

Update in preoperative cardiovascular evaluation and perioperative cardiovascular medical management

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Introduction

Major adverse cardiac events (MACE) are among the most common causes of perioperative mortality and morbidity. As such, the most recent key updates in perioperative medicine are related to perioperative cardiovascular risk assessment and management. The “2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery” provides expert consensus on these topics. This guideline includes new definitions of operative urgency and risk, as well as more direction regarding perioperative cardiovascular testing and medical management. Patient-specific plus procedure-specific risk factors are crucial to determine an individual’s perioperative risk profile. Clinical judgement remains a core

principle. Close communication among care teams also is essential [1].

Preoperative cardiovascular risk stratification

The first step of preoperative cardiovascular evaluation is to determine the urgency of the proposed non-cardiac procedure [1]. An emergency procedure is needed in less than six hours, to mitigate threat to life or to limb; in this situation, very limited preoperative evaluation is necessary. An urgent procedure is needed within 6-24 hours, to mitigate threat to life or limb; some preoperative cardiovascular evaluation may be feasible, if warranted. A time-sensitive procedure is necessary within 1-6 weeks; more preoperative testing may be feasible, if indicated; further delay for evaluation and significant changes in management will negatively affect outcome. An elective procedure may be delayed up to one year; this allows greatest time for preoperative evaluation and intervention, if needed [1].

From a cardiovascular perspective, procedures may be categorized as low procedure-specific risk or elevated procedure-specific risk [1]. Low cardiovascular risk procedures are those which confer less than 1% risk of major adverse cardiac event (MACE). Common examples include endoscopic procedures, superficial procedures, cataract surgery, most breast surgery, and ambulatory surgery. Key examples of elevated cardiovascular risk procedures (risk of MACE greater than 1%) include emergent major operations, particularly in elderly patients;

aortic and other major vascular surgery; prolonged procedures with large fluid shifts and/or blood loss; head and neck surgery; intraperitoneal and intrathoracic surgery; major orthopedic surgery; and open urologic surgery [1].

The risk of perioperative major adverse cardiac event (MACE) may be estimated by compilation of patient-specific and procedure-specific risk factors through the Revised Cardiac Risk Index (RCRI) score, National Surgical Quality Improvement Program (NSQIP) score, or other similar scoring method [1-3]. A patient is deemed of low perioperative cardiovascular risk if the risk of perioperative major adverse cardiovascular event (MACE) is less than 1%. A patient is of elevated perioperative cardiovascular risk if the risk of perioperative major adverse cardiovascular event (MACE) is greater than 1%. The combination of urgency of procedure, patient-specific risk, and procedure-specific risk is used to determine need for preoperative cardiovascular testing and perioperative cardiovascular medical management [1].

Preoperative cardiovascular testing

A screening preoperative electrocardiogram (ECG) is indicated in the setting of one or more patient-specific perioperative risk factors *plus* an elevated-risk procedure. A screening preoperative ECG is not clearly warranted in a stable patient undergoing a low-risk procedure, even in a patient with known cardiovascular disease or multiple cardiovascular risk factors. Age alone is not a well proven independent indication for preoperative ECG [1].

For non-cardiac surgery, routine screening with noninvasive cardiovascular testing is not useful for patients at low cardiovascular risk. If a patient has a functional capacity greater than 10 METs, even with known cardiovascular disease, then additional screening preoperative cardiac testing is not indicated [1].

Resting echocardiography is indicated or reasonable if clinically-suspected moderate or greater cardiac valvular disease (particularly if no echocardiography within one year, or if significant change in clinical status or physical exam); in adults who meet standard indications for cardiac valvular intervention (replacement or repair), on basis of symptoms and severity of valvular stenosis or regurgitation; if dyspnea of unknown origin; or

if heart failure with worsening dyspnea or other decline in clinical status. Resting echocardiography may be considered in a clinically stable patient with history of LV dysfunction, if no such assessment within one year; however, this recommendation is weaker, and is most applicable if results will affect management [1].

Preoperative cardiac stress testing is indicated if perioperative MACE risk is greater than 1% and results will affect management. This is particularly true in the setting of poor functional capacity (less than four METs) or unknown functional capacity, plus an elevated-risk procedure. If a cardiac stress test is warranted even in the absence of non-cardiac surgery, then it should be obtained prior to non-emergency noncardiac surgery [1].

Exercise ability, comorbidities, baseline ECG, and institutional expertise influence the choice of a cardiac stress study. Cardiac stress test selection entails selection of a cardiac physiologic stress modality, plus selection of a cardiac functional assessment modality [1, 4-6]. These are summarized further as follows:

Common cardiac physiologic stress modalities

Exercise [4- 6]

Exercise should be utilized in cardiac stress testing, when possible. Poor exercise capacity or inability to achieve >85% predicted maximal heart rate is associated with 24% risk of postoperative cardiac event, independent of ischemic ECG changes. However, exercise may not be feasible in the context of orthopedic limitation, neurologic deficit, poor pulmonary function, severe to critical vascular disease, and/or other exercise limitations.

Adenosine, regadenoson, and dipyridamole [4- 6]

These are vasodilators that cause a coronary "steal" phenomenon. They may be options for physiologic cardiac stress in some patients with exercise limitations. Major adverse effects of these agents include hypotension, atrioventricular block, and bronchospasm. Adenosine, regadenoson, and dipyridamole should be avoided in patients with low systemic blood pressure, high-grade A-V block, known poor cardiac reserve, severe to critical cerebrovascular disease, or substantial bronchospastic disease. Theophylline and caffeine also decrease the effectiveness of the vasodilators.

Dobutamine [4-6]

Dobutamine is an adrenergic agent. It may be an option for physiologic cardiac stress in some patients with exercise limitations. Major adverse effects of dobutamine include cardiac dysrhythmias and severe hypertension. Dobutamine should be avoided in patients with baseline significant dysrhythmias or poorly-controlled systemic hypertension. Theophylline and caffeine do not impede the efficacy of dobutamine.

Cardiac functional assessment modalities

Stress ECG alone [1, 4-6]

Stress ECG alone confers high sensitivity and moderate specificity for risk of perioperative major adverse cardiovascular event (MACE). It is widely available, does not involve ionizing radiation, and is relatively inexpensive. Stress ECG may be non-diagnostic if certain baseline ECG abnormalities are present (including left bundle branch block, electronic ventricular pacing, left ventricular hypertrophy with repolarization abnormalities, ventricular preexcitation, baseline ST depression greater than 1 mm, digoxin effect, prior myocardial infarction, percutaneous coronary intervention, and coronary artery bypass surgery). Stress ECG, without cardiac imaging, is a reasonable option for preoperative cardiac stress testing, when feasible, based upon balance of these considerations.

Stress echocardiography [1, 4-8]

Stress echocardiography (with exercise or pharmacologic stress) is highly sensitive and specific for detection of myocardial ischemia or infarction. Image quality can be impaired by obesity or "barrel chest;" this limitation may be overcome in some patients by the use of saline contrast. Baseline cardiac regional wall motion abnormality or left bundle branch block can lead to falsely-positive stress echocardiography results. Stress echocardiography is relatively widely available and entails no ionizing radiation exposure, but is moderately costly.

SPECT myocardial perfusion imaging (technetium or thallium) [1, 4-7]

Single-photon emission computed tomography (SPECT) myocardial perfusion imaging (technetium or thallium) confers high sensitivity and specificity for detection of myocardial ischemia or infarction. The specificity of SPECT is slightly less than that of stress echocardiography. Image quality of SPECT myocardial perfusion imaging can be impaired by

obesity, "barrel chest," or breast artifact (especially with thallium imaging). SPECT myocardial perfusion imaging is relatively widely available, does entail ionizing radiation exposure, and is costly. It is preferred over stress echocardiography in patients with known regional wall motion abnormalities.

Cardiac PET imaging [5, 6]

Cardiac positron emission tomography (PET) imaging is useful to assess cardiac perfusion in patients with severe obesity. It is not widely available, entails ionizing radiation exposure, and is very costly.

Perioperative antiplatelet therapy

As with other aspects of perioperative medicine, decisions regarding perioperative management of antiplatelet therapy entail consideration of patient-specific and procedure-specific risk factors [1]. In the POISE-2 Trial, Devereaux et al., identified increased perioperative bleeding within 30 days, among patients undergoing noncardiac surgery who received perioperative aspirin (4.6% aspirin vs. 3.8% placebo), with no significant difference in risks of myocardial infarction or mortality. However, in that study, only 23% of patients had known coronary artery disease; patients with recent coronary intervention (defined as PCI with bare metal stent placement within six weeks, PCI with drug eluting stent placement within 12 months) were excluded. Aspirin vs. non-aspirin patients had no significant difference in life-threatening bleeding [9].

Other outcomes have been noted in surgical patients who are at increased cardiovascular risk. In a 2006 meta-analysis by Biondi-Zoccai et al., involving 50,279 surgical patients at elevated cardiovascular risk, perioperative discontinuation of aspirin was associated with three-fold increased risk of major adverse cardiac events (MACE) [10]. In a 2005 meta-analysis by Burger et al, including 41 studies, secondary-prevention aspirin was associated with a 1.5-fold increased risk of perioperative bleeding, but perioperative discontinuation of aspirin preceded 10% of all acute coronary events; there was no significant difference noted in the severity of bleeding between aspirin and non-aspirin patients, except in the context of intracranial surgery and possibly in the context of transurethral resection of the prostate. Burger et al., concluded that aspirin should not be discontinued perioperatively, unless the risk of major perioperative bleeding exceeds the risk of cardiovascular events [11].

Much attention has been devoted to antiplatelet therapy following percutaneous coronary intervention (PCI), including in the context of noncardiac surgery. According to the “2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery,” dual antiplatelet therapy should be maintained at least 14 days after PCI without stent placement, 30 days after PCI with bare metal stent placement, and 365 days after PCI with drug-eluting stent placement. Elective surgery should be delayed beyond those periods. Elective noncardiac surgery may be considered more than 180 days after DES placement, if the risk of further delay of surgery is greater than expected risk of major adverse cardiac event (MACE). If noncardiac surgery must be performed within those periods after PCI, then dual antiplatelet therapy should be maintained perioperatively unless the risk of major bleeding exceeds the risk of perioperative major adverse cardiac event (MACE). Key examples of reasons to hold dual antiplatelet therapy include active life-threatening major bleeding (massive gastrointestinal tract hemorrhage that does not respond to non-surgical measures, life-threatening intracranial hemorrhage) and urgent or emergency intracranial surgery. *Primary*-prevention antiplatelet therapy should be held preoperatively, unless the risk of major adverse cardiac event (MACE) is deemed greater than the risk of major perioperative bleeding with antiplatelet therapy [1].

Perioperative beta blockade

Patient-specific and procedure-specific considerations remain important to the complex topic of perioperative beta blockade. Perioperative beta blockade is associated with reduced risk of perioperative MACE, though increased risk of bradycardia, hypotension, and stroke. Perioperative beta blockade is associated with increased mortality in patients with zero or one RCRI risk factor, while also associated with decreased mortality in those with three or more RCRI risk factors. Ultimately, the decision regarding perioperative beta blockade is based on a balance of these [1, 12].

The 2014 American College of Cardiology/American Heart Association Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery includes expert consensus on perioperative use of beta blocker

therapy. According to that guideline, perioperative beta blockade is *recommended* if a patient already chronically takes a beta-blocker agent, *reasonable* if a patient has known or strongly-suspected clinically significant coronary artery disease, and *reasonable* if a patient has three or more revised cardiac risk index (RCRI) risk factors for perioperative major adverse cardiac event (MACE) *plus* a planned elevated-risk procedure [1]. RCRI risk factors, as defined in 1999 by Lee et al., include high-risk surgery (intraperitoneal, intrathoracic, or suprainguinal vascular surgery), history of ischemic heart disease, history of heart failure, cerebrovascular disease, insulin-requiring diabetes mellitus, and serum creatinine level > 2.0 mg/dl [2].

The 2014 ACC/AHA perioperative guideline supports greatest benefit from at least one week to one month titration of beta-blockade preoperatively (if indicated), continued at least one month postoperatively. Beta blockade should not be initiated on the day of surgery [1]. More cardioselective beta blocker agents (such as bisoprolol and atenolol) might confer lower stroke and mortality risk than less cardioselective agents (such as metoprolol) [1, 12]. COPD, without severe bronchospastic disease, is not a clear contraindication to cardioselective beta blocker therapy [13, 14]. Many patients who warrant perioperative beta blockade have long-term indications for such therapy; this is best addressed by each patient’s primary care provider [1].

Perioperative statin therapy

Studies of perioperative statin therapy mostly are small, and/or retrospective, and/or limited to cardiac surgery or peripheral vascular surgery. Despite these limitations, perioperative “statin” therapy is associated with decreased perioperative major adverse cardiac event (MACE) risk, particularly in elevated perioperative cardiovascular risk situations. Plausible mechanisms for these benefits include coronary artery plaque stabilization, anti-inflammatory effects, and potentially decreased thrombogenesis [1].

Studies in 2003 and 2004 demonstrated reduced all-cause mortality, cardiac mortality, and non-fatal cardiac events in patients who received perioperative statin therapy vs. placebo [15-18]. In 2006, a large meta-analysis of 15 trials, including more than 223,000 total patients, demonstrated a significant

reduction in perioperative mortality in patients on statin therapy who underwent cardiac surgery, peripheral vascular surgery, and non-cardiovascular surgery [19]. A 2009 randomized controlled trial of statin-naïve patients undergoing vascular surgery revealed a significant reduction in perioperative myocardial infarction and cardiovascular death [20]. Based on available evidence, the 2014 American College of Cardiology/American Heart Association perioperative guideline supports perioperative continuation of statin therapy, perioperative initiation of statin therapy in patients undergoing cardiac and vascular surgery, and perioperative initiation of statin therapy in patients at elevated cardiovascular risk who undergo elevated-risk procedures [1].

Other perioperative cardiovascular medication management

Perioperative management of angiotensin converting enzyme-inhibitor (ACE-I) and of angiotensin receptor blocker (ARB) therapy has been controversial. In a 2012 retrospective study of over 79,000 patients who underwent non-cardiac surgery, ACE-I therapy was associated with higher rates of intraoperative hypotension, but was not significantly associated with other cardiovascular outcomes (death, myocardial infarction, and stroke) [21]. Two trials of ACE-I and ARB therapy in vascular surgery patients demonstrated significantly more hypotensive events with these agents, but no difference in other cardiovascular outcomes [22, 23]. In a large observational study, preoperative administration of ACE-Is and ARBs was associated with more frequent intraoperative hypotension, but no difference in rates of postoperative myocardial infarction or of renal failure [24]. A 2008 meta-analysis demonstrated a 50% incidence of perioperative hypotension in patients taking ACE-Is or ARBs, but no significant difference in other major perioperative cardiovascular outcomes [25].

Two trials addressed the effects of discontinuation of ACE-Is and ARBs prior to non-cardiac surgery. These studies demonstrated no specific harm associated with discontinuation of ACE-Is and ARBs preoperatively. However, patients with poorly controlled hypertension or heart failure were not included in those studies [23, 26].

Overall data demonstrates that ACE-Is and ARBs do increase the risk of transient intraoperative

hypotension, but without clearly proven significant adverse effect on other perioperative cardiovascular outcomes. The 2014 American College of Cardiology/American Heart Association perioperative guideline supports *either* continuation or withholding of ACE-I and ARBs preoperatively, based on clinical judgement. This guideline further indicates that, if ACE-Is or ARBs are held preoperatively, that it is reasonable to restart them as soon as feasible postoperatively [1]. A reasonable approach is as follows: Continue ACE-I or ARB therapy perioperatively in patients with uncontrolled hypertension or with congestive heart failure; withhold ACE-I or ARB therapy preoperatively in patients with satisfactory blood pressures and no known congestive heart failure, but resume these agents postoperatively once stable hemodynamic status and renal function are confirmed.

The use of clonidine in the perioperative setting also has been controversial. A 2014 multicenter randomized control trial, which involved over 10,000 non-cardiac surgery patients, revealed no significant difference in perioperative mortality or myocardial infarction with clonidine compared to placebo [27]. However, in that study, clonidine was associated with substantially-elevated incidence of clinically significant hypotension and of non-fatal cardiac arrest [27]. Based upon this data, the 2014 American College of Cardiology/American Heart Association perioperative guideline includes recommendation *against* prophylactic use of alpha-2 agonists in the perioperative setting [1]. Initiation of clonidine for treatment of perioperative hypertensive emergency is indeterminate; if clonidine is used in this context, extreme caution and strong consideration of other antihypertensive therapies should be employed. Maintenance clonidine therapy should be continued perioperatively, if well-tolerated, due to risks of rebound hypertension and tachycardia if clonidine is discontinued abruptly [1, 28].

Conclusion

Major adverse cardiac events (MACE) remain among the most common causes of perioperative mortality and morbidity. The most recent major updates in perioperative medicine are related to perioperative cardiovascular risk assessment and management. The “2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery” provides expert consensus on these topics. Highlights of this guideline include new definitions of operative

urgency and risk, as well as more direction regarding perioperative cardiovascular testing and medical management. Patient-specific risk factors, procedure-specific risk factors, and clinical judgement remain crucial to determine a perioperative risk profile and subsequent perioperative care. Close communication among care teams also is essential [1].

Conflicts of interest

Authors declare no conflicts of interest.

References

- [1] Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: Executive summary: A report of the American College of Cardiology/American Heart Association task force on practice guidelines. *Circulation*. 2014; 130(24):2215–2245.
- [2] Lee TH, Marcantonio ER, Mangione CM, Thomas EJ, Polanczyk CA, et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation*. 1999; 100(10):1043–1049.
- [3] Gupta PK, Gupta H, Sundaram A, Kaushik M, Fang X, et al. Development and validation of a risk calculator for prediction of cardiac risk after surgery. *Circulation*. 2011; 124(4):381–387.
- [4] Kertai MD, Boersma E, Sicari R, L'Italien GJ, Bax JJ, et al. Which stress test is superior for perioperative cardiac risk stratification in patients undergoing major vascular surgery? *Eur J Vasc Endovasc Surg*. 2002; 24(3):222–229.
- [5] Chareonthaitawee P, Askew JW. Selecting the optimal cardiac stress test. *UpToDate*. 2014.
- [6] Mikhail, MA. Preoperative cardiac evaluation. *Ask Mayo Expert*. 2010.
- [7] Shaw LJ, Eagle KA, Gersh BJ, Miller DD. Meta-analysis of intravenous dipyridamole-thallium-201 imaging (1985-1994) and dobutamine echocardiography for risk stratification before vascular surgery. *J Am Coll Cardiol*. 1996; 27(4):787–798.
- [8] Bach DS, Eagle KA. Dobutamine stress echocardiography: Stressing the indications for preoperative testing. *Circulation*. 1997; 95(1):8–10.
- [9] Devereaux PJ, Mrkobra M, Sessler DI, Leslie K, Alonso-Coello P, et al. Aspirin in patients undergoing noncardiac surgery. *N Engl J Med*. 2014; 370(16):1494–1503.
- [10] Biondi-Zoccai GG, Lotrionte M, Agostoni P, Abbate A, Fusaro M, et al. A systematic review and meta-analysis on the hazards of discontinuing or not adhering to aspirin among 50 279 patients at risk for coronary artery disease. *Eur Heart J*. 2006; 27(22):26670–2674.
- [11] Burger W, Chemnitz JM, Kneissl GD, Rücker G. Low-dose aspirin for secondary cardiovascular prevention-cardiovascular risks after its perioperative withdrawal versus bleeding risks with its continuation-review and meta-analysis. *J Intern Med*. 2005; 257(5):399–414.
- [12] Mushtaq M, Cohn SL. Perioperative beta-blockers in noncardiac surgery: The evidence continues to evolve. *Clev Clin J Med*. 2014; 81(8):501–512.
- [13] Salpeter SR, Ormiston TM, Salpeter EE. Cardioselective beta-blockers in patients with reactive airway disease: A meta-analysis. *Ann Intern Med*. 2002; 137(9):715–725.
- [14] Short PM, Lipworth SIW, Elder DHJ, Schembri S, Lipworth BJ. Effect of beta-blockers in treatment of chronic obstructive pulmonary disease: A retrospective cohort study. *BMJ*. 2011; 342:d2549.
- [15] Poldermans D, Bax JJ, Kertai MD, Krenning B, Westerhout CM, et al. Statins are associated with a reduced incidence of perioperative mortality in patients undergoing major noncardiac vascular surgery. *Circulation*. 2003; 107(14):1848–1851.
- [16] Lindenauer PK, Pekow P, Wang K, Mamidi DK, Gutierrez B, et al. Perioperative beta-blocker therapy and mortality after major noncardiac surgery. *N Engl J Med*. 2005; 353(4):349–361.
- [17] Kertai MD, Boersma E, Westerhout CM, van Domburg R, Klein J, et al. Association between long-term statin use and mortality after successful abdominal aortic aneurysm surgery. *Am J Med*. 2004; 116(2):96–103.
- [18] Durazzo AE, Machado FS, Ikeoka DT, Ikeoka DT, De Bernoche C, et al. Reduction in cardiovascular events after vascular surgery with atorvastatin: A randomized trial. *J Vasc Surg*. 2004; 39(5):967–975.
- [19] Hindler K, Shaw AD, Samuels J, Fulton S, Collard CD, et al. Improved postoperative outcomes associated with preoperative statin therapy. *Anesthesiology*. 2006; 105(6):1260–1272.
- [20] Schouten O, Boersma E, Hoeks SE, Benner R, van Urk H, et al. Fluvastatin and perioperative events in patients undergoing vascular surgery. *N Engl J Med*. 2009; 361(10):980–989.
- [21] Turan A, You J, Shiba A, Kurz A, Saager L, et al. Angiotensin converting enzyme inhibitors are not associated with respiratory complications or mortality after noncardiac surgery. *Anesth Analg*. 2012; 114(3):552–560.
- [22] Coriat P, Richer C, Douraki T, Gomez C, Hendricks K, et al. Influence of chronic angiotensin-converting enzyme inhibition on anesthetic induction. *Anesthesiology*. 1994; 81(2):299–307.
- [23] Bertrand M, Godet G, Meersschaert K, Brun L, Salcedo E, et al. Should the angiotensin II antagonists be discontinued before surgery? *Anesth Analg*. 2001; 92(1):26–30.
- [24] Khetarpal S, Khodaparast O, Shanks A, O'Reilly M, Tremper KK. Chronic angiotensin-converting enzyme inhibitor or angiotensin receptor blocker therapy combined with diuretic therapy is associated with increased episodes of hypotension in noncardiac surgery. *J Cardiothorac Vasc Anesth*. 2008; 22(2):180–186.
- [25] Rosenman DJ, McDonald FS, Ebbert JO, Erwin PJ, LaBella M, et al. Clinical consequences of withholding versus administering renin-angiotensin-aldosterone system antagonists in the preoperative period. *J Hosp Med*. 2008; 3(4):319–325.
- [26] Brabant SM, Bertrand M, Eyraud D, Darmon PL, Coriat P. The hemodynamic effects of anesthetic induction in vascular surgical patients chronically treated with angiotensin II receptor antagonists. *Anesth Analg*. 1999; 89(6):1388–1392.
- [27] Devereux PJ, Sessler DI, Leslie K, Kurz A, Mrkobra M, et al. Clonidine in patients undergoing noncardiac surgery. *N Engl J Med*. 2014; 370(16):1504–1513.
- [28] James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, et al. 2014 evidence-based guidelines for the management of high blood pressure in adults: Report from the panel members appointed to the Eight Joint National Committee (JNC8). *JAMA*. 2014; 311(5):507–520.