



Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery

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Key Points

Diagnosis

Treatment

Key Points

1. **The aims of preoperative evaluation in the patient undergoing noncardiac surgery are:**
 - a. 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),
 - b. determination of the need for changes in management, and
 - c. identification of cardiovascular conditions or risk factors requiring longer-term management.
2. **A validated risk-prediction tool (e.g., ACS NSQIP risk calculator and Lee Revised Cardiac Risk Index) can be useful in predicting the risk of perioperative MACE in patients undergoing noncardiac surgery.**
3. **In the absence of a coronary intervention, ≥ 60 days should elapse after a myocardial infarction before noncardiac surgery is undertaken.**
4. **The decision to perform further cardiovascular testing depends upon the urgency of surgery, assessment of risk based upon the combination of surgical and clinical factors, and functional status. Risk is dichotomized into low ($< 1\%$ incidence of MACE) and elevated risk.**
5. **Testing should only be performed if it changes management.**
6. **Elective noncardiac surgery should optimally be delayed 365 days after DES implantation. With the newer-generation DES, elective noncardiac surgery after DES implantation may be considered after 180 days if the risk of further delay is greater than the expected risks of ischemia and stent thrombosis.**
7. **The only Class I indication for perioperative beta-blocker therapy is that therapy should be continued in patients undergoing surgery who have been on beta-blockade chronically. Active management of patients on beta blockers is required during and after surgery. Particular attention should be paid to the need to modify or temporarily discontinue beta blockers as clinical circumstances (e.g., hypotension, bradycardia, bleeding) dictate.**
8. **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.**

↩ Diagnosis

Table 1. Definitions of Urgency and Risk

Category	Definitions
Emergency	<ul style="list-style-type: none">• 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 h.
Urgent	<ul style="list-style-type: none">• There may be time for a limited clinical evaluation, usually when life or limb is threatened if not in the operating room, typically between 6 and 24 h.
Time-sensitive	<ul style="list-style-type: none">• A delay of >1 to 6 wk to allow for an evaluation and significant changes in management will negatively affect outcome. (Most oncologic procedures would fall into this category.)
Elective	<ul style="list-style-type: none">• The procedure could be delayed for up to 1 y.
Low risk	<ul style="list-style-type: none">• The combined surgical and patient characteristics predict a risk of a MACE of death or MI of <1%.
Elevated risk	<ul style="list-style-type: none">• A risk of MACE of $\geq 1\%$.

Figure 1. Stepwise Approach to Perioperative Cardiac Assessment for CAD

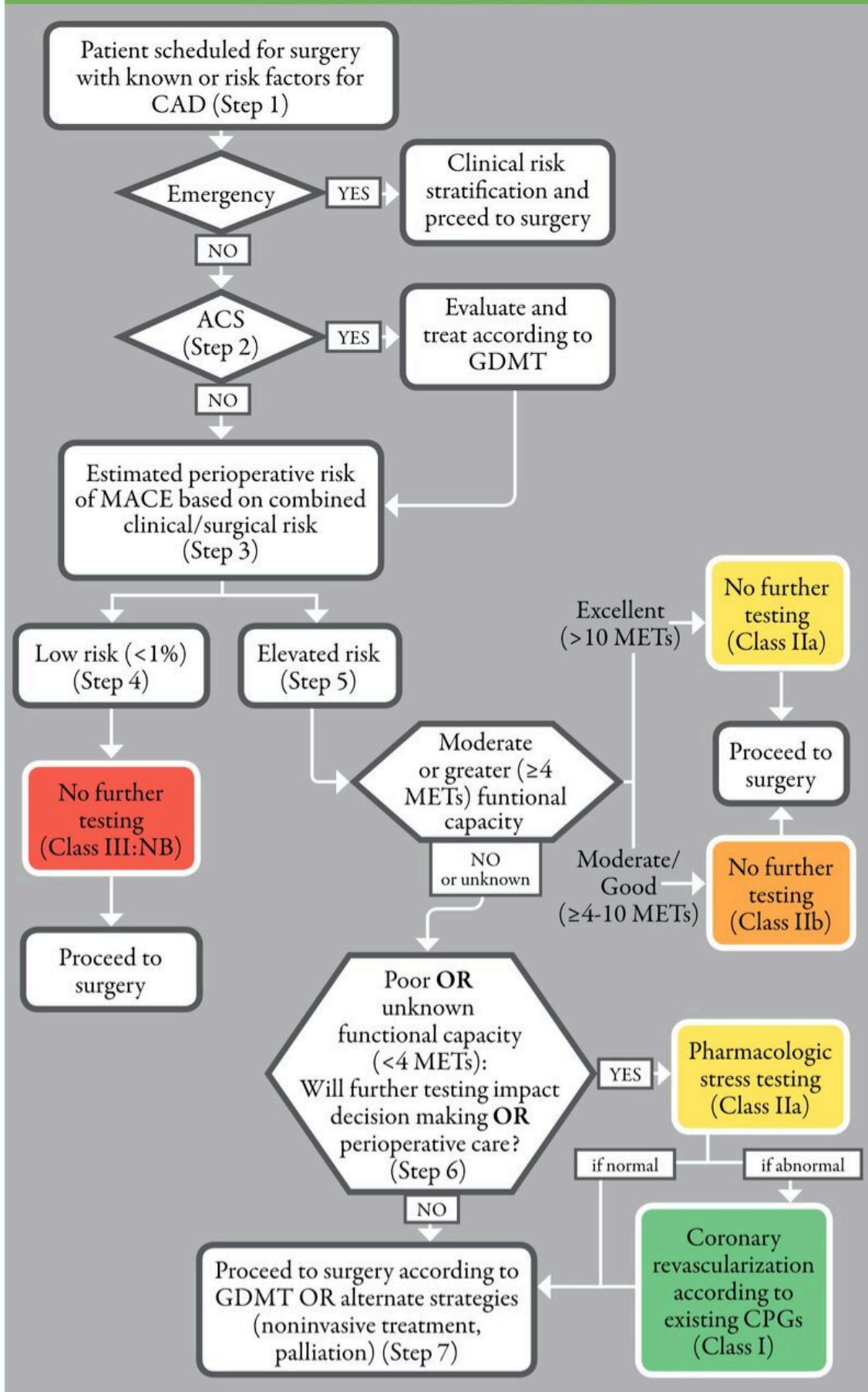


Table 2. Supplemental Preoperative Evaluation

Recommendations	COR	LOE
Multivariate Risk Indices		
A validated risk-prediction tool can be useful in predicting the risk of perioperative MACE in patients undergoing noncardiac surgery.	Ia	B
For patients with a low risk of perioperative MACE, further testing is NOT recommended before the planned operation.	III: No Benefit	B
The 12-lead ECG		
Preoperative resting 12-lead 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.	Ia	B
Preoperative resting 12-lead ECG may be considered for asymptomatic patients without known coronary heart disease, except for those undergoing low-risk surgery.	Ib	B
Routine preoperative resting 12-lead ECG is NOT useful for asymptomatic patients without known coronary heart disease, except for those undergoing low-risk surgery.	III: No Benefit	B
Assessment of LV function		
It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function.	Ia	C
It is reasonable for patients with HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function.	Ia	C
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.	Ib	C
Routine preoperative evaluation of LV function is NOT recommended.	III: No Benefit	B
Exercise stress testing for myocardial ischemia and functional capacity		
For patients with elevated risk and excellent (>10 METs) functional capacity, it is reasonable to forgo further exercise testing with cardiac imaging and proceed to surgery.	Ia	B
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.	Ib	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.	Ib	B
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.	Ib	C
Routine screening with noninvasive stress testing is NOT useful for patients at low-risk for noncardiac surgery.	III: No Benefit	B

↪ Diagnosis

Table 2. Supplemental Preoperative Evaluation (cont'd)

Recommendations	COR	LOE
Cardiopulmonary exercise testing		
Cardiopulmonary exercise testing may be considered for patients undergoing elevated risk procedures in whom functional capacity is unknown.	IIb	B
Noninvasive pharmacological stress testing before noncardiac surgery		
It is reasonable for patients who are at elevated risk for noncardiac surgery and have poor functional capacity (<4 METs) to undergo either DSE or MPI noninvasive pharmacological stress testing (either DSE or pharmacological stress MPI) if it will change management.	IIa	B
Routine screening with noninvasive stress testing is NOT useful for patients undergoing low-risk noncardiac surgery.	III: No Benefit	B
Preoperative coronary angiography		
Routine preoperative coronary angiography is NOT recommended.	III: No Benefit	C

Table 3. Valvular Heart Disease, CIEDs and Pulmonary Vascular Disease

Recommendations	COR	LOE
Valvular Heart Disease		
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.	I	C
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.	I	C
Aortic Stenosis		
Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe aortic stenosis.	IIa	B
Mitral Stenosis		
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.	IIb	C

Table 3. Valvular Heart Disease, CIEDs and Pulmonary Vascular Disease (cont'd)

Recommendations	COR	LOE
<i>Aortic and Mitral Regurgitation</i>		
Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe MR.	Ia	C
Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe AR and a normal LVEF.	Ia	C
CIEDs		
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.	I	C
Patients with ICDs who have preoperative reprogramming to inactivate tachytherapy should be on a cardiac monitor continuously during the entire period of inactivation, and external defibrillation equipment should be available. Systems should be in place to ensure that ICDs are reprogrammed to active therapy before discontinuation of cardiac monitoring and discharge from the facility.	I	C
Pulmonary Vascular Disease		
Chronic pulmonary vascular targeted therapy (i.e., 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.	I	C
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. ^a	Ia	C

^a Features of increased perioperative risk in patients with pulmonary hypertension include:
 1) diagnosis of Group 1 pulmonary hypertension (i.e., 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.

Table 4. Perioperative Therapy

Recommendations	COR	LOE
Coronary revascularization before noncardiac surgery		
Revascularization before noncardiac surgery is recommended in circumstances in which revascularization is indicated according to existing CPGs.	I	C
It is NOT recommended that routine coronary revascularization be performed before noncardiac surgery exclusively to reduce perioperative cardiac events.	III: No Benefit	B
Timing of elective noncardiac surgery in patients with previous PCI		
Elective noncardiac surgery should be delayed 14 days after balloon angioplasty and 30 days after BMS implantation.	I	C: 14 days after balloon angioplasty
		B: 30 days after BMS implantation
Elective noncardiac surgery should optimally be delayed 365 days after DES implantation.	I	B
In patients in whom noncardiac surgery is required, a consensus decision among treating clinicians as to the relative risks of discontinuation or continuation of antiplatelet therapy can be useful.	IIa	C
Elective noncardiac surgery after DES implantation may be considered after 180 days if the risk of further delay is greater than the expected risks of ischemia and stent thrombosis.	IIb ^a	B
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.	III: Harm	B
Elective noncardiac surgery should NOT be performed within 14 days of balloon angioplasty in patients in whom aspirin will need to be discontinued perioperatively.	III: Harm	C
Perioperative beta-blocker therapy		
Beta blockers should be continued in patients undergoing surgery who have been on beta blockers chronically.	I	B ^{SRb}
It is reasonable for the management of beta blockers after surgery to be guided by clinical circumstances, independent of when the agent was started.	IIa	B ^{SRb}
In patients with intermediate- or high-risk myocardial ischemia noted in preoperative risk stratification tests, it may be reasonable to begin perioperative beta blockers.	IIb	C ^{SRb}

^a Because of new evidence, this is a new recommendation since the publication of the 2011 PCI CPG.

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

Table 4. Perioperative Therapy (cont'd)

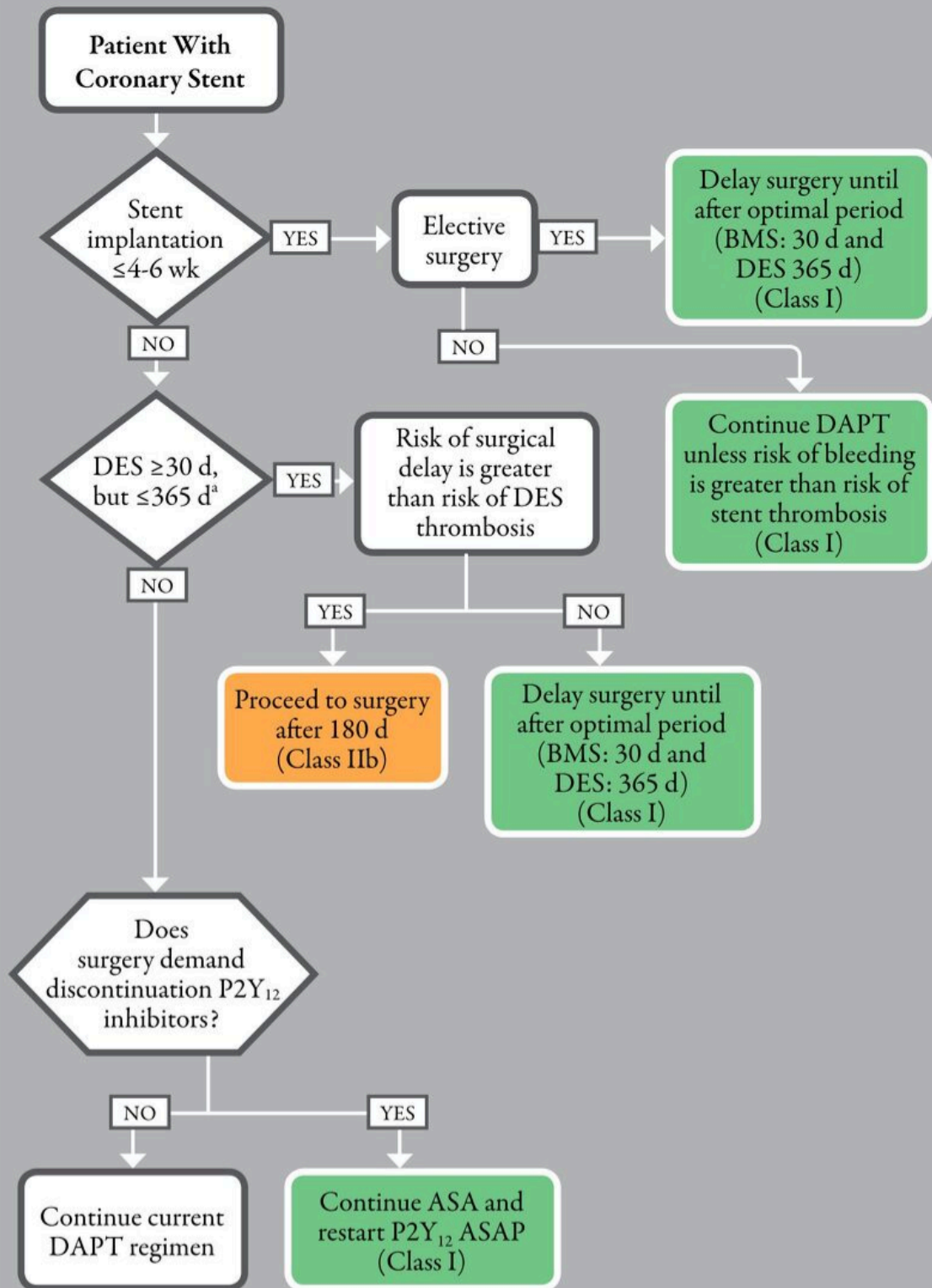
Recommendations	COR	LOE
Perioperative beta-blocker therapy (cont'd)		
In patients with ≥ 3 RCRI risk factors (e.g., diabetes mellitus, HF, coronary artery disease, renal insufficiency, cerebrovascular accident), it may be reasonable to begin beta blockers before surgery.	I Ib	B ^{SRb}
In patients with 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.	I Ib	B ^{SRb}
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 >1 day before surgery.	I Ib	B ^{SRb}
Beta-blocker therapy should NOT be started on the day of surgery.	III: Harm	B ^{SRb}
Perioperative statin therapy		
Statins should be continued in patients currently taking statins and scheduled for noncardiac surgery.	I	B
Perioperative initiation of statin use is reasonable in patients undergoing vascular surgery.	IIa	B
Perioperative initiation of statins may be considered in patients with clinical indications according to GDMT who are undergoing elevated-risk procedures.	I Ib	C
Alpha-2 agonists		
Alpha-2 agonists for prevention of cardiac events are NOT recommended in patients who are undergoing noncardiac surgery.	III: No Benefit	B
ACE inhibitors		
Continuation of ACE inhibitors or ARBs perioperatively is reasonable.	IIa	B
If ACE inhibitors or ARBs are held before surgery, it is reasonable to restart as soon as clinically feasible postoperatively.	IIa	C

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

Table 4. Perioperative Therapy (cont'd)

Recommendations	COR	LOE
Antiplatelet agents		
Continue DAPT in patients undergoing urgent noncardiac surgery during the first 4-6 weeks after BMS or DES implantation, unless the risk of bleeding outweighs the benefit of stent thrombosis prevention. In patients undergoing urgent noncardiac surgery during the first 4-6 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.	I	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.	I	C
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.	I	C
In patients undergoing nonemergency/nonurgent noncardiac surgery without prior coronary stenting who have not had previous coronary stenting, it may be reasonable to continue aspirin when the risk of increased cardiac events outweighs the risk of increased bleeding.	IIb	B
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 C: If risk of ischemic events outweighs risk of surgical bleeding

Figure 2. Algorithm for Antiplatelet Management in Patients With PCI and Noncardiac Surgery



^a Assuming patient is currently on DAPT.

Table 5. Anesthetic Consideration and Intraoperative Management

Recommendations	COR	LOE
Volatile general anesthesia versus total intravenous anesthesia		
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.	IIa	A
Perioperative pain management		
Neuraxial anesthesia for <i>postoperative</i> pain relief can be effective in patients undergoing abdominal aortic surgery to decrease the incidence of perioperative MI.	IIa	B
Preoperative epidural analgesia may be considered to decrease the incidence of <i>preoperative</i> cardiac events in patients with hip fracture.	IIb	B
Prophylactic intraoperative nitroglycerin		
Prophylactic intravenous nitroglycerin is NOT effective in reducing myocardial ischemia in patients undergoing noncardiac surgery.	III: No Benefit	B
Intraoperative monitoring techniques		
Emergency use of perioperative TEE 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.	IIa	C
Routine use of intraoperative TEE 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 neurologic compromise.	III: No Benefit	C
Maintenance of body temperature		
Maintenance of normothermia may be reasonable to reduce perioperative cardiac events in patients undergoing noncardiac surgery.	IIb	B
Hemodynamic assist devices		
Use of hemodynamic assist devices may be considered when urgent or emergency noncardiac surgery is required in the setting of acute severe cardiac dysfunction (i.e., acute MI, cardiogenic shock) that cannot be corrected before surgery.	IIb	C

Table 5. Anesthetic Consideration and Intraoperative Management (cont'd)

Recommendations	COR	LOE
Perioperative use of pulmonary artery catheters		
The use of pulmonary artery catheterization may be considered when underlying medical conditions that significantly affect hemodynamics (i.e., HF, severe valvular disease, combined shock states) cannot be corrected before surgery.	I Ib	C
Routine use of pulmonary artery catheterization in patients, even those with elevated risk, is <i>NOT</i> recommended.	III: No Benefit	A

Table 6. Surveillance and Management for Perioperative MI

Recommendations	COR	LOE
Measurement of troponin levels is recommended in the setting of signs or symptoms suggestive of myocardial ischemia or MI.	I	A
Obtaining an ECG is recommended in the setting of signs or symptoms suggestive of myocardial ischemia, MI, or arrhythmia.	I	B
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.	I Ib	B
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.	I Ib	B
Routine postoperative screening with troponin levels in unselected patients without signs or symptoms suggestive of myocardial ischemia or MI is <i>NOT</i> useful for guiding perioperative management.	III: No Benefit	B