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

Developed in Collaboration With the American College of Surgeons, American Society of Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Vascular Medicine

Endorsed by the Society of Hospital Medicine

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Preamble

The American College of Cardiology (ACC) and the American Heart Association (AHA) are committed to the prevention and management of cardiovascular diseases through professional education and research for clinicians, providers, and patients. Since 1980, the ACC and AHA have shared a responsibility to translate scientific evidence into clinical practice guidelines (CPGs) with recommendations to standardize and improve cardiovascular health. These CPGs, based on systematic methods to evaluate and classify evidence, provide a cornerstone of quality cardiovascular care.

In response to published reports from the Institute of Medicine[1,2] and the ACC/AHA's mandate to evaluate new knowledge and maintain relevance at the point of care, the ACC/AHA Task Force on Practice Guidelines (Task Force) began modifying its methodology. This modernization effort is published in the 2012 Methodology Summit Report[3] and 2014 perspective article.[4] The latter recounts the history of the collaboration, changes over time, current policies, and planned initiatives to meet the needs of an evolving healthcare environment. Recommendations on value in proportion to resource utilization will be incorporated as high-quality comparative-effectiveness data become available.[5] The relationships between CPGs and data standards, appropriate use criteria, and performance measures are addressed elsewhere.[4]

Intended Use—CPGs provide recommendations applicable to patients with or at risk of developing cardiovascular disease. The focus is on medical practice in the United States, but CPGs developed in collaboration with other organizations may have a broader target. Although CPGs may be used to inform regulatory or payer decisions, the intent is to improve quality of care and be aligned with the patient's best interest.

Evidence Review—Guideline writing committee (GWC) members are charged with reviewing the literature; weighing the strength and quality of evidence for or against particular tests, treatments, or procedures; and estimating expected health outcomes when data exist. In analyzing the data and developing CPGs, the GWC uses evidence-based methodologies developed by the Task Force.[6] A key component of the ACC/AHA CPG methodology is the development of recommendations on the basis of all available evidence. Literature searches focus on randomized controlled trials (RCTs) but also include registries, nonrandomized comparative and descriptive studies, case series, cohort studies, systematic reviews, and expert opinion. Only selected references are cited in the CPG. To ensure that CPGs remain current, new data are reviewed biannually by the GWCs and the Task Force to determine if recommendations

should be updated or modified. In general, a target cycle of 5 years is planned for full revision.[1]

The Task Force recognizes the need for objective, independent Evidence Review Committees (ERCs) to address key clinical questions posed in the PICOTS format (P=population; I=intervention; C=comparator; O=outcome; T=timing; S=setting). The ERCs include methodologists, epidemiologists, clinicians, and biostatisticians who systematically survey, abstract, and assess the quality of the evidence base.[3,4] Practical considerations, including time and resource constraints, limit the ERCs to addressing key clinical questions for which the evidence relevant to the guideline topic lends itself to systematic review and analysis when the systematic review could impact the sense or strength of related recommendations. The GWC develops recommendations on the basis of the systematic review and denotes them with superscripted "SR" (ie, ^{SR}) to emphasize support derived from formal systematic review.

Guideline-Directed Medical Therapy—Recognizing advances in medical therapy across the spectrum of cardiovascular diseases, the Task Force designated the term "guideline-directed medical therapy" (GDMT) to represent recommended medical therapy as defined mainly by Class I measures—generally a combination of lifestyle modification and drug- and device-based therapeutics. As medical science advances, GDMT evolves, and hence GDMT is preferred to "optimal medical therapy." For GDMT and all other recommended drug treatment regimens, the reader should confirm the dosage with product insert material and carefully evaluate for contraindications and possible drug interactions. Recommendations are limited to treatments, drugs, and devices approved for clinical use in the United States.

Class of Recommendation and Level of Evidence—Once recommendations are written, the Class of Recommendation (COR; ie, the strength the GWC assigns to the recommendation, which encompasses the anticipated magnitude and judged certainty of benefit in proportion to risk) is assigned by the GWC. Concurrently, the Level of Evidence (LOE) rates the scientific evidence supporting the effect of the intervention on the basis of the type, quality, quantity, and consistency of data from clinical trials and other reports (Table 1).[4]

Relationships With Industry and Other Entities—The ACC and AHA exclusively sponsor the work of GWCs, without commercial support, and members volunteer their time for this activity. The Task Force makes every effort to avoid actual, potential, or perceived conflicts of interest that might arise through relationships with industry or other entities (RWI). All GWC members and reviewers are required to fully disclose current industry relationships or personal interests, from 12 months before initiation of the writing effort. Management of RWI involves selecting a balanced GWC and requires that both the chair and a majority of GWC members have no relevant RWI (see Appendix 1 for the definition of relevance). GWC members are restricted with regard to writing or voting on sections to which their RWI apply. In addition, for transparency, GWC members' comprehensive disclosure information is available as an online supplement. Comprehensive disclosure information for the Task Force is also available at http://www.cardiosource.org/en/ACC/About-ACC/Who-We-Are/Leadership/Guidelines-and-Documents-Task-Forces.aspx. The Task Force strives to avoid bias by selecting experts from a broad array of backgrounds representing different geographic regions, genders, ethnicities, intellectual perspectives/biases, and scopes of clinical practice. Selected organizations and professional societies with related interests and expertise are invited to participate as partners or collaborators.

Individualizing Care in Patients With Associated Conditions and Comorbidities—The ACC and AHA recognize the complexity of managing patients with multiple conditions, compared with managing patients with a single disease, and the challenge is compounded when CPGs for evaluation or treatment of several coexisting illnesses are discordant or interacting.[7] CPGs attempt to define practices that meet the needs of patients in most, but not all, circumstances and do not replace clinical judgment.

Clinical Implementation—Management in accordance with CPG recommendations is effective only when followed; therefore, to enhance the patient's commitment to treatment and compliance with lifestyle adjustment, clinicians should engage the patient to participate in selecting interventions on the basis of the patient's individual values and preferences, taking associated conditions and comorbidities into consideration (eg, shared decision making). Consequently, there are circumstances in which deviations from these CPGs are appropriate.

The recommendations in this CPG are the official policy of the ACC and AHA until they are superseded by a published addendum, focused update, or revised full-text CPG. The reader is encouraged to consult the full-text CPG[8] for additional guidance and details about perioperative cardiovascular evaluation and noncardiac surgery, because the executive summary contains mainly the recommendations.

Jeffrey L. Anderson, MD, FACC, FAHA
Chair, ACC/AHA Task Force on Practice Guidelines

1. Introduction

1.1. Methodology and Evidence Review

The recommendations listed in this CPG are, whenever possible, evidence based. In April 2013, an extensive evidence review was conducted, which included a literature review through July 2013. Other selected references published through May 2014 were also incorporated by the GWC. Literature included was conducted in human subjects, published in English, and indexed in MEDLINE (through PubMed), EMBASE, the Cochrane Library, Agency for Healthcare Research and Quality Reports, and other selected databases relevant to this CPG. The relevant data are included in evidence tables in the Data Supplement available online. Key search words included but were not limited to the following: *anesthesia protection; arrhythmia; atrial fibrillation; atrioventricular block; bundle branch block; cardiac ischemia; cardioprotection; cardiovascular implantable electronic device; conduction disturbance; dysrhythmia; electrocardiography; electrocautery; electromagnetic interference; heart disease; heart failure; implantable cardioverter-defibrillator; intraoperative; left ventricular ejection fraction; left ventricular function; myocardial infarction; myocardial protection; National Surgical Quality Improvement Program; pacemaker; perioperative; perioperative pain management; perioperative risk; postoperative; preoperative; preoperative*

Table 1. Applying Classification of Recommendations and Level of Evidence

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	SIZE OF TREATMENT EFFECT			
	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	**CLASS IIa** *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	**CLASS IIb** *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	**CLASS III** *No Benefit* or **CLASS III** *Harm* COR III: No benefit — Procedure/Test: Not Helpful — Treatment: No Proven Benefit COR III: Harm — Procedure/Test: Excess Cost w/o Benefit or Harmful — Treatment: Harmful to Patients
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care
Suggested phrases for writing recommendations	should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	COR III: No Benefit is not recommended is not indicated should not be performed/ administered/ other is not useful/ beneficial/ effective COR III: Harm potentially harmful causes harm associated with excess morbidity/mortality should not be performed/ administered/ other
Comparative effectiveness phrases†	treatment/strategy A is recommended/indicated in preference to treatment B treatment A should be chosen over treatment B	treatment/strategy A is probably recommended/indicated in preference to treatment B it is reasonable to choose treatment A over treatment B		

A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important key clinical questions addressed in the guidelines do not lend themselves to clinical trials. Although randomized trials are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as sex, age, history of diabetes mellitus, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

†For comparative-effectiveness recommendations (Class I and IIa; Level of Evidence A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

evaluation; surgical procedures; ventricular premature beats; ventricular tachycardia; and *volatile anesthetics.*

An independent ERC was commissioned to perform a systematic review of a critical question, the results of which were incorporated into this CPG. See the systematic review report published in conjunction with this CPG[9] and its respective data supplements.

1.2. Organization of the GWC

The GWC was composed of clinicians with content and methodological expertise, including general cardiologists, subspecialty cardiologists, anesthesiologists, a surgeon, a hospitalist, and a patient representative/lay volunteer. The GWC included representatives from the ACC, AHA, American College of Surgeons, American Society of Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society for Vascular Medicine.

1.3. Document Review and Approval

This document was reviewed by 2 official reviewers each from the ACC and the AHA; 1 reviewer each from the American College of Surgeons, American Society of Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology, HRS, Society for Cardiovascular

Angiography and Interventions, Society of Cardiovascular Anesthesiologists, Society of Hospital Medicine, and Society for Vascular Medicine; and 24 individual content reviewers (including members of the ACC Adult Congenital and Pediatric Cardiology Section Leadership Council, ACC Electrophysiology Section Leadership Council, ACC Heart Failure and Transplant Section Leadership Council, ACC Interventional Section Leadership Council, and ACC Surgeons' Council). Reviewers' RWI information was distributed to the GWC and is published in this document (Appendix 2).

This document was approved for publication by the governing bodies of the ACC and the AHA and endorsed by the American College of Surgeons, American Society of Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, Society of Hospital Medicine, and Society of Vascular Medicine.

1.4. Scope of the CPG

The focus of this CPG is the perioperative cardiovascular evaluation and management of the adult patient undergoing noncardiac surgery. This includes preoperative risk assessment and cardiovascular testing, as well as (when indicated) perioperative pharmacological (including anesthetic) management and perioperative monitoring that includes devices and biochemical markers. This CPG is intended to inform all the medical professionals involved in the care of these patients. The preoperative evaluation of the patient undergoing noncardiac surgery can be performed for multiple purposes, including 1) assessment of perioperative risk (which can be used to inform the decision to proceed or the choice of surgery and which includes the patient's perspective), 2) determination of the need for changes in management, and 3) identification of cardiovascular conditions or risk factors requiring longer-term management. Changes in management can include the decision to change medical therapies, the decision to perform further cardiovascular interventions, or recommendations about postoperative monitoring. This may lead to recommendations and discussions with the perioperative team about the optimal location and timing of surgery (eg, ambulatory surgery center versus outpatient hospital, or inpatient admission) or alternative strategies.

The key to optimal management is communication among all of the relevant parties (ie, surgeon, anesthesiologist, primary caregiver, and consultants) and the patient. The goal of preoperative evaluation is to promote patient engagement and facilitate shared decision making by providing patients and their providers with clear, understandable information about perioperative cardiovascular risk in the context of the overall risk of surgery.

The Task Force has chosen to make recommendations about care management on the basis of available evidence from studies of patients undergoing noncardiac surgery. Extrapolation from data from the nonsurgical arena or cardiac surgical arena was made only when no other data were available and the benefits of extrapolating the data outweighed the risks.

During the initiation of the writing effort, concern was expressed by Erasmus University about the scientific integrity of studies led by Poldermans.[10] The GWC reviewed 2 reports from Erasmus University published on the Internet,[10,11] as well as other relevant articles on this body of scientific investigation.[12–14] The 2012 report from Erasmus University concluded that the conduct in the DECREASE (Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography) IV and V trials "was in several respects negligent and scientifically incorrect" and that "essential source documents are lacking" to make conclusions about other studies led by Poldermans.[10] Additionally, Erasmus University was contacted to ensure that the GWC had up-to-date information. On the basis of the published information, discussions between the Task Force and GWC leadership ensued to determine how best to treat any study in which Poldermans was the senior investigator (ie, either the first or last author). The Task Force developed the following framework for this document:

1. The ERC will include the DECREASE trials in the sensitivity analysis, but the systematic review report will be based on the published data on perioperative beta blockade, with data from all DECREASE trials excluded.
2. The DECREASE trials and other derivative studies by Poldermans should not be included in the CPG data supplements and evidence tables.
3. If nonretracted DECREASE publications and/or other derivative studies by Poldermans are relevant to the topic, they can only be cited in the text with a comment about the finding compared with the current recommendation but should not form the basis of that recommendation or be used as a reference for the recommendation.

The Task Force and GWC believe that it is crucial for the sake of transparency to include the nonretracted publications in the text of the document. This is particularly important because further investigation is occurring simultaneously with deliberation of the CPG recommendations. Because of the availability of new evidence and the international impact of the controversy about the DECREASE trials, the ACC/AHA and European Society of Cardiology/European Society of Anesthesiology began revising their respective CPGs concurrently. The respective GWCs performed their literature reviews and analyses independently and then developed their recommendations. Once peer review of both CPGs was completed, the GWCs chose to discuss their respective recommendations for beta-blocker therapy and other relevant issues. Any differences in recommendations were discussed and clearly articulated in the text; however, the GWCs aligned a few recommendations to avoid confusion within the clinical community, except where international practice variation was prevalent.

In developing this CPG, the GWC reviewed prior published CPGs and related statements. Table 2 lists these publications and statements deemed pertinent to this effort and is intended for use as a resource. However, because of the availability of new evidence, the current CPG may include recommendations that supersede those previously published.

1.5. Definitions of Urgency and Risk

In describing the temporal necessity of operations in this CPG, the GWC developed the following definitions by consensus. An *emergency* procedure is one in which life or limb is threatened if not in the operating room, where there is time for no or very limited or minimal clinical evaluation, typically within <6 hours. An *urgent* procedure is one in which there may be time for a limited clinical evaluation, usually when life or limb is threatened if

Table 2. Associated CPGs and Statements

Title	Organization	Publication Year (Reference)
CPGs		
Management of patients with atrial fibrillation	AHA/ACC/HRS	2014[15]
Management of valvular heart disease	AHA/ACC	2014[16]
Management of heart failure	ACC/AHA	2013[17]
Performing a comprehensive transesophageal echocardiographic examination	ASE/SCA	2013[18]
Management of ST-elevation myocardial infarction	ACC/AHA	2013[19]
Diagnosis and management of patients with stable ischemic heart disease	ACC/AHA/AATS/PCNA/ SCAI/STS	2012[19a] 2014[20]
Focused update incorporated into the 2007 guidelines for the management of patients with unstable angina/non–ST-elevation myocardial infarction*	ACC/AHA	2012[21]
Red blood cell transfusion	AABB	2012[22]
Management of patients with peripheral artery disease: focused update and guideline	ACC/AHA	2011[23] 2006[24]
Diagnosis and treatment of hypertrophic cardiomyopathy	ACC/AHA	2011[25]
Coronary artery bypass graft surgery	ACC/AHA	2011[26]
Percutaneous coronary intervention	ACC/AHA/SCAI	2011[27]
Perioperative transesophageal echocardiography	American Society of Anesthesiologists/SCA	2010[28]
Management of adults with congenital heart disease	ACC/AHA	2008[29]
Statements		
Perioperative beta blockade in noncardiac surgery: a systematic review	ACC/AHA	2014[9]
Basic perioperative transesophageal echocardiography examination	ASE/SCA	2013[30]
Practice advisory for preanesthesia evaluation	American Society of Anesthesiologists	2012[31]
Cardiac disease evaluation and management among kidney and liver transplantation candidates	AHA/ACC	2012[32]
Inclusion of stroke in cardiovascular risk prediction instruments	AHA/American Stroke Association	2012[33]
Perioperative management of patients with implantable defibrillators, pacemakers and arrhythmia monitors: facilities and patient management	HRS/American Society of Anesthesiologists	2011[34]

*The 2012 UA/NSTEMI CPG[21] is considered policy at the time of publication of this CPG; however, a fully revised CPG is in development, with publication expected in 2014.

AABB indicates American Association of Blood Banks; AATS, American Association for Thoracic Surgery; ACC, American College of Cardiology; AHA, American Heart Association; ASE, American Society of Echocardiography; CPG, clinical practice guideline; HRS, Heart Rhythm Society; PCNA, Preventive Cardiovascular Nurses Association; SCAI, Society for Cardiovascular Angiography and Interventions; SCA, Society of Cardiovascular Anesthesiologists; STEMI, ST-elevation myocardial infarction; STS, Society of Thoracic Surgeons; and UA/NSTEMI, unstable angina/non–ST-elevation myocardial infarction.

not in the operating room, typically between 6 and 24 hours. A *time-sensitive* procedure is one in which a delay of >1 to 6 weeks to allow for an evaluation and significant changes in management will negatively affect outcome. Most oncologic procedures would fall into this category. An *elective* procedure is one in which the procedure could be delayed for up to 1 year. Individual institutions may use slightly different definitions, but this framework could be mapped to local categories. A *low-risk* procedure is one in which the combined surgical and patient characteristics predict a risk of a major adverse cardiac event (MACE) of death or myocardial infarction (MI) of <1%. Selected examples of low-risk procedures include cataract and plastic surgery.[35,36] Procedures with a risk of MACE of ≥1% are considered *elevated risk*. Many previous risk-stratification schema have included intermediate- and high-risk classifications. Because recommendations for intermediate- and high-risk procedures are similar, classification into 2 categories simplifies the recommendations without loss of fidelity. Additionally, a risk calculator has been developed that allows more precise calculation of surgical risk, which can be incorporated into perioperative decision making.[37] Approaches to establishing low and elevated risk are developed more fully in Section 3 in the full-text CPG.

2. Clinical Risk Factors: Recommendations

2.1. Valvular Heart Disease

See the 2014 valvular heart disease CPG for the complete set of recommendations and specific definitions of disease severity.[16]

Class I

1. **It is recommended that patients with clinically suspected moderate or greater degrees of valvular**

stenosis or regurgitation undergo preoperative echocardiography if there has been either 1) no prior echocardiography within 1 year or 2) a significant change in clinical status or physical examination since last evaluation.[39] *(Level of Evidence: C)*

2. **For adults who meet standard indications for valvular intervention (replacement and repair) on the basis of symptoms and severity of stenosis or regurgitation, valvular intervention before elective noncardiac surgery is effective in reducing perioperative risk.[16] *(Level of Evidence: C)***

Class IIa

1. **Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe aortic stenosis.[40–50] *(Level of Evidence: B)***

Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe MR. *(Level of Evidence: C)*

2. **Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe aortic regurgitation and a normal left ventricular ejection fraction. *(Level of Evidence: C)***

Class IIb

1. **Elevated-risk elective noncardiac surgery using appropriate intraoperative and postoperative hemodynamic monitoring may be reasonable in asymptomatic patients with severe mitral stenosis if valve morphology is not favorable for percutaneous mitral balloon commissurotomy. *(Level of Evidence: C)***

2.2. Other Clinical Risk Factors

See Section 5.8 for intraoperative/postoperative cardiovascular implantable electronic device (CIED) management.

Class I

1. **Before elective surgery in a patient with a CIED, the surgical/procedure team and clinician following the CIED should communicate in advance to plan perioperative management of the CIED. *(Level of Evidence: C)***
2. **Chronic pulmonary vascular targeted therapy (ie, phosphodiesterase type 5 inhibitors, soluble guanylate cyclase stimulators, endothelin receptor antagonists, and prostanoids) should be continued unless contraindicated or not tolerated in patients with pulmonary hypertension who are undergoing noncardiac surgery. *(Level of Evidence: C)***

Class IIa

1. **Unless the risks of delay outweigh the potential benefits, preoperative evaluation by a pulmonary hypertension specialist before noncardiac surgery can be beneficial for patients with pulmonary hypertension, particularly for those with features of increased perioperative risk.[51]* *(Level of Evidence: C)***

3. Approach to Perioperative Cardiac Testing

3.1. Multivariate Risk Indices: Recommendations

Class IIa

1. **A validated risk-prediction tool can be useful in predicting the risk of perioperative MACE in patients undergoing noncardiac surgery.[59–61] *(Level of Evidence: B)***

Class III: No Benefit

1. **For patients with a low risk of perioperative MACE, further testing is not recommended before the planned operation.[35,36] *(Level of Evidence: B)***

3.2. Stepwise Approach to Perioperative Cardiac Assessment: Treatment Algorithm

See Figure 1 for a stepwise approach to perioperative cardiac assessment for CAD.

The GWC developed an algorithmic approach to perioperative cardiac assessment on the basis of the available evidence and expert opinion, the rationale of which is outlined throughout the CPG. The algorithm incorporates the perspectives of clinicians caring for the patient to provide informed consent and help guide perioperative management to minimize risk. It is also crucial to incorporate the patient's perspective with regard to the assessment of the risk of surgery or alternative therapy and the risk of any GDMT or coronary and valvular interventions before noncardiac surgery. Patients may elect to forgo a surgical intervention if the risk of perioperative morbidity and mortality is extremely high; soliciting this information from the patient before surgery is a key part of shared decision making.

4. Supplemental Preoperative Evaluation: Recommendations

See Table 3 for a summary of recommendations for supplemental preoperative evaluation.

4.1. The 12-Lead Electrocardiogram

Class IIa

1. **Preoperative resting 12-lead electrocardiogram (ECG) is reasonable for patients with known coronary heart disease, significant arrhythmia, peripheral arterial disease, cerebrovascular disease, or other significant structural heart disease, except for those undergoing low-risk surgery.[64–66] *(Level of Evidence: B)***

Class IIb

1. **Preoperative resting 12-lead ECG may be considered for asymptomatic patients without known coronary**

*Features of increased perioperative risk in patients with pulmonary hypertension include: 1) diagnosis of Group 1 pulmonary hypertension (ie, pulmonary arterial hypertension), 2) other forms of pulmonary hypertension associated with high pulmonary pressures (pulmonary artery systolic pressures >70 mm Hg) and/or moderate or greater right ventricular dilatation and/or dysfunction and/or pulmonary vascular resistance >3 Wood units, and 3) World Health Organization/New York Heart Association class III or IV symptoms attributable to pulmonary hypertension.[52–58]

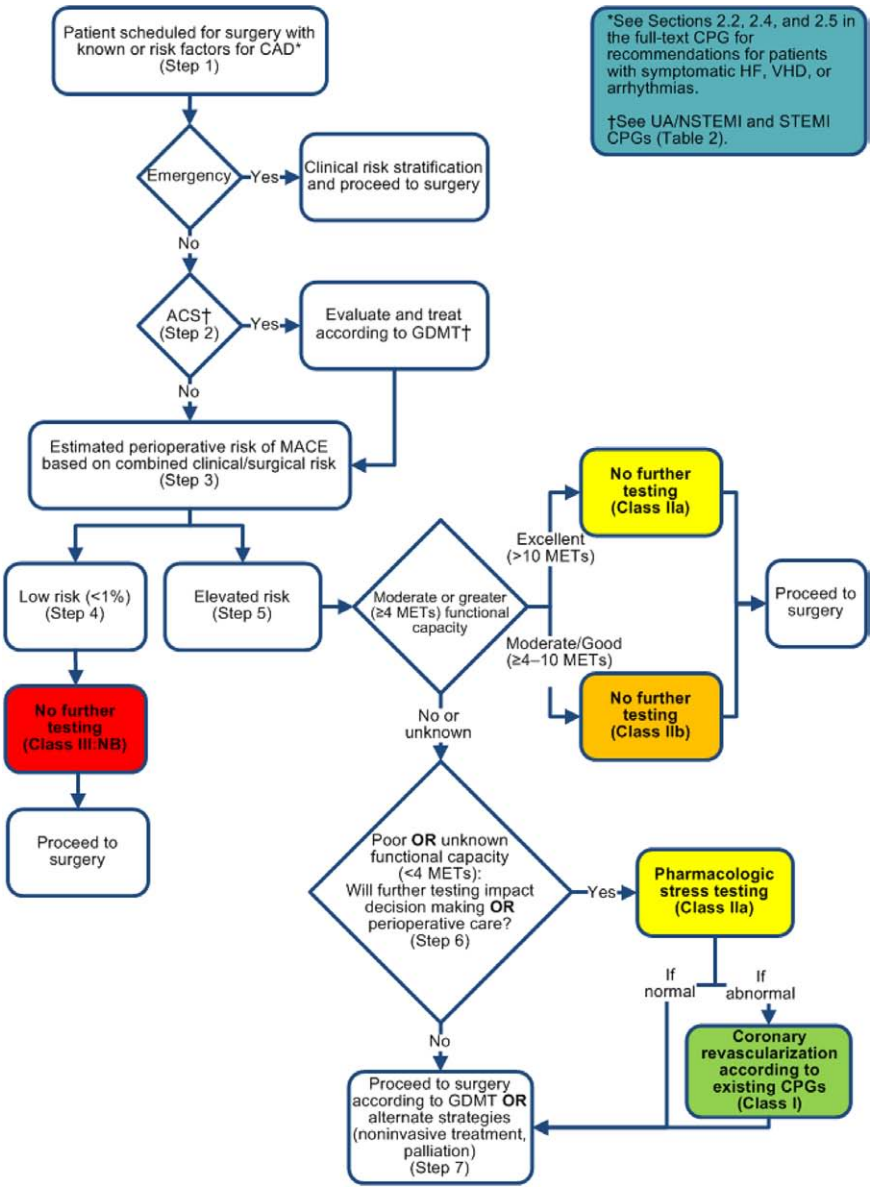

Figure 1. Stepwise approach to perioperative cardiac assessment for CAD. Colors correspond to the Classes of Recommendations in Table 1. **Step 1:** In patients scheduled for surgery with risk factors for or known CAD, determine the urgency of surgery. If an emergency, then determine the clinical risk factors that may influence perioperative management and proceed to surgery with appropriate monitoring and management strategies based on the clinical assessment (see Section 2.5 in the full-text CPG for more information on CAD). (For patients with symptomatic HF, VHD, or arrhythmias, see Sections 2.2, 2.4, and 2.5 in the full-text CPG for information on evaluation and management.) **Step 2:** If the surgery is urgent or elective, determine if the patient has an ACS. If yes, then refer patient for cardiology evaluation and management according to GDMT according to the UA/NSTEMI and STEMI CPGs.[19,21] **Step 3:** If the patient has risk factors for stable CAD, then estimate the perioperative risk of MACE on the basis of the combined clinical/surgical risk. This estimate can use the American College of Surgeons NSQIP risk calculator (http://www.riskcalculator.facs.org) or incorporate the RCRI[62] with an estimation of surgical risk. For example, a patient undergoing very low-risk surgery (eg, ophthalmologic surgery), even with multiple risk factors, would have a low risk of MACE, whereas a patient undergoing major vascular surgery with few risk factors would have an elevated risk of MACE (see Section 3 in the full-text CPG). **Step 4:** If the patient has a low risk of MACE (<1%), then no further testing is needed, and the patient may proceed to surgery (Section 3 in the full-text CPG). **Step 5:** If the patient is at elevated risk of MACE, then determine functional capacity with an objective measure or scale such as the DASI.[63] If the patient has moderate, good, or excellent functional capacity (≥4 METs), then proceed to surgery without further evaluation (Section 4.1 in the full-text CPG). **Step 6:** If the patient has poor (<4 METs) or unknown functional capacity, then the clinician should consult with the patient and perioperative team to determine whether further testing will impact patient decision making (eg, decision to perform original surgery or willingness to undergo CABG or PCI, depending on the results of the test) or perioperative care. If yes, then pharmacological stress testing is appropriate. In those patients with unknown functional capacity, exercise stress testing may be reasonable to perform. If the stress test is abnormal, consider coronary angiography and revascularization depending on the extent of the abnormal test. The patient can then proceed to surgery with GDMT or consider alternative strategies, such as noninvasive treatment of the indication for surgery (eg, radiation therapy for cancer) or palliation. If the test is normal, proceed to surgery according to GDMT (Section 4.3). **Step 7:** If testing will not impact decision making or care, then proceed to surgery according to GDMT or consider alternative strategies, such as noninvasive treatment of the indication for surgery (eg, radiation therapy for cancer) or palliation. ACS indicates acute coronary syndrome; CABG, coronary artery bypass graft; CAD, coronary artery disease; CPG, clinical practice guideline; DASI, Duke Activity Status Index; GDMT, guideline-directed medical therapy; HF, heart failure; MACE, major adverse cardiac event; MET, metabolic equivalent; NB, No Benefit; NSQIP, National Surgical Quality Improvement Program; PCI, percutaneous coronary intervention; RCRI, Revised Cardiac Risk Index; STEMI, ST-elevation myocardial infarction; UA/NSTEMI, unstable angina/non–ST-elevation myocardial infarction; and VHD, valvular heart disease.

Table 3. Summary of Recommendations for Supplemental Preoperative Evaluation

Recommendations	COR	LOE	References
The 12-lead ECG			
Preoperative resting 12-lead ECG is reasonable for patients with known coronary heart disease or other significant structural heart disease, except for low-risk surgery	IIa	B	64–66
Preoperative resting 12-lead ECG may be considered for asymptomatic patients, except for low-risk surgery	IIb	B	59, 65–67
Routine preoperative resting 12-lead ECG is not useful for asymptomatic patients undergoing low-risk surgical procedures	III: No Benefit	B	36, 68
Assessment of LV function			
It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function	IIa	C	N/A
It is reasonable for patients with HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function	IIa	C	N/A
Reassessment of LV function in clinically stable patients may be considered	IIb	C	N/A
Routine preoperative evaluation of LV function is not recommended	III: No Benefit	B	69–71
Exercise stress testing			
For patients with elevated risk and excellent functional capacity, it is reasonable to forgo further exercise testing and proceed to surgery	IIa	B	72–76
For patients with elevated risk and unknown functional capacity it may be reasonable to perform exercise testing to assess for functional capacity if it will change management	IIb	B	75–77
Cardiopulmonary exercise testing may be considered for patients undergoing elevated risk procedures	IIb	B	78–86
For patients with elevated risk and moderate to good functional capacity, it may be reasonable to forgo further exercise testing and proceed to surgery	IIb	B	72–74
For patients with elevated risk and poor or unknown functional capacity it may be reasonable to perform exercise testing with cardiac imaging to assess for myocardial ischemia	IIb	C	N/A
Routine screening with noninvasive stress testing is not useful for low-risk noncardiac surgery	III: No Benefit	B	87, 88
Noninvasive pharmacological stress testing before noncardiac surgery			
It is reasonable for patients at elevated risk for noncardiac surgery with poor functional capacity to undergo either DSE or MPI if it will change management	IIa	B	89–93
Routine screening with noninvasive stress testing is not useful for low-risk noncardiac surgery	III: No Benefit	B	87, 88
Preoperative coronary angiography			
Routine preoperative coronary angiography is not recommended	III: No Benefit	C	N/A

COR indicates Class of Recommendation; DSE, dobutamine stress echocardiogram; ECG, electrocardiogram; HF, heart failure; LOE, Level of Evidence; LV, left ventricular; MPI, myocardial perfusion imaging; and N/A, not applicable.

heart disease, except for those undergoing low-risk surgery.[59,65–67] *(Level of Evidence: B)*

Class III: No Benefit

1. **Routine preoperative resting 12-lead ECG is not useful for asymptomatic patients undergoing low-risk surgical procedures.[36,68] *(Level of Evidence: B)***

4.2. Assessment of Left Ventricular Function

Class IIa

1. **It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of left ventricular (LV) function. *(Level of Evidence: C)***
2. **It is reasonable for patients with heart failure (HF) with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function. *(Level of Evidence: C)***

Class IIb

1. **Reassessment of LV function in clinically stable patients with previously documented LV dysfunction may be considered if there has been no assessment within a year. *(Level of Evidence: C)***

Class III: No Benefit

1. **Routine preoperative evaluation of LV function is not recommended.[69–71] *(Level of Evidence: B)***

4.3. Exercise Testing

Class IIa

1. **For patients with elevated risk and excellent (>10 metabolic equivalents [METs]) functional capacity, it is reasonable to forgo further exercise testing with cardiac imaging and proceed to surgery.[72–76] *(Level of Evidence: B)***

Class IIb

1. **For patients with elevated risk and unknown functional capacity, it may be reasonable to perform exercise testing to assess for functional capacity if it will change management.[75–77] *(Level of Evidence: B)***

Cardiopulmonary exercise testing may be considered for patients undergoing elevated risk procedures in whom functional capacity is unknown.[78–86] *(Level of Evidence: B)*

For patients with elevated risk and moderate to good (≥4 METs to 10 METs) functional capacity, it may be reasonable to forgo further exercise testing with cardiac imaging and proceed to surgery.[72–74] *(Level of Evidence: B)*

2. **For patients with elevated risk and poor (<4 METs) or unknown functional capacity, it may be reasonable to perform exercise testing with cardiac imaging to assess for myocardial ischemia if it will change management. *(Level of Evidence: C)***

Class III: No Benefit

1. **Routine screening with noninvasive stress testing is not useful for patients at low risk for noncardiac surgery.[87,88] *(Level of Evidence: B)***

4.4. Noninvasive Pharmacological Stress Testing Before Noncardiac Surgery

Class IIa

1. **It is reasonable for patients who are at an elevated risk for noncardiac surgery and have poor functional capacity (<4 METs) to undergo noninvasive pharmacological stress testing (either dobutamine stress echocardiogram or pharmacological stress myocardial perfusion imaging) if it will change management.[89–93] *(Level of Evidence: B)***

Class III: No Benefit

1. **Routine screening with noninvasive stress testing is not useful for patients undergoing low-risk noncardiac surgery.[87,88] *(Level of Evidence: B)***

4.5. Preoperative Coronary Angiography

Class III: No Benefit

1. **Routine preoperative coronary angiography is not recommended. *(Level of Evidence: C)***

5. Perioperative Therapy: Recommendations

See Table 4 for a summary of recommendations for perioperative therapy.

5.1. Coronary Revascularization Before Noncardiac Surgery

Class I

1. **Revascularization before noncardiac surgery is recommended in circumstances in which revascularization is indicated according to existing CPGs.[95,96] *(Level of Evidence: C)*** (See Table A in Appendix 3 for related recommendations.)

Class III: No Benefit

1. **It is not recommended that routine coronary revascularization be performed before noncardiac surgery exclusively to reduce perioperative cardiac events.[97] *(Level of Evidence: B)***

Patients undergoing risk stratification surgery before elective noncardiac procedures and whose evaluation recommends coronary artery bypass graft surgery should undergo coronary revascularization before an elevated-risk surgical procedure.[98] The cumulative mortality and morbidity risks of both the coronary revascularization procedure and the noncardiac surgery should be weighed carefully in light of the individual patient's overall health, functional status, and prognosis. The indications for preoperative surgical coronary revascularization are identical to those recommended in the 2011 coronary artery bypass graft surgery CPG and the 2011 percutaneous coronary intervention (PCI) CPG and the accumulated data on which those conclusions were based.[95,96] (See Table A in Appendix 3 for the related recommendations.)

The role of preoperative PCI in reducing untoward perioperative cardiac complications is uncertain given the available data. Performing PCI before noncardiac surgery should be limited to 1) patients with left main disease whose comorbidities preclude bypass surgery without undue risk and 2) patients with unstable coronary artery disease who would be appropriate candidates for emergency or urgent revascularization.[95,96] Patients with ST-elevation MI or non–ST-elevation acute coronary syndrome benefit from early invasive management.[96] In such patients, in whom noncardiac surgery is time sensitive despite an increased risk in the perioperative period, a strategy of balloon angioplasty or bare-metal stent (BMS) implantation should be considered.

5.2. Timing of Elective Noncardiac Surgery in Patients With Previous PCI

Class I

1. **Elective noncardiac surgery should be delayed 14 days after balloon angioplasty *(Level of Evidence: C)* and 30 days after BMS implantation.[99–101] *(Level of Evidence B)***
2. **Elective noncardiac surgery should optimally be delayed 365 days after drug-eluting stent (DES) implantation.[102–105] *(Level of Evidence: B)***

Class IIa

1. **In patients in whom noncardiac surgery is required, a consensus decision among treating clinicians as to the relative risks of surgery and discontinuation or continuation of antiplatelet therapy can be useful. *(Level of Evidence: C)***

Class IIb*

1. **Elective noncardiac surgery after DES implantation may be considered after 180 days if the risk of further**

*Because of new evidence, this is a new recommendation since the publication of the 2011 PCI CPG.[96]

Table 4. Summary of Recommendations for Perioperative Therapy

Recommendations	COR	LOE	References
Coronary revascularization before noncardiac surgery			
Revascularization before noncardiac surgery is recommended when indicated by existing CPGs	I	C	95, 96
Coronary revascularization is not recommended before noncardiac surgery exclusively to reduce perioperative cardiac events	III: No Benefit	B	97
Timing of elective noncardiac surgery in patients with previous PCI			
Noncardiac surgery should be delayed after PCI	I	C: 14 d after balloon angioplasty	N/A
		B: 30 d after BMS implantation	99–101
Noncardiac surgery should optimally be delayed 365 d after DES implantation	I	B	102–105
A consensus decision as to the relative risks of discontinuation or continuation of antiplatelet therapy can be useful	IIa	C	N/A
Elective noncardiac surgery after DES implantation may be considered after 180 d	IIb*	B	102, 106
Elective noncardiac surgery should not be performed in patients in whom DAPT will need to be discontinued perioperatively within 30 d after BMS implantation or within 12 mo after DES implantation	III: Harm	B	99–105, 107
Elective noncardiac surgery should not be performed within 14 d of balloon angioplasty in patients in whom aspirin will need to be discontinued perioperatively	III: Harm	C	N/A
Perioperative beta-blocker therapy			
Continue beta blockers in patients who are on beta blockers chronically	I	B SR†	111–117
Guide management of beta blockers after surgery by clinical circumstances	IIa	B SR†	110,117,118
In patients with intermediate- or high-risk preoperative tests, it may be reasonable to begin beta blockers	IIb	C SR†	119
In patients with ≥3 RCRI factors, it may be reasonable to begin beta blockers before surgery	IIb	B SR†	117
Initiating beta blockers in the perioperative setting as an approach to reducing perioperative risk is of uncertain benefit in those with a long-term indication but no other RCRI risk factors	IIb	B SR†	111, 117, 120
It may be reasonable to begin perioperative beta blockers long enough in advance to assess safety and tolerability, preferably >1 d before surgery	IIb	B SR†	110, 121–123
Beta-blocker therapy should not be started on the d of surgery	III: Harm	B SR†	110
Perioperative statin therapy			
Continue statins in patients currently taking statins	I	B	131–134
Perioperative initiation of statin use is reasonable in patients undergoing vascular surgery	IIa	B	135
Perioperative initiation of statins may be considered in patients with a clinical risk factor who are undergoing elevated-risk procedures	IIb	C	N/A
Alpha-2 agonists			
Alpha-2 agonists are not recommended for prevention of cardiac events	III: No Benefit	B	136–140
ACE inhibitors			
Continuation of ACE inhibitors or ARBs is reasonable perioperatively	IIa	B	141, 142
If ACE inhibitors or ARBs are held before surgery, it is reasonable to restart as soon as clinically feasible postoperatively	IIa	C	N/A
Antiplatelet agents			
Continue DAPT in patients undergoing urgent noncardiac surgery during the first 4 to 6 wk after BMS or DES implantation, unless the risk of bleeding outweighs the benefit of stent thrombosis prevention	I	C	N/A
In patients with stents undergoing surgery that requires discontinuation of $P2Y_{12}$ inhibitors, continue aspirin and restart the $P2Y_{12}$ platelet receptor–inhibitor as soon as possible after surgery	I	C	N/A

(*Continued*)

Table 4. Continued

Recommendations	COR	LOE	References
Management of perioperative antiplatelet therapy should be determined by consensus of treating clinicians and the patient	I	C	N/A
In patients undergoing nonemergency/nonurgent noncardiac surgery without prior coronary stenting, it may be reasonable to continue aspirin when the risk of increased cardiac events outweighs the risk of increased bleeding	IIb	B	143, 144
Initiation or continuation of aspirin is not beneficial in patients undergoing elective noncardiac noncarotid surgery who have not had previous coronary stenting	III: No Benefit	B	143
		C: If risk of ischemic events outweighs risk of surgical bleeding	N/A
Perioperative management of patients with CIEDs			
Patients with ICDs should be on a cardiac monitor continuously during the entire period of inactivation, and external defibrillation equipment should be available. Ensure that ICDs are reprogrammed to active therapy	I	C	145

*Because of new evidence, this is a new recommendation since the publication of the 2011 PCI CPG.[96]

†These recommendations have been designated with a SR to emphasize the rigor of support from the ERC's systematic review.

ACE indicates angiotensin-converting-enzyme; ARB, angiotensin-receptor blocker; BMS, bare-metal stent; CIED, cardiovascular implantable electronic device; COR, Class of Recommendation; CPG, clinical practice guideline; DAPT, dual antiplatelet therapy; DES, drug-eluting stent; ERC, Evidence Review Committee; ICD, implantable cardioverter-defibrillator; LOE, Level of Evidence; N/A, not applicable; PCI, percutaneous coronary intervention; RCRI, Revised Cardiac Risk Index; and SR, systematic review.

delay is greater than the expected risks of ischemia and stent thrombosis.[102,106] *(Level of Evidence: B)*

Class III: Harm

1. **Elective noncardiac surgery should not be performed within 30 days after BMS implantation or within 12 months after DES implantation in patients in whom dual antiplatelet therapy will need to be discontinued perioperatively.[99–105,107] *(Level of Evidence: B)***
2. **Elective noncardiac surgery should not be performed within 14 days of balloon angioplasty in patients in whom aspirin will need to be discontinued perioperatively. *(Level of Evidence: C)***

5.3. Perioperative Beta-Blocker Therapy

See the ERC systematic review report, "Perioperative Beta Blockade in Noncardiac Surgery: A Systematic Review for the 2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery" for the complete evidence review on perioperative beta-blocker therapy.[9] These recommendations have been designated with a SR to emphasize the rigor of support from the ERC's systematic review.

As noted in the Scope of this CPG (Section 1.4), the recommendations in Section 5.3 are based on a separately commissioned review of the available evidence, the results of which were used to frame our decision making. Full details are provided in the ERC's systematic review report[9] and data supplements. However, 3 key findings were powerful influences on this CPG's recommendations:

1. The systematic review suggests that preoperative use of beta blockers was associated with a reduction in cardiac events in the studies examined, but few data support the effectiveness of preoperative administration of beta blockers to reduce risk of surgical death.
2. Consistent and clear associations exist between beta-blocker administration and adverse outcomes, such as bradycardia and stroke.
3. These findings were quite consistent even when the DECREASE studies[108,109] in question or POISE (Perioperative Ischemic Evaluation Study)[110] were excluded. Stated alternatively, exclusion of these studies did not substantially affect estimates of risk or benefit.

Class I

1. **Beta blockers should be continued in patients undergoing surgery who have been on beta blockers chronically.[111–117] *(Level of Evidence: B)* SR**

Class IIa

1. **It is reasonable for the management of beta blockers after surgery to be guided by clinical circumstances, independent of when the agent was started.[110,117,118] *(Level of Evidence: B)* SR**

Class IIb

1. **In patients with intermediate- or high-risk myocardial ischemia noted in preoperative risk stratification tests, it may be reasonable to begin perioperative beta blockers.[119] *(Level of Evidence: C)* SR**

In patients with 3 or more RCRI risk factors (eg, diabetes mellitus, HF, coronary artery disease, renal insufficiency, cerebrovascular accident), it may be

reasonable to begin beta blockers before surgery.[117] *(Level of Evidence: B)* SR

In patients with a compelling long-term indication for beta-blocker therapy but no other RCRI risk factors, initiating beta blockers in the perioperative setting as an approach to reduce perioperative risk is of uncertain benefit.[111,117,120] *(Level of Evidence: B)* SR

2. In patients in whom beta-blocker therapy is initiated, it may be reasonable to begin perioperative beta blockers long enough in advance to assess safety and tolerability, preferably more than 1 day before surgery.[110,121–123] *(Level of Evidence: B)* SR

Class III: Harm

1. Beta-blocker therapy should not be started on the day of surgery.[110] *(Level of Evidence: B)* SR

If well tolerated, continuing beta blockers in patients who are currently receiving them for longitudinal reasons, particularly when longitudinal treatment is provided according to GDMT, such as for MI, is recommended (see Table B in Appendix 3 for applicable recommendations from the 2011 secondary prevention CPG).[124] This recommendation is consistent with the Surgical Care Improvement Project National Measures (CARD-2) as of November 2013.[125] Particular attention should be paid to the need to modify or temporarily discontinue beta blockers as clinical circumstances (eg, hypotension, bradycardia,[126] bleeding)[118] dictate.

The risks and benefits of perioperative beta blocker use appear to be favorable in patients who have intermediate- or high-risk myocardial ischemia noted on preoperative stress testing.[119,127] The decision to begin beta blockers should be influenced by whether a patient is at risk for stroke[128–130] and whether the patient has other relative contraindications (such as uncompensated HF). Observational data suggest that patients appear to benefit from use of beta blockers in the perioperative setting if they have ≥3 RCRI risk factors. It may be reasonable to begin beta blockers long enough in advance of the operative date that clinical effectiveness and tolerability can be assessed.[110,121–123] Starting the medication 2 to 7 days before surgery may be preferred, but few data support the need to start beta blockers >30 days beforehand.[121–123]

5.4. Perioperative Statin Therapy

Class I

1. Statins should be continued in patients currently taking statins and scheduled for noncardiac surgery.[131–134] *(Level of Evidence: B)*

Class IIa

1. Perioperative initiation of statin use is reasonable in patients undergoing vascular surgery.[135] *(Level of Evidence: B)*

Class IIb

1. Perioperative initiation of statins may be considered in patients with clinical indications according to GDMT who are undergoing elevated-risk procedures. *(Level of Evidence: C)*

5.5. Alpha-2 Agonists

Class III: No Benefit

1. Alpha-2 agonists for prevention of cardiac events are not recommended in patients who are undergoing noncardiac surgery.[136–140] *(Level of Evidence: B)*

5.6. Angiotensin-Converting Enzyme Inhibitors

Class IIa

1. Continuation of angiotensin-converting enzyme inhibitors or angiotensin-receptor blockers perioperatively is reasonable.[141,142] *(Level of Evidence: B)*

2. If angiotensin-converting enzyme inhibitors or angiotensin-receptor blockers are held before surgery, it is reasonable to restart as soon as clinically feasible postoperatively. *(Level of Evidence: C)*

5.7. Antiplatelet Agents

Please see Figure 2 for an algorithm for antiplatelet management in patients with PCI and noncardiac surgery.

Class I

1. In patients undergoing urgent noncardiac surgery during the first 4 to 6 weeks after BMS or DES implantation, dual antiplatelet therapy should be continued unless the relative risk of bleeding outweighs the benefit of the prevention of stent thrombosis. *(Level of Evidence: C)*

In patients who have received coronary stents and must undergo surgical procedures that mandate the discontinuation of $P2Y_{12}$ platelet receptor–inhibitor therapy, it is recommended that aspirin be continued if possible and the $P2Y_{12}$ platelet receptor–inhibitor be restarted as soon as possible after surgery. *(Level of Evidence: C)*

2. Management of the perioperative antiplatelet therapy should be determined by a consensus of the surgeon, anesthesiologist, cardiologist, and patient, who should weigh the relative risk of bleeding with that of stent thrombosis. *(Level of Evidence: C)*

Class IIb

1. In patients undergoing nonemergency/nonurgent noncardiac surgery who have not had previous coronary stenting, it may be reasonable to continue aspirin when the risk of potential increased cardiac events outweighs the risk of increased bleeding.[143,144] *(Level of Evidence: B)*

Class III: No Benefit

1. Initiation or continuation of aspirin is not beneficial in patients undergoing elective noncardiac noncarotid surgery who have not had previous coronary stenting[143] *(Level of Evidence: B)*, unless the risk of ischemic events outweighs the risk of surgical bleeding. *(Level of Evidence: C)*

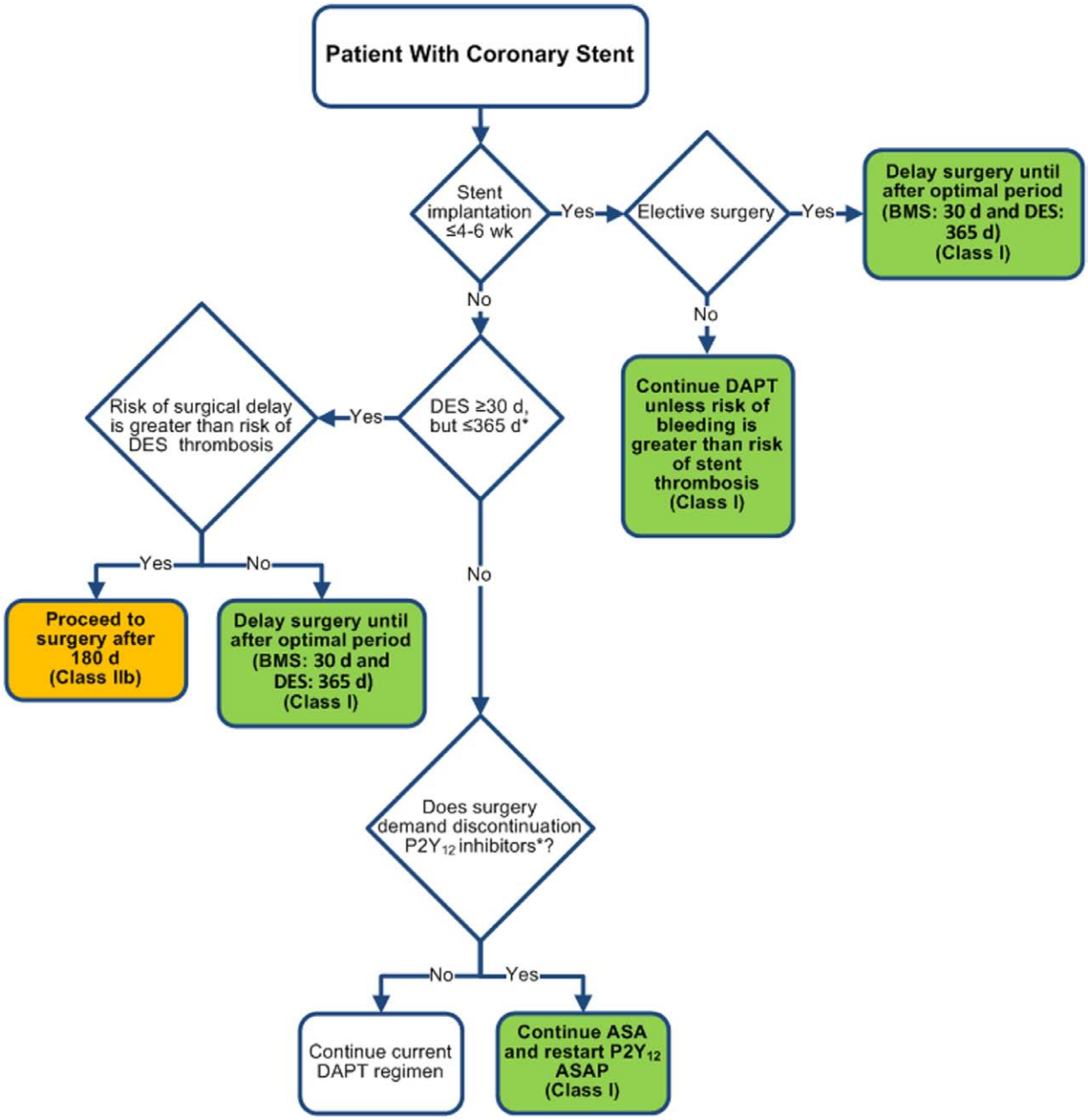

Figure 2. Algorithm for antiplatelet management in patients with PCI and noncardiac surgery. Colors correspond to the Classes of Recommendations in Table 1. *Assuming patient is currently on DAPT. ASA indicates aspirin; ASAP, as soon as possible; BMS, bare-metal stent; DAPT, dual antiplatelet therapy; DES, drug-eluting stent; and PCI, percutaneous coronary intervention.

5.8. Perioperative Management of Patients With CIEDs

Class I

1. **Patients with implantable cardioverter-defibrillators who have preoperative reprogramming to inactivate tachytherapy should be on cardiac monitoring continuously during the entire period of inactivation, and external defibrillation equipment should be readily available. Systems should be in place to ensure that implantable cardioverter-defibrillators are reprogrammed to active therapy before discontinuation of cardiac monitoring and discharge from the facility.[145] *(Level of Evidence: C)***

6. Anesthetic Consideration and Intraoperative Management: Recommendations

See Table 5 for a summary of recommendations for anesthetic consideration and intraoperative management.

6.1. Choice of Anesthetic Technique and Agent

Class IIa

1. **Use of either a volatile anesthetic agent or total intravenous anesthesia is reasonable for patients undergoing noncardiac surgery, and the choice is determined by factors other than the prevention of myocardial ischemia and MI.[146,147] *(Level of Evidence: A)***

Table 5. Summary of Recommendations for Anesthetic Consideration and Intraoperative Management

Recommendations	COR	LOE	References
Choice of anesthetic technique and agent			
Use of either a volatile anesthetic agent or total intravenous anesthesia is reasonable for patients undergoing noncardiac surgery	IIa	A	146, 147
Neuraxial anesthesia for *postoperative* pain relief can be effective to reduce MI in patients undergoing abdominal aortic surgery	IIa	B	148
Preoperative epidural analgesia may be considered to decrease the incidence of *preoperative* cardiac events in patients with hip fracture	IIb	B	149
Intraoperative management			
Emergency use of perioperative TEE in patients with hemodynamic instability is reasonable in patients undergoing noncardiac surgery if expertise is readily available	IIa	C	N/A
Maintenance of normothermia may be reasonable to reduce perioperative cardiac events	IIb	B	150, 151
Use of hemodynamic assist devices may be considered when urgent or emergency noncardiac surgery is required in the setting of acute severe cardiac dysfunction	IIb	C	N/A
Use of pulmonary artery catheterization may be considered when underlying medical conditions that significantly affect hemodynamics cannot be corrected before surgery	IIb	C	N/A
Routine use of pulmonary artery catheterization is not recommended	III: No Benefit	A	152–154
Prophylactic intravenous nitroglycerin is not effective in reducing myocardial ischemia in patients undergoing noncardiac surgery	III: No Benefit	B	137, 155, 156
Routine use of intraoperative TEE during noncardiac surgery is not recommended	III: No Benefit	C	N/A

COR indicates Class of Recommendation; LOE, Level of Evidence; MI, myocardial infarction; N/A, not applicable; and TEE, transesophageal echocardiogram.

2. **Neuraxial anesthesia for postoperative pain relief can be effective in patients undergoing abdominal aortic surgery to decrease the incidence of perioperative MI.[148] *(Level of Evidence: B)***

Class IIb

1. **Perioperative epidural analgesia may be considered to decrease the incidence of preoperative cardiac events in patients with a hip fracture.[149] *(Level of Evidence: B)***

6.2. Intraoperative Management

Class IIa

1. **The emergency use of perioperative transesophageal echocardiogram is reasonable in patients with hemodynamic instability undergoing noncardiac surgery to determine the cause of hemodynamic instability when it persists despite attempted corrective therapy, if expertise is readily available. *(Level of Evidence: C)***

Class IIb

1. **Maintenance of normothermia may be reasonable to reduce perioperative cardiac events in patients undergoing noncardiac surgery.[150,151] *(Level of Evidence: B)***

Use of hemodynamic assist devices may be considered when urgent or emergency noncardiac surgery is required in the setting of acute severe cardiac dysfunction (ie, acute MI, cardiogenic shock) that cannot be corrected before surgery. *(Level of Evidence: C)*

2. **The use of pulmonary artery catheterization may be considered when underlying medical conditions that significantly affect hemodynamics (ie, HF, severe valvular disease, combined shock states) cannot be corrected before surgery. *(Level of Evidence: C)***

Class III: No Benefit

1. **Routine use of pulmonary artery catheterization in patients, even those with elevated risk, is not recommended.[152–154] *(Level of Evidence: A)***

Prophylactic intravenous nitroglycerin is not effective in reducing myocardial ischemia in patients undergoing noncardiac surgery.[137,155,156] *(Level of Evidence: B)*

2. **The routine use of intraoperative transesophageal echocardiogram during noncardiac surgery to screen for cardiac abnormalities or to monitor for myocardial ischemia is not recommended in patients without risk factors or procedural risks for significant hemodynamic, pulmonary, or neurological compromise. *(Level of Evidence: C)***

7. Surveillance and Management for Perioperative MI: Recommendations

Class I

1. **Measurement of troponin levels is recommended in the setting of signs or symptoms suggestive of myocardial ischemia or MI.[157,158] *(Level of Evidence: A)***
2. **Obtaining an ECG is recommended in the setting of signs or symptoms suggestive of myocardial ischemia, MI, or arrhythmia.[158,159] *(Level of Evidence: B)***

Class IIb

1. **The usefulness of postoperative screening with troponin levels in patients at high risk for perioperative MI but without signs or symptoms suggestive of myocardial ischemia or MI, is uncertain in the absence of established risks and benefits of a defined management strategy.[160–166] *(Level of Evidence: B)***

2. **The usefulness of postoperative screening with ECGs in patients at high risk for perioperative MI, but without signs or symptoms suggestive of myocardial ischemia, MI, or arrhythmia, is uncertain in the absence of established risks and benefits of a defined management strategy.[158,159,167–169] *(Level of Evidence: B)***

Class III: No Benefit

1. **Routine postoperative screening with troponin levels in unselected patients without signs or symptoms suggestive of myocardial ischemia or MI is not useful for guiding perioperative management.[157,158] *(Level of Evidence: B)***

8. Future Research Directions

Current recommendations for perioperative cardiovascular evaluation and management for noncardiac surgery are based largely on clinical experience and observational studies, with few prospective RCTs. The GWC recommends that future research on perioperative evaluation and management span the spectrum from RCTs to regional and national registries to focus on patient outcomes.

Diagnostic cardiovascular testing continues to evolve, with newer imaging modalities being developed, such as coronary calcium scores, computed tomography angiography, and cardiac magnetic resonance imaging. The value of these modalities in preoperative screening is uncertain and warrants further study.

The use of perioperative beta blockers in beta–blocker-naïve patients undergoing noncardiac surgery remains controversial because of uncertainty about the following issues: 1) optimal duration for the initiation of beta blockers before elective noncardiac surgery; 2) optimal dosing and titration protocol perioperatively to avoid hemodynamic instability, including hypotension and bradycardia; and 3) which elevated-risk patient subsets would benefit the most from initiation of perioperative beta blocker. RCTs are needed to demonstrate when to start beta-blocker therapy before noncardiac surgery, the optimal type and dose, and titration protocol.

The evidence base for the predictive value of biomarkers in the perioperative period has grown. However, the utility of this information in influencing management and outcome is unknown and is currently undergoing investigation. The results of these investigations could lead to changes in recommendations in the future.

To implement the recommendations of the current perioperative CPGs effectively, a "perioperative team approach" is needed. The perioperative team is intended to engage clinicians with appropriate expertise; enhance communication of the benefits, risks, and alternatives; and include the patient's preferences, values, and goals. Future research will also be needed to understand how information on perioperative risk is incorporated into patient decision making.

Presidents and Staff

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KEY WORDS: AHA Scientific Statements ■ adrenergic beta-antagonists ■ anesthesia and analgesia ■ diagnostic techniques, cardiovascular ■ monitoring, intraoperative ■ perioperative care ■ troponin ■ platelet aggregation inhibitors ■ referral and consultation

Appendix 1. Author Relationships With Industry and Other Entities (Relevant)—2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery (March 2013)

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Voting Recusals by Section*
Lee A. Fleisher (Chair)	University of Pennsylvania Health System Department of Anesthesiology and Critical Care—Chair	None	None	None	None	None	None	None
Kirsten E. Fleischmann (Vice Chair)	UCSF School of Medicine, Division of Cardiology—Professor of Clinical Medicine	None	None	None	None	None	None	None
Andrew D. Auerbach	UCSF Division of Hospital Medicine—Professor of Medicine in Residence	None	None	None	None	None	None	None
Susan A. Barnason	University of Nebraska Medical Center, College of Nursing—Professor and Director of the Doctor of Nursing Practice Program	None	None	None	None	None	None	None
Joshua A. Beckman	Harvard Medical School—Associate Professor of Medicine; Brigham and Women's Hospital Cardiovascular Fellowship Program—Director	• AstraZeneca • Bristol-Myers Squibb† • Novartis† • Merck	None	None	None	• Boston Scientific	None	6.1, 6.1.1, 6.2.1, 6.2.2, 6.2.4, 6.2.5, 6.2.6, 6.3, 6.4, 7.3, 7.4, and 7.7
Biykem Bozkurt	Winters Center for Heart Failure Research, Baylor College of Medicine—The Mary and Gordon Cain Chair, Professor of Medicine, and Director; Michael E. DeBakey VA Medical Center Cardiology Section—Chief	None	None	None	• Forest Pharmaceuticals (PI)†	• Novartis	None	6.2.1, 6.2.2, and 6.2.5
Victor G. Davila-Roman	Washington University School of Medicine Anesthesiology and Radiology Cardiovascular Division—Professor of Medicine	• ValveXchange† • Boston Scientific† • St. Jude Medical†	None	None	None	None	None	2.4, 2.4.1, 2.4.2, 2.4.3, 5.7, 6.1, 6.1.1, 6.3, 6.4, 7.4, and 7.7
Marie D. Gerhard-Herman	Harvard Medical School—Associate Professor	None	None	None	None	None	None	None
Thomas A. Holly	Northwestern University Feinberg School of Medicine—Medical Director, Nuclear Cardiology; Associate Professor of Medicine and Radiology; Program Director, Cardiovascular Disease Fellowship	None	None	None	None	Astellas‡	None	5.5.1 and 5.7
Garvan C. Kane	Mayo Clinic, Division of Cardiovascular Diseases—Codirector and Echocardiography Laboratory Consultant; Associate Professor of Medicine	None	None	None	None	None	None	None
Joseph E. Marine	Johns Hopkins University School of Medicine—Associate Professor of Medicine; Associate Director of Electrophysiology; Associate Division Chief of Cardiology	None	None	None	None	None	None	None
M. Timothy Nelson	University of New Mexico—Professor; Program Director and Vice Chair of Education, Department of Surgery; Executive Medical Director, Adult Inpatient Services		None	None	None	None	None	None
Crystal C. Spencer	Spencer Meador Johnson—Lawyer	None	None	None	None	None	None	None

(Continued)

Appendix 1. Continued

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Voting Recusals by Section*
Annemarie Thompson	Duke University School of Medicine—Professor of Anesthesiology	None	None	None	None	None	None	None
Henry H. Ting	Mayo Clinic—Professor of Medicine; Mayo Clinic Quality Academy—Director; Mayo School for Continuous Professional Development—Associate Dean	None	None	None	None	None	None	None
Barry F. Uretsky	University of Arkansas for Medical Sciences—Clinical Professor of Medicine, Director of Interventional Cardiology	None	None	None	None	• St. Jude Medical†§	None	None
Duminda N. Wijeysundera (ERC Chair)	Li Ka Shing Knowledge Institute of St. Michael's Hospital—Scientist; Toronto General Hospital—Staff, Department of Anesthesia and Pain Management; University of Toronto—Assistant Professor, Department of Anesthesia and Institute of Health Policy Management and Evaluation; Institute for Clinical Evaluative Sciences—Adjunct Scientist	None	None	None	None	None	None	None

This table represents the relationships of committee members with industry and other entities that were determined to be relevant to this document. These relationships were reviewed and updated in conjunction with all meetings and/or conference calls of the writing committee during the document development process. The table does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of ≥5% of the voting stock or share of the business entity, or ownership of ≥$10 000 of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. Relationships that exist with no financial benefit are also included for the purpose of transparency. Relationships in this table are modest unless otherwise noted.

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*Writing committee members are required to recuse themselves from voting on sections to which their specific relationships with industry and other entities may apply. Section numbers pertain to those in the full-text CPG.

†Significant relationship.

‡No financial benefit.

§Dr. Uretsky's relationship with St. Jude Medical began just before balloting of the recommendations and was not relevant during the writing stage.

ACC indicates American College of Cardiology; AHA, American Heart Association; CPG, clinical practice guideline; ERC, Evidence Review Committee; PI, principal investigator; UCSF, University of California, San Francisco; and VA, Veterans Affairs.

Appendix 2. Reviewer Relationships With Industry and Other Entities (Relevant)—2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery (June 2014)

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Kim Eagle	Official Reviewer—AHA	University of Michigan Health System—Albion Walter Hewlett Professor of Internal Medicine	None	None	None	• GORE • Medtronic	None	None
Dipti Itchhaporia	Official Reviewer—ACC Board of Trustees	Hoag Memorial Hospital Presbyterian—Robert and Georgia Roth Chair for Excellence in Cardiac Care; Director of Disease Management	None	None	None	None	None	None
Mary Lough	Official Reviewer—AHA	Stanford Hospital and Clinics—Critical Care Clinical Nurse Specialist	None	None	None	None	None	None
G. B. John Mancini	Official Reviewer—ACC Board of Governors	Vancouver Hospital Research Pavilion—Professor of Medicine	• Merck • Pfizer • Servier	None	None	• Merck*	• Miraculins*	None
Frank W. Sellke	Official Reviewer—ACC/AHA Task Force on Practice Guidelines	Brown Medical School, Rhode Island Hospital—Professor; Chief of Cardiothoracic Surgery	None	None	None	None	• CSL Behring • The Medicines Company	None
Michael Baker	Organizational Reviewer—ASE	Vanderbilt University—Assistant Professor of Medicine	None	None	None	None	• Medtronic†	None
Michael England	Organizational Reviewer—ASA	Tufts University School of Medicine—Division Chief, Cardiac Anesthesiology; Assistant Professor	None	• Hospira	None	None	None	None
Leonard Feldman	Organizational Reviewer—SHM	Johns Hopkins School of Medicine– Director, Medicine-Pediatrics Urban Health Residency Program; Assistant Professor of Pediatrics; Assistant Professor of Medicine	None	None	None	None	None	• Defendant, pulmonary embolism, 2013 • Defendant, aortic dissection, 2013 • Defendant, stroke, 2013 • Defendant, sudden cardiac death, 2013
Jason Kovacic	Organizational Reviewer—SCAI	Mount Sinai School of Medicine—Assistant Professor of Medicine	• AstraZeneca*	• AstraZeneca	None	None	None	None
Martin London	Organizational Reviewer—SCA	University of California, San Francisco Medical Center—Professor of Clinical Anesthesia	None	None	None	None	None	None

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Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Rupa Mehta Sanghani	Organizational Reviewer—ASNC	University of Chicago Medicine—Director, Cardiac Rehabilitation; Assistant Professor of Medicine	• Astellas	• Astellas	None	None	None	None
Reena Pande	Organizational Reviewer—SVM	Brigham and Women's Hospital, Prevention Brigham and Women's Hospital—Associate Physician; Harvard Medical School, Professor	None	None	None	None	None	None
Jeanne Poole	Organizational Reviewer—HRS	University of Washington—Professor of Medicine, Division of Cardiology	• Biotronik • Boston Scientific* • Medtronic • St. Jude Medical	None	None	None	• Boston Scientific • Medtronic	None
Russell Postier	Organizational Reviewer—ACS	University of Oklahoma Health Sciences Center—John A. Schilling Professor and Chairman, Department of Surgery	None	None	None	None	None	None
M. Obadah N. Al-Chekakie	Content Reviewer—ACC Board of Governors	Cheyenne Regional Medical Group—Physician	None	None	None	None	None	None
Jeffrey L. Anderson	Content Reviewer—ACC/AHA Task Force on Practice Guidelines	Intermountain Medical Center—Associate Chief of Cardiology	• Sanofi-aventis • The Medicines Company	None	None	None	None	None
H. Vernon Anderson	Content Reviewer—ACC Interventional Section Leadership Council	University of Texas Cardiology Division—Professor of Medicine	None	None	None	None	• MedPlace Medical Devices (DSMB)	None
Hugh Calkins	Content Reviewer	Johns Hopkins Hospital—Professor of Medicine; Director of Electrophysiology	None	None	None	• St. Jude Medical*	None	None
Steven Cohn	Content Reviewer	University of Miami—Professor of Clinical Medicine; University of Miami Hospital— Director, Medical Consultation Service; University Health Preoperative Assessment Center—Medical Director	None	None	• AstraZeneca* • Bristol-Myers Squibb* • GlaxoSmithKline* • Merck* • Pfizer*	None	None	• Defendant, venous thromboemboli pulmonary embolism, 2013 • Defendant, preoperative evaluation, 2013

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Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
George Crossley	Content Reviewer—ACC Electrophysiology Section Leadership Council	St. Thomas Heart—Medical Director, Cardiac Services	• Boston Scientific • Medtronic*	• Medtronic* • Sanofi-aventis	None	None	None	• Defendant, pacemaker complication, 2012 • Defendant, EP procedure complication, 2013
P.J. Devereaux	Content Reviewer	McMaster University—Associate Professor, Departments of Clinical Epidemiology and Biostatistics; Juravinski Hospital and Cancer Centre—Head of Cardiology and the Perioperative Cardiovascular Service	None	None	None	• Abbott Diagnostics* • Bayer* • Boehringer Ingelheim* • Roche Diagnostics* • Stryker*	• Canadian Perioperative Guideline Chair	None
Richard Lange	Content Reviewer	University of Texas Health Science Center at San Antonio—Professor of Medicine	None	None	None	None	None	None
Maria Lantin-Hermoso	Content Reviewer—ACC Congenital and Pediatric Cardiology Section Leadership Council	Baylor College of Medicine—Associate Professor, Department of Pediatrics, Section of Cardiology; Texas Children's Hospital—Attending Physician	None	None	None	None	None	None
Srinivas Murali	Content Reviewer—ACC Board of Governors	Temple University School of Medicine—Professor of Medicine; Director, Division of Cardiovascular Medicine; Cardiovascular Institute Medical—Medical director	• Actelion • Bayer • Gilead • Lung Biotechnology	• Actelion	None	• Cardiokinetics • CVRx • Gilead • Ikaria • Medtronic • St. Jude Medical	None	None
E. Magnus Ohman	Content Reviewer—ACC/AHA Task Force on Practice Guidelines	Duke University Medical Center—Professor of Medicine; Director, Program for Advanced Coronary Disease	• Abiomed* • AstraZeneca • Daiichi-Sankyo* • Gilead Sciences • Janssen Pharmaceuticals* • Pozen • Sanofi-aventis* • The Medicines Company	None	None	• Eli Lilly* • Gilead Sciences*	None	None

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Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Gurusher Panjrath	Content Reviewer—ACC Heart Failure and Transplant Section Leadership Council	George Washington Heart and Vascular Institute—Assistant Professor of Medicine; Director, Heart Failure and Mechanical Support Program	None	None	None	None	None	None
Susan J. Pressler	Content Reviewer—ACC/AHA Task Force on Practice Guidelines	University of Michigan School of Nursing—Professor	None	None	None	None	• Pfizer†	None
Pasala Ravichandran	Content Reviewer—ACC Surgeons' Council	Oregon Health and Science University—Associate Professor	None	None	None	None	None	None
Ezra Amsterdam	Content Reviewer	University of California Davis Medical Center Division of Cardiology—Professor	None	None	None	None	None	None
John Erwin	Content Reviewer	Scott and White Hospital and Clinic—Senior Staff Cardiologist, Associate Professor of Medicine	None	None	None	• Eli Lilly (PI)*	None	None
Samuel Gidding	Content Reviewer—ACC/AHA Task Force on Practice Guidelines	Nemours/Alfred I. DuPont Hospital for Children—Chief, Division of Pediatric Cardiology	None	None	None	• GlaxoSmithKline*	None	None
Robert Hendel	Content Reviewer	University of Miami School of Medicine—Director Cardiac Imaging and Outpatient Services	• Adenosine Therapeutics • Astellas • Bayer	None	None	None	None	None
Glenn Levine	Content Reviewer	Baylor College of Medicine—Associate Professor of Medicine	None	None	None	None	None	None
Karen Mauck	Content Reviewer	Mayo Clinic Minnesota—Associate Professor of Medicine	None	None	None	None	None	None
Win-Kuang Shen	Content Reviewer—ACC/AHA Task Force on Practice Guidelines	Mayo Clinic Arizona—Professor of Medicine	None	None	None	None	None	None

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Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Ralph Verdino	Content Reviewer	Hospital of the University of Pennsylvania—Associate Professor of Medicine; Director, Cardiology Electrophysiology Fellowship Program	• Biotronik • Medtronic • St. Jude Medical*	None	None	None	• LifeWatch*	None
L. Samuel Wann	Content Reviewer	Columbia St. Mary's Cardiovascular Physicians—Clinical Cardiologist	None	None	None	None	None	None
Clyde W. Yancy	Content Reviewer	Northwestern University, Feinberg School of Medicine—Magerstadt Professor of Medicine; Chief, Division of Cardiology	None	None	None	None	None	None

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*Significant relationship.

†No financial benefit.

ACC indicates American College of Cardiology; ACS, American College of Surgeons; AHA, American Heart Association; ASA, American Society of Anesthesiologists; ASE, American Society of Echocardiography; ASNC, American Society of Nuclear Cardiology; DSMB, data safety monitoring board; EP, electrophysiology; HRS, Heart Rhythm Society; PI, principal investigator; SCA, Society of Cardiovascular Anesthesiologists; SCAI, Society for Cardiovascular Angiography and Interventions; SHM, Society of Hospital Medicine; and SVM, Society for Vascular Medicine.

Appendix 3. Related Recommendations From Other CPGs

Table A. Left Main CAD Revascularization Recommendations From the 2011 CABG and PCI CPGs

Anatomic Setting	COR	LOE	References
UPLM or complex CAD			
CABG and PCI	I—Heart Team approach recommended	C	170–172
CABG and PCI	IIa—Calculation of the STS and SYNTAX scores	B	170, 173–180
UPLM*			
CABG	I	B	181–187
PCI	IIa—For SIHD when both of the following are present: 2. Anatomic conditions associated with a low risk of PCI procedural complications and a high likelihood of good long-term outcome (eg, a low SYNTAX score of ≤22, ostial, or trunk left main CAD) 3. Clinical characteristics that predict a significantly increased risk of adverse surgical outcomes (eg, STS-predicted risk of operative mortality ≥5%)	B	173, 176, 180, 188–206
	IIa—For UA/NSTEMI if not a CABG candidate	B	173, 194–197, 202, 203, 205–207
	IIa—For STEMI when distal coronary flow is TIMI flow grade <3 and PCI can be performed more rapidly and safely than CABG	C	191, 208, 209
	IIb—For SIHD when *both* of the following are present: 2. Anatomic conditions associated with a low-to-intermediate risk of PCI procedural complications and intermediate-to-high likelihood of good long-term outcome (eg, low–intermediate SYNTAX score of <33, bifurcation left main CAD) 3. Clinical characteristics that predict an increased risk of adverse surgical outcomes (eg, moderate–severe COPD, disability from prior stroke, or prior cardiac surgery; STS-predicted risk of operative mortality >2%)	B	173, 176, 180, 188–206, 210
	III: Harm—For SIHD in patients (versus performing CABG) with unfavorable anatomy for PCI and who are good candidates for CABG	B	173, 176, 180–187, 189, 190
3-vessel disease with or without proximal LAD artery disease*			
CABG	I	B	183, 187, 211–214
	IIa—It is reasonable to choose CABG over PCI in patients with complex 3-vessel CAD (eg, SYNTAX >22) who are good candidates for CABG	B	190, 205, 213, 215, 216
PCI	IIb—Of uncertain benefit	B	183, 204, 211, 213, 217
2-vessel disease with proximal LAD artery disease*			
CABG	I	B	183, 187, 211–214
PCI	IIb—Of uncertain benefit	B	183, 211, 213, 217
2-vessel disease without proximal LAD artery disease*			
CABG	IIa—With extensive ischemia	B	218–221
	IIb—Of uncertain benefit without extensive ischemia	C	213
PCI	IIb—Of uncertain benefit	B	183, 211, 213, 217
1-vessel proximal LAD artery disease			
CABG	IIa—With LIMA for long-term benefit	B	187, 213, 222, 223
PCI	IIb—Of uncertain benefit	B	183, 211, 213, 217
1-vessel disease without proximal LAD artery involvement			
CABG	III: Harm	B	187, 211, 218, 219, 224–227
PCI	III: Harm	B	187, 211, 218, 219, 224–227

(Continued)

Table A. Continued

Anatomic Setting	COR	LOE	References
LV dysfunction			
CABG	IIa—EF 35% to 50%	B	187, 228–232
CABG	IIb—EF <35% without significant left main CAD	B	187, 228–234
PCI	Insufficient data		N/A
Survivors of sudden cardiac death with presumed ischemia-mediated VT			
CABG	I	B	235–237
PCI	I	C	236
No anatomic or physiological criteria for revascularization			
CABG	III: Harm	B	187, 211, 218, 219, 224–227, 238
PCI	III: Harm	B	187, 211, 218, 219, 224–227, 238

*In patients with multivessel disease who also have diabetes mellitus, it is reasonable to choose CABG (with LIMA) over PCI[220,239–246] (*Class IIa; LOE: B*).

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; COR, Class of Recommendation; CPG, clinical practice guideline; EF, ejection fraction; LAD, left anterior descending; LIMA, left internal mammary artery; LOE, Level of Evidence; LV, left ventricular; N/A, not applicable; PCI, percutaneous coronary intervention; SIHD, stable ischemic heart disease; STEMI, ST-elevation myocardial infarction; STS, Society of Thoracic Surgeons; SYNTAX, Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery; TIMI, Thrombolysis In Myocardial Infarction; UA/NSTEMI, unstable angina/non–ST-elevation myocardial infarction; UPLM, unprotected left main disease; and VT, ventricular tachycardia.

Reproduced from Levine et al[96] and Hillis et al.[95]

Table B. GDMT Recommendations for Beta Blockers From 2011 Secondary Prevention CPG

Beta Blockers	**Class I** 1. Beta-blocker therapy should be used in all patients with LV systolic dysfunction (EF ≤40%) with HF or prior MI, unless contraindicated. (Use should be limited to carvedilol, metoprolol succinate, or bisoprolol, which have been shown to reduce mortality.)[247–249] ***(Level of Evidence: A)*** 2. Beta-blocker therapy should be started and continued for 3 years in all patients with normal LV function who have had MI or ACS.[250–252] ***(Level of Evidence: B)*** **Class IIa** 1. It is reasonable to continue beta blockers >3 years as chronic therapy in all patients with normal LV function who have had MI or ACS.[250–252] ***(Level of Evidence: B)*** 2. It is reasonable to give beta-blocker therapy in patients with LV systolic dysfunction (EF ≤40%) without HF or prior MI. ***(Level of Evidence: C)***

ACS indicates acute coronary syndrome; CPG, clinical practice guideline; EF, ejection fraction; GDMT, guideline-directed medical therapy; HF, heart failure; LV, left ventricular; and MI, myocardial infarction.

Reproduced from Smith Jr et al.[124]