2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention

A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions

Citation

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The full-text guidelines are also available on the following Web sites:
ACC (www.cardiosource.org), AHA (my.americanheart.org), and SCAI (www.scai.org)

Special Thanks To

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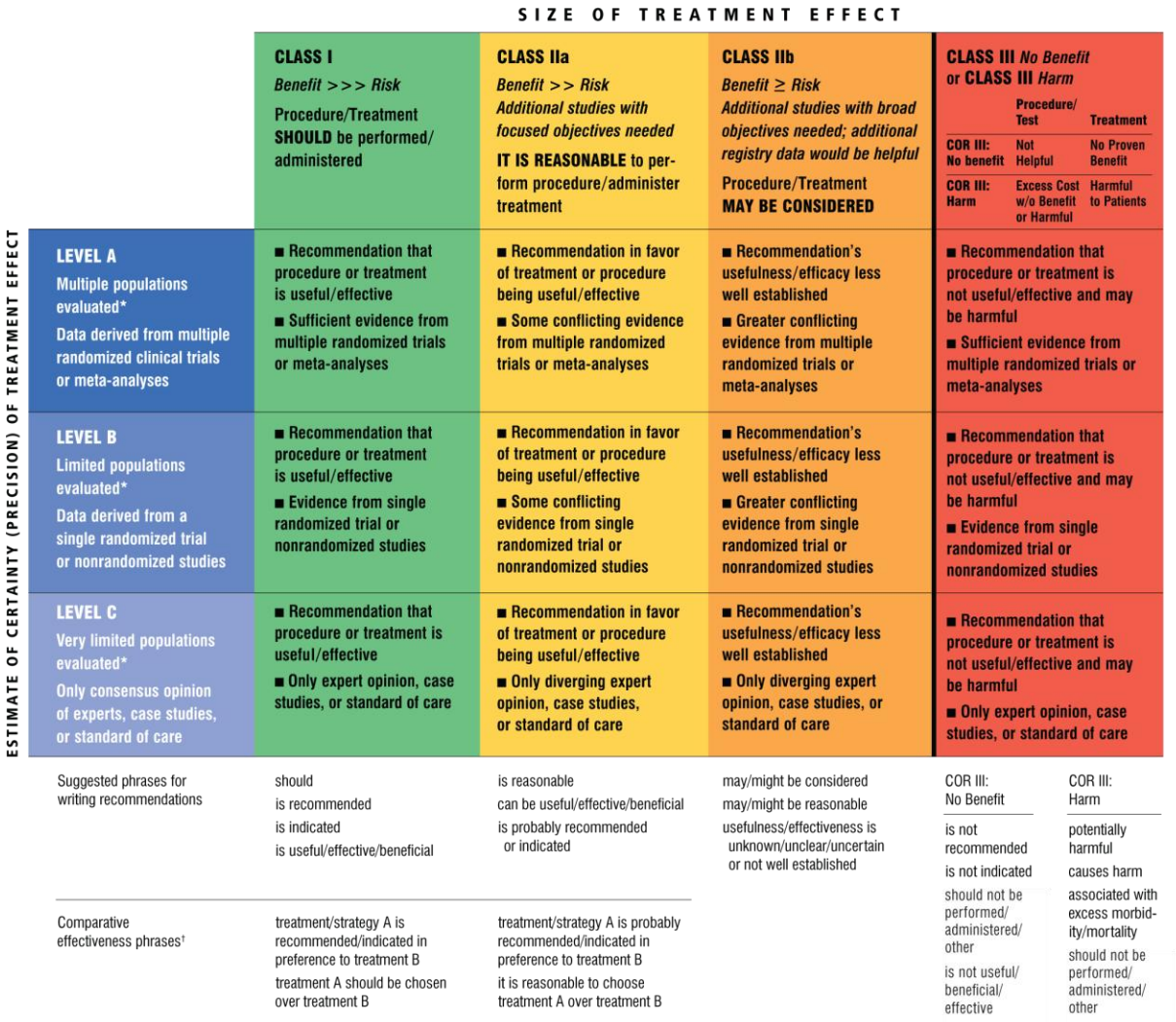
Classification of Recommendations and Levels of Evidence



SIZE OF TREATMENT EFFECT

ESTIMATE OF CERTAINTY (PRECISION) 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 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, 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.

Introduction

The PCI guideline reflects the growth of knowledge in the field and parallels the many advances and innovations in the field of interventional cardiology, including primary PCI, BMS and DES, IVUS and physiologic assessments of stenosis, and newer antiplatelet and anticoagulant therapies. This guideline addresses ethical aspects of PCI, vascular access considerations, CAD revascularization, including hybrid revascularization, revascularization before noncardiac surgery, optical coherence tomography, advanced hemodynamic support devices, no-reflow therapies, and vascular closure devices.

Most of this document is organized according to "patient flow," consisting of preprocedural considerations, procedural considerations, and postprocedural considerations.

The STEMI, PCI, and CABG guidelines were written concurrently, with additional collaboration with the SIHD guideline writing committee, allowing for greater collaboration on topics such as PCI in STEMI and revascularization strategies in patients with CAD.

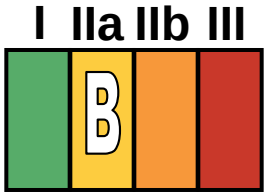
Guideline for CABG

CAD Revascularization

Heart Team Approach to Revascularization Decisions

Heart Team Approach to Revascularization Decisions

A Heart Team approach to revascularization is recommended in patients with unprotected left main or complex CAD.



Calculation of the STS and SYNTAX scores is reasonable in patients with unprotected left main and complex CAD.

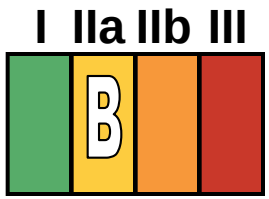
Revascularization to Improve Survival

Revascularization to Improve Survival: Left Main CAD Revascularization

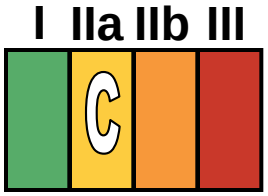
CABG to improve survival is recommended for patients with significant (≥50% diameter stenosis) left main CAD.

PCI to improve survival is reasonable as an alternative to CABG in selected stable patients with significant (≥50% diameter stenosis) unprotected left main CAD with: 1) anatomic conditions associated with a low risk of PCI procedural complications and a high likelihood of a good long-term outcome (e.g., a low SYNTAX score [≤22], ostial or trunk left main CAD); and 2) clinical characteristics that predict a significantly increased risk of adverse surgical outcomes (e.g., STS-predicted risk of operative mortality ≥5%).

Revascularization to Improve Survival: Left Main CAD Revascularization (cont.)

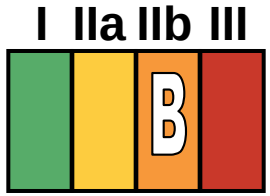


PCI to improve survival is reasonable in patients with UA/NSTEMI when an unprotected left main coronary artery is the culprit lesion and the patient is not a candidate for CABG.



PCI to improve survival is reasonable in patients with acute STEMI when an unprotected left main coronary artery is the culprit lesion, distal coronary flow is TIMI (Thrombolysis In Myocardial Infarction) grade <3, and PCI can be performed more rapidly and safely than CABG.

Revascularization to Improve Survival: Left Main CAD Revascularization (cont.)



PCI to improve survival may be reasonable as an alternative to CABG in selected stable patients with significant (≥50% diameter stenosis) unprotected left main CAD with: 1) anatomic conditions associated with a low to intermediate risk of PCI procedural complications and an intermediate to high likelihood of good long-term outcome (e.g., low-intermediate SYNTAX score of <33, bifurcation left main CAD); and 2) clinical characteristics that predict an increased risk of adverse surgical outcomes (e.g., moderate-severe chronic obstructive pulmonary disease, disability from previous stroke, or previous cardiac surgery; STS-predicted risk of operative mortality >2%).

Revascularization to Improve Survival: Left Main CAD Revascularization (cont.)

Harm

PCI to improve survival should not be performed in stable patients with significant (≥50% diameter stenosis) unprotected left main CAD who have unfavorable anatomy for PCI and who are good candidates for CABG.

Revascularization to Improve Survival: Non-Left Main CAD Revascularization

CABG to improve survival is beneficial in patients with significant (≥70% diameter) stenoses in 3 major coronary arteries (with or without involvement of the proximal LAD artery) or in the proximal LAD plus 1 other major coronary artery.

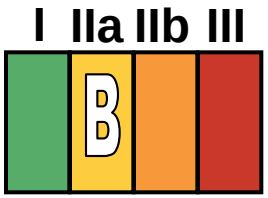
Revascularization to Improve Survival: Non-Left Main CAD Revascularization (cont.)

CABG

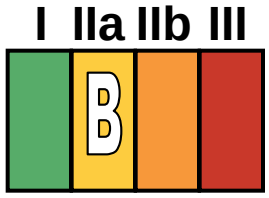
PCI

CABG or PCI to improve survival is beneficial in survivors of sudden cardiac death with presumed ischemia-mediated ventricular tachycardia caused by a significant (≥70% diameter) stenosis in a major coronary artery.

Revascularization to Improve Survival: Non-Left Main CAD Revascularization (cont.)

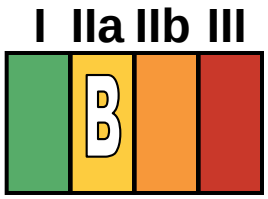


CABG to improve survival is reasonable in patients with significant (≥70% diameter) stenoses in 2 major coronary arteries with severe or extensive myocardial ischemia (e.g., high-risk criteria on stress testing, abnormal intracoronary hemodynamic evaluation, or >20% perfusion defect by myocardial perfusion stress imaging) or target vessels supplying a large area of viable myocardium.

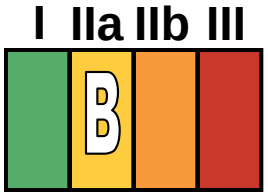


CABG to improve survival is reasonable in patients with mild-moderate left ventricular systolic dysfunction (ejection fraction 35% to 50%) and significant (≥70% diameter stenosis) multivessel CAD or proximal LAD coronary artery stenosis, when viable myocardium is present in the region of intended revascularization.

Revascularization to Improve Survival: Non-Left Main CAD Revascularization (cont.)

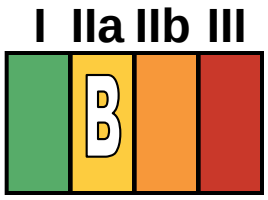


CABG with a LIMA graft to improve survival is reasonable in patients with a significant (≥70% diameter) stenosis in the proximal LAD artery and evidence of extensive ischemia.



It is reasonable to choose CABG over PCI to improve survival in patients with complex 3-vessel CAD (e.g., SYNTAX score >22) with or without involvement of the proximal LAD artery who are good candidates for CABG.

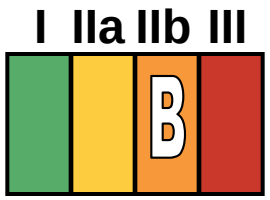
Revascularization to Improve Survival: Non-Left Main CAD Revascularization (cont.)



CABG is probably recommended in preference to PCI to improve survival in patients with multivessel CAD and diabetes mellitus, particularly if a LIMA graft can be anastomosed to the LAD artery.

The usefulness of CABG to improve survival is uncertain in patients with significant (≥70%) stenoses in 2 major coronary arteries not involving the proximal LAD artery and without extensive ischemia.

Revascularization to Improve Survival: Non-Left Main CAD Revascularization (cont.)



The usefulness of PCI to improve survival is uncertain in patients with 2- or 3-vessel CAD (with or without involvement of the proximal LAD artery) or 1-vessel proximal LAD disease.

CABG might be considered with the primary or sole intent of improving survival in patients with SIHD with severe LV systolic dysfunction (EF<35%) whether or not viable myocardium is present.

The usefulness of CABG or PCI to improve survival is uncertain in patients with previous CABG and extensive anterior wall ischemia on noninvasive testing.

Revascularization to Improve Survival: Non-Left Main CAD Revascularization (cont.)

Harm

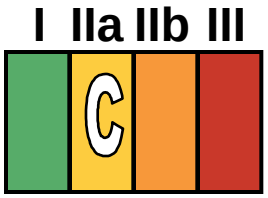
CABG or PCI should not be performed with the primary or sole intent to improve survival in patients with SIHD with 1 or more coronary stenoses that are not anatomically or functionally significant (e.g., <70% diameter non–left main coronary artery stenosis, fractional flow reserve >0.80, no or only mild ischemia on noninvasive testing), involve only the left circumflex or right coronary artery, or subtend only a small area of viable myocardium.

Revascularization to Improve Symptoms

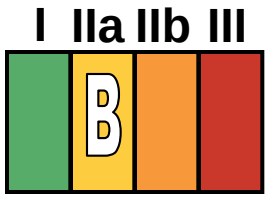
CABG or PCI to improve symptoms is beneficial in patients with 1 or more significant (≥70% diameter) coronary artery stenoses amenable to revascularization and unacceptable angina despite GDMT.

CABG or PCI to improve symptoms is reasonable in patients with 1 or more significant (≥70% diameter) coronary artery stenoses and unacceptable angina for whom GDMT cannot be implemented because of medication contraindications, adverse effects, or patient preferences.

Revascularization to Improve Symptoms (cont.)



PCI to improve symptoms is reasonable in patients with previous CABG, 1 or more significant (≥70% diameter) coronary artery stenoses associated with ischemia, and unacceptable angina despite GDMT.



It is reasonable to choose CABG over PCI to improve symptoms in patients with complex 3-vessel CAD (e.g., SYNTAX score >22), with or without involvement of the proximal LAD artery who are good candidates for CABG.

Revascularization to Improve Symptoms (cont.)

CABG to improve symptoms might be reasonable for patients with previous CABG, 1 or more significant (≥70% diameter) coronary artery stenoses not amenable to PCI, and unacceptable angina despite GDMT.

Transmyocardial laser revascularization performed as an adjunct to CABG to improve symptoms may be reasonable in patients with viable ischemic myocardium that is perfused by arteries that are not amenable to grafting.

Revascularization to Improve Symptoms (cont.)

Harm

CABG or PCI to improve symptoms should not be performed in patients who do not meet anatomic (≥50% left main or ≥70% non–left main stenosis) or physiologic (e.g., abnormal fractional flow reserve) criteria for revascularization.

Dual Antiplatelet Therapy Compliance and Stent Thrombosis

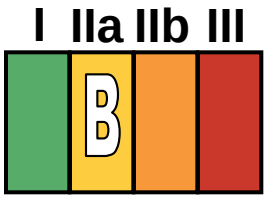
Dual Antiplatelet Therapy Compliance and Stent Thrombosis

Harm

PCI with coronary stenting (BMS or DES) should not be performed if the patient is not likely to be able to tolerate and comply with DAPT for the appropriate duration of treatment based on the type of stent implanted.

Hybrid Coronary Revascularization

Hybrid Coronary Revascularization



Hybrid coronary revascularization (defined as the planned combination of LIMA-to-LAD artery grafting and PCI of ≥1 non-LAD coronary arteries) is reasonable in patients with 1 or more of the following:

a. Limitations to traditional CABG, such as a heavily calcified proximal aorta or poor target vessels for CABG (but amenable to PCI);

b. Lack of suitable graft conduits;

c. Unfavorable LAD artery for PCI (i.e., excessive vessel tortuosity or chronic total occlusion).

Hybrid Coronary Revascularization (cont.)

Hybrid coronary revascularization (defined as the planned combination of LIMA-to-LAD artery grafting and PCI of ≥1 non-LAD coronary arteries) may be reasonable as an alternative to multivessel PCI or CABG in an attempt to improve the overall risk-benefit ratio of the procedures.

Preprocedural Considerations

Radiation Safety

Radiation Safety

Cardiac catheterization laboratories should routinely record relevant available patient procedural radiation dose data (e.g., total air kerma at the international reference point [$K_{a,r}$], air kerma air product [P_{KA}], fluoroscopy time, number of cine images), and should define thresholds with corresponding follow-up protocols for patients who receive a high procedural radiation dose.

Preprocedural Considerations

Contrast-Induced Acute Kidney Injury

Contrast-Induced Acute Kidney Injury

Patients should be assessed for risk of contrast-induced AKI before PCI.

Patients undergoing cardiac catheterization with contrast media should receive adequate preparatory hydration.

In patients with CKD (Crcl <60 mL/min), the volume of contrast media should be minimized.

Contrast-Induced Acute Kidney Injury (cont.)

No Benefit

Administration of N-acetyl-L-cysteine is not useful for the prevention of contrast-induced AKI.

Anaphylactoid Reactions

Anaphylactoid Reactions

Patients with prior evidence of an anaphylactoid reaction to contrast media should receive appropriate steroid and antihistamine prophylaxis before repeat contrast administration.

No Benefit

In patients with a prior history of allergic reactions to shellfish or seafood, anaphylactoid prophylaxis for contrast reaction is not beneficial.

Preprocedural Considerations

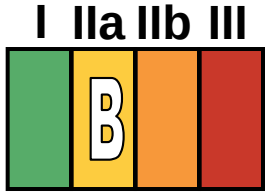
Statin Treatment

Statin Treatment

Statin-naive patients:

Administration of a high-dose statin is reasonable before PCI to reduce the risk of periprocedural MI.

Patients on chronic statin therapy:

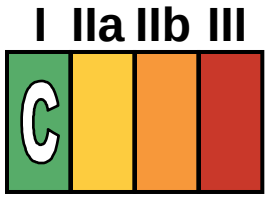


Administration of a high-dose statin is reasonable before PCI to reduce the risk of periprocedural MI.

Preprocedural Considerations

Bleeding Risk

Bleeding Risk

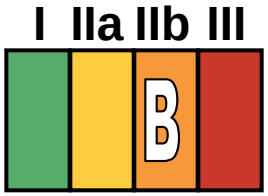


All patients should be evaluated for risk of bleeding before PCI.

PCI in Hospitals Without On-Site Surgical Backup

PCI in Hospitals Without On-Site Surgical Backup

Primary PCI is reasonable in hospitals without on-site cardiac surgery, provided that appropriate planning for program development has been accomplished.



Elective PCI might be considered in hospitals without on-site cardiac surgery, provided that appropriate planning for program development has been accomplished and rigorous clinical and angiographic criteria are used for proper patient selection.

PCI in Hospitals Without On-Site Surgical Backup (cont.)

Harm

Primary or elective PCI should not be performed in hospitals without on-site cardiac surgery capabilities without a proven plan for rapid transport to a cardiac surgery operating room in a nearby hospital or without appropriate hemodynamic support capabilities for transfer.

Procedural Considerations

Vascular Access

Vascular Access

The use of radial artery access can be useful to decrease access site complications.

PCI in Specific Clinical Situations

PCI in Specific Clinical Situations: UA/NSTEMI

An early invasive strategy (i.e., diagnostic angiography with intent to perform revascularization) is indicated in UA/NSTEMI patients who have refractory angina or hemodynamic or electrical instability (without serious comorbidities or contraindications to such procedures).

PCI in Specific Clinical Situations: UA/NSTEMI (cont.)

An early invasive strategy (i.e., diagnostic angiography with intent to perform revascularization) is indicated in initially stabilized UA/NSTEMI patients (without serious comorbidities or contraindications to such procedures) who have an elevated risk for clinical events.

PCI in Specific Clinical Situations: UA/NSTEMI (cont.)

The selection of PCI or CABG as the means of revascularization in the patient with ACS should generally be based on the same considerations as those without ACS.

PCI in Specific Clinical Situations: UA/NSTEMI (cont.)

No Benefit

An early invasive strategy (i.e., diagnostic angiography with intent to perform revascularization) is not recommended in patients with extensive comorbidities (e.g., liver or pulmonary failure, cancer) in whom

a. The risks of revascularization and comorbid conditions are likely to outweigh the benefits of revascularization,

b. There is a low likelihood of ACS despite acute chest pain, or

c. Consent to revascularization will not be granted regardless of the findings.

PCI in Specific Clinical Situations: STEMI

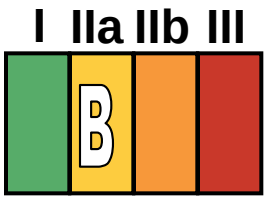
PCI in Specific Clinical Situations: STEMI–Coronary Angiography Strategies in STEMI

A strategy of immediate coronary angiography with intent to perform PCI (or emergency CABG) in patients with STEMI is recommended for

a. Patients who are candidates for primary PCI.

b. Patients with severe heart failure or cardiogenic shock who are suitable candidates for revascularization.

PCI in Specific Clinical Situations: STEMI–Coronary Angiography Strategies in STEMI (cont.)

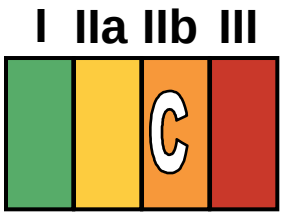


A strategy of immediate coronary angiography (or transfer for immediate coronary angiography) with intent to perform PCI is reasonable for patients with STEMI, a moderate to large area of myocardium at risk, and evidence of failed fibrinolysis.

PCI in Specific Clinical Situations: STEMI–Coronary Angiography Strategies in STEMI (cont.)

A strategy of coronary angiography (or transfer for coronary angiography) 3 to 24 hours after initiating fibrinolytic therapy with intent to perform PCI is reasonable for hemodynamically stable patients with STEMI and evidence for successful fibrinolysis when angiography and revascularization can be performed as soon as logistically feasible in this time frame.

PCI in Specific Clinical Situations: STEMI–Coronary Angiography Strategies in STEMI (cont.)



A strategy of coronary angiography performed before hospital discharge might be reasonable in stable patients with STEMI who did not undergo cardiac catheterization within 24 hours of STEMI onset.

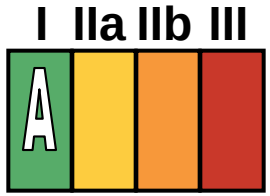
PCI in Specific Clinical Situations: STEMI–Coronary Angiography Strategies in STEMI (cont.)

No Benefit

A strategy of coronary angiography with intent to perform PCI is not recommended in patients with STEMI in whom the risks of revascularization are likely to outweigh the benefits or when the patient or designee does not want invasive care.

PCI in Specific Clinical Situations: Primary PCI of the Infarct Artery

PCI in Specific Clinical Situations: STEMI–Primary PCI of the Infarct Artery



Primary PCI should be performed in patients within 12 hours of onset of STEMI.

Primary PCI should be performed in patients with STEMI presenting to a hospital with PCI capability within 90 minutes of first medical contact as a systems goal.

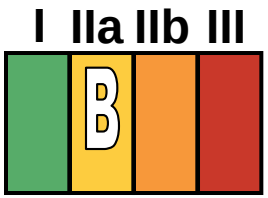
PCI in Specific Clinical Situations: STEMI–Primary PCI of the Infarct Artery (cont.)

Primary PCI should be performed in patients with STEMI presenting to a hospital without PCI capability within 120 minutes of first medical contact as a systems goal.

Primary PCI should be performed in patients with STEMI who develop severe heart failure or cardiogenic shock and are suitable candidates for revascularization as soon as possible, irrespective of time delay.

PCI in Specific Clinical Situations: STEMI–Primary PCI of the Infarct Artery (cont.)

Primary PCI should be performed as soon as possible in patients with STEMI and contraindications to fibrinolytic therapy with ischemic symptoms for <12 hours.



Primary PCI is reasonable in patients with STEMI if there is clinical and/or electrocardiographic evidence of ongoing ischemia between 12 and 24 hours after symptom onset.

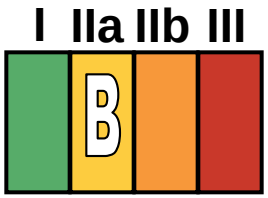
PCI in Specific Clinical Situations: STEMI–Primary PCI of the Infarct Artery (cont.)

Primary PCI might be considered in asymptomatic patients with STEMI and higher risk presenting between 12 and 24 hours after symptom onset.

Harm

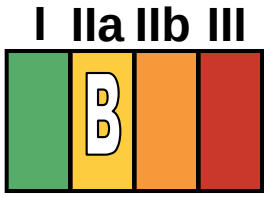
PCI should not be performed in a noninfarct artery at the time of primary PCI in patients with STEMI without hemodynamic compromise.

Delayed or Elective PCI in Patients with STEMI



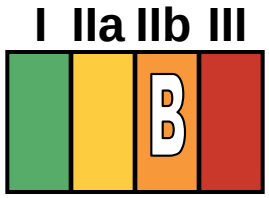
PCI is reasonable in patients with STEMI and clinical evidence for fibrinolytic failure or infarct artery reocclusion.

PCI is reasonable in patients with STEMI and a patent infarct artery 3 to 24 hours after fibrinolytic therapy.



PCI is reasonable in patients with STEMI who demonstrate ischemia on noninvasive testing.

Delayed or Elective PCI in Patients with STEMI



PCI of a hemodynamically significant stenosis in a patent infarct artery >24 hours after STEMI may be considered as part of an invasive strategy.

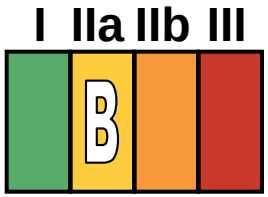
PCI of a totally occluded infarct artery >24 hours after STEMI should not be performed in asymptomatic patients with 1- or 2-vessel disease if patients are hemodynamically and electrically stable and do not have evidence of severe ischemia.

PCI in Specific Clinical Situations: Cardiogenic Shock

PCI is recommended for patients with acute MI who develop cardiogenic shock and are suitable candidates.

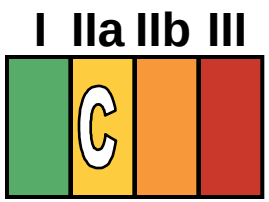
A hemodynamic support device is recommended for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacologic therapy.

PCI in Specific Clinical Situations: Revascularization Before Noncardiac Surgery



For patients who require PCI and who are scheduled for elective noncardiac surgery in the subsequent 12 months, a strategy of balloon angioplasty, or BMS implantation followed by 4 to 6 weeks of DAPT, is reasonable.

PCI in Specific Clinical Situations: Revascularization Before Noncardiac Surgery



For patients with a DES who must undergo urgent surgical procedures that mandate the discontinuation of DAPT, it is reasonable to continue aspirin if possible and restart the $P2Y_{12}$ inhibitor as soon as possible in the immediate postoperative period.

PCI in Specific Clinical Situations: Revascularization Before Noncardiac Surgery

Harm

Routine prophylactic coronary revascularization should not be performed in patients with stable CAD before noncardiac surgery.

Harm

Elective noncardiac surgery should not be performed in the 4 to 6 weeks after balloon angioplasty or BMS implantation or the 12 months after DES implantation in patients in whom the $P2Y_{12}$ inhibitor will need to be discontinued perioperatively.

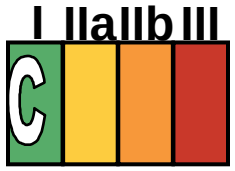
Procedural Considerations

Coronary Stents

Coronary Stents

Before implantation of DES, the interventional cardiologist should discuss with the patient the need for and duration of DAPT and the ability of the patient to comply with and tolerate DAPT.

PCI/STEMI



UA/NSTEMI

DES is useful as an alternative to BMS to reduce the risk of restenosis in cases in which the risk of restenosis is increased and the patient is likely to be able to tolerate and comply with prolonged DAPT.

Coronary Stents (cont.)

Balloon angioplasty or BMS should be used in patients with high bleeding risk, inability to comply with 12 months of DAPT, or with anticipated invasive or surgical procedures within the next 12 months during which time DAPT may be interrupted.

Coronary Stents (cont.)

Harm

PCI with coronary stenting should not be performed if the patient is not likely to be able to tolerate and to comply with DAPT.

Harm

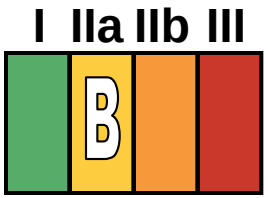
DES should not be implanted if the patient is not likely to be able to tolerate and comply with prolonged DAPT, or this cannot be determined prior to stent implantation.

Adjunctive Diagnostic Devices

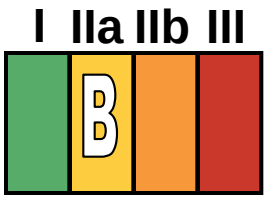
Fractional Flow Reserve

FFR is reasonable to assess angiographic intermediate coronary lesions (50% to 70% diameter stenosis) and can be useful in guiding revascularization decisions in patients with SIHD.

Intravascular Ultrasound

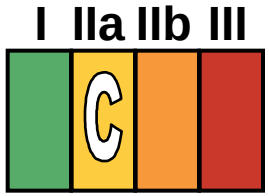


IVUS is reasonable for the assessment of angiographically indeterminate left main CAD.

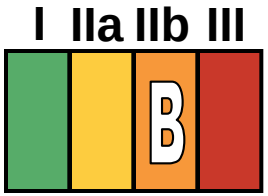


IVUS and coronary angiography are reasonable 4 to 6 weeks and 1 year after transplantation to exclude donor CAD, to detect rapidly progressive cardiac allograft vasculopathy, and to provide prognostic information.

Intravascular Ultrasound (cont.)

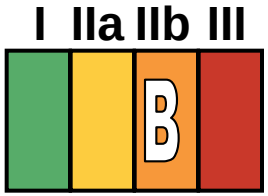


IVUS is reasonable to determine the mechanism of stent restenosis.

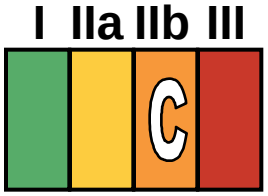


IVUS may be reasonable for the assessment of non-left main coronary arteries with angiographically intermediate coronary stenoses (50% to 70% diameter stenosis).

Intravascular Ultrasound (cont.)



IVUS may be considered for guidance of coronary stent implantation, particularly in cases of left main coronary artery stenting.



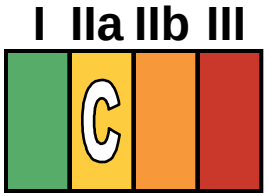
IVUS may be reasonable to determine the mechanism of stent thrombosis.

No Benefit

IVUS for routine lesion assessment is not recommended when revascularization with PCI or CABG is not being contemplated.

Adjunctive Therapeutic Devices

Coronary Atherectomy

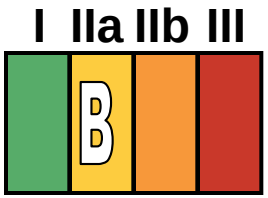


Rotational atherectomy is reasonable for fibrotic or heavily calcified lesions that might not be crossed by a balloon catheter or adequately dilated before stent implantation.

No Benefit

Rotational atherectomy should not be performed routinely for de novo or in-stent restenosis.

Thrombectomy



Aspiration thrombectomy is reasonable for patients undergoing primary PCI.

Laser Angioplasty

Laser angioplasty might be considered for fibrotic or moderately calcified lesions that cannot be crossed or dilated with conventional balloon angioplasty.

No Benefit

Laser angioplasty should not be used routinely during PCI.

Cutting Balloon Angioplasty

Cutting balloon angioplasty might be considered to avoid slippage-induced coronary artery trauma during PCI for in-stent restenosis or for ostial lesions in side branches.

No Benefit

Cutting balloon angioplasty should not be performed routinely during PCI.

Embolic Protection Devices

Embolic protection devices should be used during saphenous vein graft PCI when technically feasible.

Percutaneous Hemodynamic Support Devices

Percutaneous Hemodynamic Support Devices

Elective insertion of an appropriate hemodynamic support device as an adjunct to PCI may be reasonable in carefully selected high-risk patients.

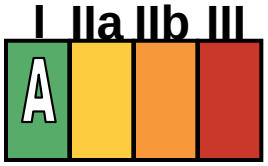
Oral Antiplatelet Therapy

Patients already taking daily aspirin therapy should take 81 to 325 mg prior to PCI.

Patients not on aspirin therapy should be given nonenteric aspirin 325 mg prior to PCI.

After PCI, aspirin should be continued indefinitely.

Oral Antiplatelet Therapy (cont.)



A loading dose of a $P2Y_{12}$ receptor inhibitor should be given to patients undergoing PCI with stenting. Options include:

a. Clopidogrel 600 mg (ACS and non-ACS patients).

b. Prasugrel 60 mg (ACS patients).

c. Ticagrelor 180 mg (ACS patients).

Oral Antiplatelet Therapy (cont.)

The loading dose of clopidogrel for patients undergoing PCI after fibrinolytic therapy should be 300 mg within 24 hours and 600 mg more than 24 hours after receiving fibrinolytic therapy.

Patients should be counseled on the need for and risks of DAPT before placement of intracoronary stents, especially a DES, and alternative therapies should be pursued if they are unwilling or unable to comply with the recommended duration of DAPT.

Oral Antiplatelet Therapy (cont.)

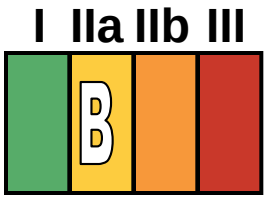
The duration of $P2Y_{12}$ inhibitor therapy after stent implantation should generally be as follows:

a)In patients receiving a stent (BMS or DES) during PCI for ACS, $P2Y_{12}$ inhibitor therapy should be given for at least 12 months. Options include: clopidogrel 75 mg daily, prasugrel 10 mg daily, and ticagrelor 90 mg twice daily.

b) In patients receiving a DES for a non–ACS indication, clopidogrel 75 mg daily should be given for at least 12 months if patients are not at high risk of bleeding.

c)In patients receiving a BMS for a non-ACS indication, clopidogrel should be given for a minimum of 1 month and ideally up to 12 months (unless the patient is at increased risk of bleeding; then it should be given for a minimum of 2 weeks).

Oral Antiplatelet Therapy (cont.)



After PCI, it is reasonable to use 81 mg per day of aspirin in preference to higher maintenance doses.

If the risk of morbidity from bleeding outweighs the anticipated benefit afforded by a recommended duration of $P2Y_{12}$ inhibitor therapy after stent implantation, earlier discontinuation (e.g., <12 months) of $P2Y_{12}$ inhibitor therapy is reasonable.

Oral Antiplatelet Therapy (cont.)

Continuation of DAPT beyond 12 months may be considered in patients undergoing DES implantation.

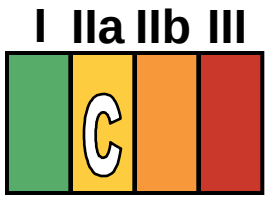
Harm

Prasugrel should not be administered in patients with a prior history of stroke or TIA.

Intravenous Antiplatelet Therapy: STEMI

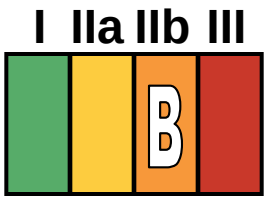
In patients undergoing primary PCI treated with UFH, it is reasonable to administer a GP IIb/IIIa inhibitor (abciximab, double-bolus eptifibatide, or high-bolus dose tirofiban), whether or not pretreated with clopidogrel.

For GP IIb/IIIa inhibitor administration in patients not pretreated with clopidogrel.



For GP IIb/IIIa inhibitor administration in patients who are pretreated with clopidogrel.

Intravenous Antiplatelet Therapy : STEMI (cont.)



In patients undergoing primary PCI with abciximab, it may be reasonable to administer intracoronary abciximab.

Intravenous Antiplatelet Therapy: STEMI (cont.)

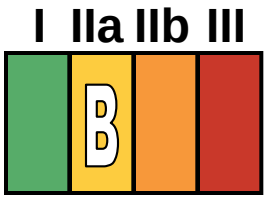
No Benefit

Routine precatheterization laboratory (e.g., ambulance or emergency room) administration of GP IIb/IIIa inhibitors as part of an upstream strategy for patients with STEMI undergoing PCI is not beneficial.

Intravenous Antiplatelet Therapy : UA/NSTEMI

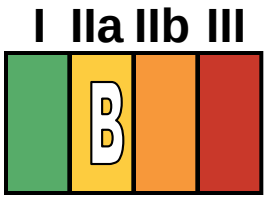
In UA/NSTEMI patients with high-risk features (e.g., elevated troponin level) not treated with bivalirudin and not adequately pretreated with clopidogrel, it is useful at the time of PCI to administer a GP IIb/IIIa inhibitor (abciximab, double-bolus eptifibatide, or high-bolus dose tirofiban) in patients treated with UFH.

Intravenous Antiplatelet Therapy : UA/NSTEMI (cont.)



In UA/NSTEMI patients with high-risk features (e.g., elevated troponin level) treated with UFH and adequately pretreated with clopidogrel, it is reasonable at the time of PCI to administer a GP IIb/IIIa inhibitor (abciximab, double-bolus eptifibatide, or high-bolus dose tirofiban).

Intravenous Antiplatelet Therapy: SIHD



In patients undergoing elective PCI treated with UFH and not pretreated with clopidogrel, it is reasonable to administer a GP IIb/IIIa inhibitor (abciximab, double-bolus eptifibatide, or high-bolus dose tirofiban).

Intravenous Antiplatelet Therapy: SIHD (cont.)

In patients undergoing elective PCI with stent implantation treated with UFH and adequately pretreated with clopidogrel, it might be reasonable to administer a GP IIb/IIIa inhibitor (abciximab, double-bolus eptifibatide, or high-bolus dose tirofiban).

Antiocoagulant Therapy: Use of Parenteral Anticoagulants During PCI

An anticoagulant should be administered to patients undergoing PCI.

Antiocoagulant Therapy: UFH

Administration of intravenous UFH is useful in patients undergoing PCI.

Anticoagulant Therapy: Enoxaparin

An additional dose of 0.3 mg/kg intravenous enoxaparin should be administered at the time of PCI to patients who have received <2 therapeutic subcutaneous doses (e.g., 1 mg/kg) or received the last subcutaneous enoxaparin dose 8 to12 hours prior to PCI.

Performance of PCI with enoxaparin may be reasonable in patients either treated with “upstream” subcutaneous enoxaparin for UA/NSTEMI or who have not received prior antithrombin therapy and are administered intravenous enoxaparin at the time of PCI.

Harm

UFH should not be given to patients already receiving therapeutic subcutaneous enoxaparin.

Antiocoagulant Therapy: Bivalirudin and Argatroban

For patients undergoing PCI, bivalirudin is useful as an anticoagulant with or without prior treatment with UFH.

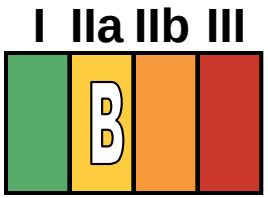
For patients with heparin-induced thrombocytopenia, it is recommended that bivalirudin or argatroban be used to replace UFH.

Antiocoagulant Therapy: Fondaparinux

Harm

Fondaparinux should not be used as the sole anticoagulant to support PCI. An additional anticoagulant with anti-IIa activity should be administered because of the risk of catheter thrombosis.

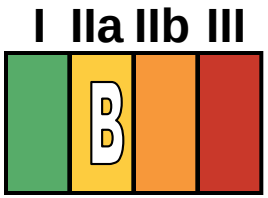
No-Reflow Pharmacologic Therapies



Administration of an intracoronary vasodilator (adenosine, calcium channel blocker, or nitroprusside) is reasonable to treat PCI-related no-reflow that occurs during primary or elective PCI.

PCI in Specific Anatomic Situations

Chronic Total Occlusions



PCI of a CTO in patients with appropriate clinical indications and suitable anatomy is reasonable when performed by operators with appropriate expertise.

Saphenous Vein Grafts

EPDs should be used during SVG PCI when technically feasible.

No Benefit

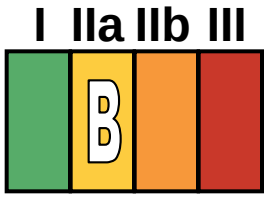
Platelet GP IIb/IIIa inhibitors are not beneficial as adjunctive therapy during SVG PCI.

Harm

PCI is not recommended for chronic SVG occlusions.

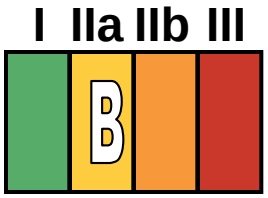
Bifurcation Lesions

Provisional side-branch stenting should be the initial approach in patients with bifurcation lesions when the side branch is not large and has only mild or moderate focal disease at the ostium.

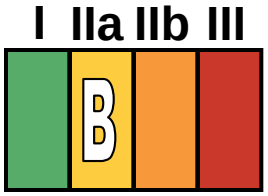


It is reasonable to use elective double stenting in patients with complex bifurcation morphology involving a large side branch where the risk of side-branch occlusion is high and the likelihood of successful side-branch reaccess is low.

Aorto-Ostial Stenosis

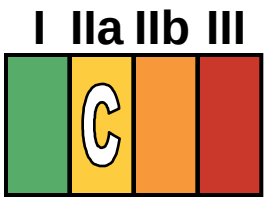


IVUS is reasonable for the assessment of angiographically-indeterminant left main CAD.



Use of DES is reasonable when PCI is indicated in patients with an aorto-ostial stenosis.

Calcified Lesions



Rotational atherectomy is reasonable for fibrotic or heavily calcified lesions that might not be crossed by a balloon catheter or adequately dilated before stent implantation.

PCI in Specific Patient Populations

Chronic Kidney Disease

In patients undergoing PCI, the glomerular filtration rate should be estimated and the dosage of renally-cleared medications should be adjusted.

Periprocedural Myocardial Infarction Assessment

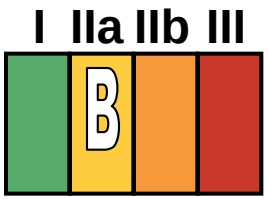
In patients who have signs or symptoms suggestive of MI during or after PCI, or in asymptomatic patients with significant *persistent* angiographic complications (e.g., large side-branch occlusion, flow limiting dissection, no-reflow phenomenon or coronary thrombosis), creatinine kinase-MB and troponin I or T should be measured.

Periprocedural Myocardial Infarction Assessment (cont.)

Routine measurement of cardiac biomarkers (creatinine kinase-MB and/or troponin I or T) in all patients post-PCI may be reasonable.

Vascular Closure Devices

Patients considered for vascular closure devices should undergo a femoral angiogram to ensure anatomic suitability for deployment.



The use of vascular closure devices is reasonable for the purposes of achieving faster hemostasis and earlier ambulation compared with the use of manual compression.

No Benefit

The routine use of vascular closure devices is not recommended for the purpose of decreasing vascular complications, including bleeding.

Postprocedural Antiplatelet Therapy

Postprocedural Antiplatelet Therapy

After PCI, aspirin should be continued indefinitely.

The duration of $P2Y_{12}$ inhibitor therapy after stent implantation should generally be as follows:

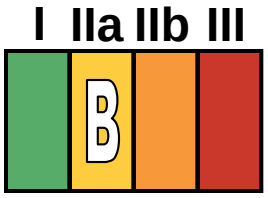
a) In patients receiving a stent (BMS or DES) during PCI for ACS, $P2Y_{12}$ inhibitor therapy should be given for at least 12 months (clopidogrel 75 mg daily); prasugrel 10 mg daily; and ticagrelor 90 mg twice daily.

b) In patients receiving a DES for a non–ACS indication, clopidogrel 75 mg daily should be given for at least 12 months if patients are not at high risk of bleeding.

c) In patients receiving a BMS for a non-ACS indication, clopidogrel should be given for a minimum of 1 month and ideally up to 12 months (unless the patient is at increased risk of bleeding; then it should be given for a minimum of 2 weeks).

Postprocedural Antiplatelet Therapy (cont.)

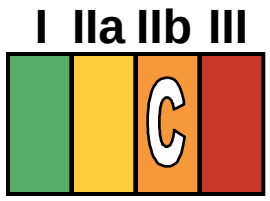
Patients should be counseled on the importance of compliance with DAPT, and that therapy should not be discontinued before discussion with the relevant cardiologist.



After PCI, it is reasonable to use 81 mg per day of aspirin in preference to higher maintenance doses.

If the risk of morbidity from bleeding outweighs the anticipated benefit afforded by a recommended duration of $P2Y_{12}$ inhibitor therapy after stent implantation, earlier discontinuation (e.g., >12 months) of $P2Y_{12}$ inhibitor therapy is reasonable.

Postprocedural Antiplatelet Therapy (cont.)

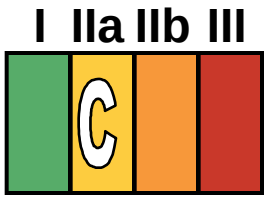


Continuation of clopidogrel, prasugrel or ticagrelor beyond 12 months may be considered in patients undergoing DES placement.

Proton Pump Inhibitors and Antiplatelet Therapy

PPIs and Antiplatelet Therapy

PPI should be used in patients with history of prior GI who require DAPT.

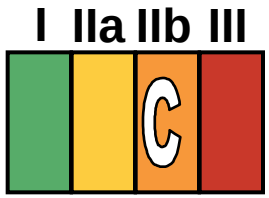


PPI use is reasonable in patients with increased risk of gastrointestinal bleeding (advanced age, concomitant use of warfarin, steroids, nonsteroidal anti-inflammatory drugs, H pylori infection, etc.) who require DAPT.

No Benefit

Routine use of a PPI is not recommended for patients at low risk of gastrointestinal bleeding, who have much less potential to benefit from prophylactic therapy.

Clopidogrel Genetic Testing



Genetic testing might be considered to identify whether a patient at high risk for poor clinical outcomes is predisposed to inadequate platelet inhibition with clopidogrel.

When a patient predisposed to inadequate platelet inhibition with clopidogrel is identified by genetic testing, treatment with an alternate $P2Y_{12}$ inhibitor (e.g., prasugrel or ticagrelor) might be considered.

No Benefit

The routine clinical use of genetic testing to screen clopidogrel-treated patients undergoing PCI is not recommended.

Platelet FunctionTesting

Platelet function testing may be considered in patients at high risk for poor clinical outcomes.

In clopidogrel-treated patients with high platelet reactivity, alternative agents, such as prasugrel or ticagrelor, might be considered.

No Benefit

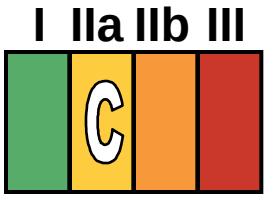
The routine clinical use of platelet function testing to screen clopidogrel-treated patients undergoing PCI is not recommended.

Restenosis

Patients who develop clinical restenosis after balloon angioplasty should be treated with BMS or DES if anatomic factors are appropriate and if the patient is able to comply with and tolerate DAPT.

Patients who develop clinical restenosis after BMS should be treated with DES if anatomic factors are appropriate and the patient is able to comply with and tolerate DAPT.

Restenosis (cont.)



IVUS is reasonable to determine the mechanism of stent restenosis.

Patients who develop clinical restenosis after DES may be considered for repeat PCI with balloon angioplasty, BMS, or DES containing the same drug or an alternative antiproliferative drug if anatomic factors are appropriate and patient is able to comply with and tolerate DAPT.

Exercise Testing

In patients entering a formal cardiac rehabilitation program after PCI, treadmill exercise testing is reasonable.

No Benefit

Routine, periodic stress testing of asymptomatic patients after PCI without specific clinical indications should not be performed.

Cardiac Rehabilitation

Medically-supervised exercise programs (cardiac rehabilitation) should be recommended to patients after PCI, particularly for moderate- to high-risk patients for whom supervised exercise training is warranted.

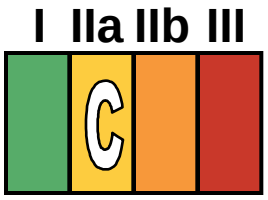
Quality and Performance

Quality and Performance

Every PCI program should operate a quality improvement program that routinely: a) reviews quality and outcomes of the entire program; b) reviews results of individual operators; c) includes risk adjustment; d) provides peer review of difficult or complicated cases, and; e) performs random case reviews.

Every PCI program should participate in a regional or national PCI registry for the purpose of benchmarking its outcomes against current national norms.

Certification and Maintenance of Certification



It is reasonable for all physicians that perform PCI to participate in the American Board of Internal Medicine interventional cardiology board certification and maintenance of certification program.

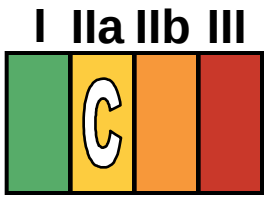
Operator and Institutional Competency and Volume

Elective/urgent PCI should be performed by operators with acceptable annual volume (≥75 procedures) at high-volume centers (>400 procedures) with onsite cardiac surgery.

Elective/urgent PCI should be performed by operators and institutions whose current risk-adjusted outcomes statistics are comparable to those reported in contemporary national data registries.

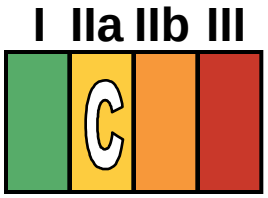
Operator and Institutional Competency and Volume (cont.)

Primary PCI for STEMI should be performed by experienced operators who perform more than 75 elective PCI procedures per year and, ideally, at least 11 PCI procedures for STEMI per year. Ideally, these procedures should be performed in institutions that perform more than 400 elective PCIs per year and more than 36 primary PCI procedures for STEMI per year.



It is reasonable that operators with acceptable volume (≥75 PCI procedures per year) perform elective/urgent PCI at low-volume centers (200 to 400 PCI procedures per year) with onsite cardiac surgery.

Operator and Institutional Competency and Volume (cont.)



It is reasonable that low-volume operators (<75 PCI procedures per year) perform elective/urgent PCI at high-volume centers (>400 PCI procedures per year) with onsite cardiac surgery. Ideally, operators with an annual procedure volume <75 should only work at institutions with an activity level of more than 600 procedures per year. Operators who perform <75 procedures per year should develop a defined mentoring relationship with a highly experienced operator who has an annual procedural volume of at least 150 procedures per year.

Operator and Institutional Competency and Volume (cont.)

The benefit of primary PCI for STEMI patients eligible for fibrinolysis when performed by an operator who performs <75 procedures per year (<11 PCIs for STEMI per year) is not well established.

No Benefit

It is not recommended that elective/urgent PCI be performed by low-volume operators (<75 procedures per year) at low-volume centers (200 to 400 procedures per year) with or without onsite cardiac surgery. An institution with a volume of <200 procedures per year, unless in a region that is underserved because of geography, should carefully consider whether it should continue to offer this service.