angioplasty

<table>
<thead>
<tr>
<th>Table 4. Recommendations for Preoperative Coronary Revascularization With CABG or PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I (consistent with the 2004 ACC/AHA guidelines for CABG surgery)</td>
</tr>
<tr>
<td>Coronary revascularization is useful/recommended in patients with:</td>
</tr>
<tr>
<td>1. Stable angina and significant left main disease</td>
</tr>
<tr>
<td>2. Stable angina and 3-vessel disease, especially when LV ejection fraction &lt;50%</td>
</tr>
<tr>
<td>3. Stable angina and 2-vessel disease with significant proximal left anterior descending coronary artery stenosis and either LV ejection fraction &lt;50% or demonstrable ischemia on noninvasive testing</td>
</tr>
<tr>
<td>4. High-risk unstable angina or non-STEMI</td>
</tr>
<tr>
<td>5. Acute STEMI</td>
</tr>
</tbody>
</table>

Class IIa

1. In symptomatic patients in whom PCI in appropriate and who need elective surgery in the next 12 months, balloon angioplasty or bare-metal stent placement followed by 4- to 6-week dual antiplatelet therapy is probably indicated |
2. In patients who have received drug-eluting stent and must undergo urgent surgery that requires discontinuation of thienopyridine therapy, it is reasonable to continue aspirin if at all possible and restart the thienopyridine as soon as possible |

Class IIb

1. The usefulness of preoperative coronary revascularization is not well established in high-risk and low-risk ischemic patients with an abnormal dobutamine stress echocardiogram |

Class III

1. Prophylactic routine revascularization before noncardiac surgery is not recommended for patients with stable CHD |
2. Elective noncardiac surgery is not recommended within 4 to 6 weeks of bare-metal stent or with 12 months of drug-eluting stent implantation in patients in whom antiplatelet therapy will need to be discontinued perioperatively |
3. Elective noncardiac surgery is not recommended within 4 weeks of revascularization with balloon angioplasty |

STEMI indicates ST-segment elevation MI. Adapted from the guideline text.
depends on the timing and the risk of bleeding of the planned noncardiac surgery. The risks of perioperative antiplatelet therapy interruption are reviewed in detail and integrated into a simple decision-making algorithm (Figure 2) that includes specific recommendations regarding the desirable interval between PCI and noncardiac surgery. The guidelines caution against premature discontinuation of antiplatelet therapy and list the specific recommendations of the recent Science Advisory.44

The perioperative management of patients who have undergone a prior PCI is dealt with separately and also in accordance with the Science Advisory44 and the 2005 ACC/AHA/Society for Cardiovascular Angiography and Interventions PCI guidelines.45 The proposed management of such patients is based solely on expert consensus because of lack of high-quality evidence and is summarized in an algorithm (Figure 3) that lists specific time intervals between PCI and noncardiac surgery and antiplatelet therapy recommended depending on the type of prior intervention.

**Perioperative β-Blocker Therapy**

Many of the early studies on the role of β-blockers in reducing perioperative cardiac events were not randomized; only recently have several randomized prospective studies been reported.46–52 Despite the limitations of the available data and the conflicting conclusions of some studies47,48 and meta-analyses,53 the guidelines authors opine that the weight of evidence favors the use of perioperative β-blockers in reducing perioperative ischemia and possibly MI and death, especially in high-risk patients undergoing vascular and other high-risk surgery. No recommendations are made regarding the relative benefit of different β-blocker agents, dose and appropriate duration of preoperative treatment, and route of administration because there are no robust data. Nevertheless, the guidelines suggest that longer-acting β-blockers may be more efficacious than shorter-acting ones and that it is important to control the resting heart rate between 60 and 65 bpm, initiate β-blockers days to weeks before elective surgery, and continue β-blocker administration during the intra- and perioperative periods. The large cohort study by Lindenauer et al.54 which suggests that β-blocker benefit is confined to the highest-risk patients and that low-risk patients may actually be harmed by perioperative β-blockade, is reviewed in detail.

The 2007 recommendations on perioperative β-blockade (Table 5) further refine the recommendations of a 2006 update55 of the 2002 version. In a footnote, caution is advised in prescribing β-blockers de novo to patients with decompen- sated heart failure, nonischemic cardiomyopathy, or severe valvular disease who are scheduled for noncardiac surgery. Given the conflicting trial results and the uncertainty regarding potential harm from the perioperative use of β-blockers in low-risk patients and the preliminary results of the Peri Operative ISchemic Evaluation (POISE) trial (see below), the prudent physician should most likely prescribe β-blockers perioperatively only to patients described in the class I and IIa
recommendations and use long-acting agents that are started days to weeks before the planned surgery.

The POISE Trial
The recently published POISE trial has raised new questions regarding perioperative β-blockade therapy and may lead to further modification of the guideline recommendations. In this large multicenter, randomized, double-blind trial, 4174 patients were randomized to extended-release metoprolol and 4177 to placebo. At study entry, 43% of patients had CHD, 41% had peripheral arterial disease, and 15% had a prior stroke. Type of surgery performed was vascular in 42% of patients, intraperitoneal in 22%, orthopedic in 21%, and other types in 15%. The primary composite end point of cardiovascular death, MI, or cardiac arrest was reduced in the metoprolol group compared with placebo (5.8% versus 6.9%; hazard ratio [HR] 0.83; 95% CI, 0.70 to 0.99; P=0.04), driven primarily by reduction in nonfatal MI (3.6% versus 5.1%; hazard ratio HR = 0.83; 95% CI, 0.70 to 0.99; P = 0.04), driven primarily by reduction in nonfatal MI (3.6% versus 5.1%; HR = 0.70; P = 0.0007). There were also significant reductions of revascularizations and episodes of atrial fibrillation in the metoprolol group. However, total mortality was paradoxically increased in the metoprolol group (3.1% versus 2.3%; HR = 1.33; P = 0.03), as was stroke (1% versus 0.5%; HR = 2.17; P = 0.005). Significant bradycardia and hypotension were also noted in the metoprolol group.

The potential impact of the POISE results on perioperative β-blocker use must await the careful analysis of the full trial results. Several issues have been raised. The dose of metoprolol may have been excessive, particularly for patients with prior documented cerebrovascular disease. Although dose equivalency of β-blockers is inexact, the Food and Drug Administration Center for Drug Evaluation and Research Database suggests that metoprolol is 20 times less potent than bisoprolol and has half the potency of atenolol. Thus, the initial 100-mg dose of metoprolol used in POISE had double the adrenergic blocking potency of 2.5 mg oral bisoprolol used as the initial dose in other studies and 2.5 times the potency of 10-mg intravenous atenolol used in another study. The dose of metoprolol was not titrated. The initial dose of 100 mg was given 2 to 4 hours preoperatively, with a second 100-mg dose administered within 6 hours postoperatively but withheld for a systolic blood pressure <100 mm Hg. An additional 200-mg dose was administered 12 hours later, bringing to 400 mg the total amount of metoprolol in the first 24 hours, at least for some patients. This is indeed an aggressive acute treatment regimen, particularly for elderly patients and those with preexisting cerebrovascular disease. It will be relevant to know whether the majority of episodes of bradycardia, hypotension, and strokes occurred during the initial 24-hour perioperative period when patients were more likely to experience postoperative bleeding and hypotension. The third issue is the timing of the preoperative β-blocker therapy; at least 1 study...
**Table 5. Recommendations for Perioperative β-Blockade Therapy**

| Class I | 1. β-Blockade should be continued in patients who are receiving β-blockers to treat angina, symptomatic arrhythmias, hypertension, or other standard indications.
| Class IIa | 2. β-Blockers should be given to patients undergoing vascular surgery who are at high cardiac risk due to the finding of ischemia on preoperative testing.
| Class IIa | 1. β-Blockers are probably recommended for patients undergoing vascular surgery or intermediate-risk surgery in whom preoperative assessment identifies CHD or high-cardiac risk, as defined by the presence of >1 clinical risk factor.
| Class IIb | 2. The usefulness of β-blockade is uncertain for patients undergoing vascular or intermediate-risk surgery, in whom preoperative assessment identifies the presence of a single clinical risk factor.
| Class III | 1. β-Blockers should not be given to patients undergoing surgery who have absolute contraindications to β-blockade.

Adapted from the guideline text.  
*See Table 1 for definitions.*

suggests that acute administration is not effective in decreasing perioperative cardiac complications. The choice of β-blockers has also been questioned; is metoprolol as effective as bisoprolol or atenolol? In a review of this topic, Redelmeier et al. suggest that metoprolol is inferior to atenolol in the perioperative setting. Finally, we await a detailed analysis of the patient population in POISE. It will be particularly important to know the proportion of patients undergoing urgent or emergent surgery and the risk level of included patients. If it is assumed that the metoprolol and placebo groups were well matched for risk of perioperative events, subgroup analysis of POISE may help to better define who benefits and who does not from perioperative β-blockers. Until these issues are resolved, the message from POISE is that routine administration of β-blockers preoperatively is not advisable, which is exactly the message of the guidelines.

**Statin Therapy**

In addition to their lipid-lowering activity, statins improve endothelial function, stabilize atherosclerotic plaques, and reduce vascular inflammation and by these mechanisms may reduce perioperative events. The guidelines review in detail whether statin therapy reduces perioperative cardiac complications. The available evidence is primarily based on observational cohort studies and 1 small randomized trial. Acknowledging that the appropriate timing of initiation and duration of therapy, optimal dose, and targets for low-density lipoprotein cholesterol levels are all unknown, the guidelines provide only 1 class I recommendation to continue statins perioperatively in those already on this therapy. A class IIa recommendation states that it is reasonable to prescribe a statin to patients undergoing vascular surgery whether or not they have other risk factors, presumably because such patients have atherosclerotic vascular disease, and 1 class IIb recommendation suggests that statin therapy may be considered for patients with 1 or more clinical risk factors undergoing intermediate risk procedures.

**Other Medical Therapies**

The role of α-2 agonists is also examined in some detail, and the results of several small randomized trials and 1 meta-analysis of 23 studies are summarized. Despite the generally convincing evidence that α-2 agonists reduce perioperative cardiac events and 1 recent study that showed that they reduce long-term cardiovascular mortality, the guidelines include a single IIb recommendation that α-2 agonists may be considered for perioperative control of hypertension in patients with CHD or at least 1 clinical risk factor. This recommendation seems rather limited in view of the summarized evidence but is probably appropriate given the side effects of these agents.

The continuation of aspirin therapy perioperatively is dealt with only in the context of preoperative revascularization with PCI or CABG and not in the section dealing with medical therapies. The lack of specific reference to aspirin therapy in other settings and the lack of recommendations regarding its uninterrupted administration, if possible, in specific patient groups are unfortunate omissions.

The role of perioperative calcium channel blocker therapy is addressed briefly, and in the absence of convincing data, no specific recommendations are made. A class IIb recommendation (usefulness unclear) for intraoperative nitroglycerin to prevent myocardial ischemia comes with a major caveat regarding the possibility that nitroglycerin may aggravate the vasodilatory actions of anesthetic agents.

**Intraoperative and Postoperative Monitoring**

The guidelines also tackle the use of preoperative intensive care monitoring of high-risk patients, the role of intraoperative transesophageal echocardiography, the utility of intraaortic balloon counterpulsation, the importance of blood glucose control perioperatively, the use of pulmonary arterial catheters for hemodynamic monitoring, and the use of intraoperative and postoperative ST-segment monitoring for detection of ischemia. The issue of patient surveillance for a perioperative MI is reviewed in detail. An important class IIb recommendation states that the use of postoperative troponin measurements in clinically stable patients after vascular or intermediate-risk surgery is not well established. This recommendation should discourage the routine monitoring of biomarkers, such as troponin, in stable asymptomatic patients who have undergone high-risk surgery. Such practices frequently initiate an unfortunate cascade of iatrogenic events and contribute to cost escalation.
Conclusions
The ACC/AHA 2007 perioperative guidelines have compiled the available evidence relating to perioperative cardiac complications, analyzed it critically, and developed reasonable recommendations that are based on the evidence and supported by clinical consensus. Compared with the 2002 version, the most significant change in recommendations is that preoperative stress testing and coronary revascularization strictly for the purpose of reducing the perioperative risk of cardiac complications have a limited role and should be applied as clinically indicated irrespective of the patient’s preoperative status. Despite some ambiguities, the guidelines can serve as a useful framework for clinicians engaged in preoperative risk assessment and perioperative management of patients with cardiac disease. Practitioners who provide preoperative consultations should be fully conversant with these guidelines and apply them judiciously and in accordance with each patient’s particular circumstances. By so doing, they will indeed be able to provide optimal perioperative care to their patients.

Acknowledgments
The author thanks Elyse Foster, MD, for editorial assistance and Erin McGann, BA, for expert assistance in preparation of this manuscript.

Disclosures
None.

References

Response to Gregoratos
Allan S. Brett, MD

Dr Gregoratos presents a comprehensive analysis of the ACC/AHA guideline on perioperative cardiovascular evaluation. For the most part, he provides a balanced overview of the strengths and limitations of the evidence relevant to the guideline. Nevertheless, he appears to endorse certain decision-making criteria that lack evidence or remain ambiguous. For example, he states "...ample evidence supports the view that...sedentary patients with additional risk factors...could benefit from more extensive evaluation preoperatively." However, his sole reference is a 1991 review article (Reference 18), not empirical research showing that preoperative testing is beneficial in such patients. He also applauds the guideline’s directive to consider testing “if it will change management.” To be sure, ordering tests only when they will plausibly change management is an essential element of good medical practice. However, “changing management” is a necessary, but not sufficient, condition: It must be coupled with evidence that the resulting interventions will improve clinical outcomes. For better or worse, clinicians use guidelines and algorithms as action-guiding shortcuts when they cannot be experts in everything. Clinical guidelines should direct us to interventions from which benefits clearly outweigh harms. Most of the evidence that has accumulated between 2002 and 2007 suggests that stress testing, coronary revascularization, and preoperative initiation of β-blockers do not improve perioperative outcomes in patients undergoing noncardiac surgery. Although the 2007 version of the ACC/AHA guideline unquestionably moves in the direction of fewer preoperative interventions, it remains trapped in the outdated algorithmic structure of previous versions. Perhaps it is time to abandon that structure.
Current Guideline-Based Preoperative Evaluation Provides the Best Management of Patients Undergoing Noncardiac Surgery
Gabriel Gregoratos

Circulation. 2008;117:3134-3144
doi: 10.1161/CIRCULATIONAHA.107.761759
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2008 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/117/24/3134

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org/subscriptions/