AMERICAN COLLEGE of CARDIOLOGY FOUNDATION

American Heart Association®

ACCF/AHA Pocket Guideline

Management of Patients Undergoing Coronary Artery Revascularization

November 2011

Adapted from the 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention and the 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery (Developed in Collaboration With the American Association for Thoracic Surgery, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons)

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This pocket guideline is available on the World Wide Web sites of the American College of Cardiology (www.cardiosource.org) and the American Heart Association (my.americanheart.org).

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1. Introduction

The goals of revascularization for patients with coronary artery disease (CAD) are 1) to improve survival and/or 2) to relieve symptoms, so the recommendations have been formulated to address these specific issues. When one method of revascularization is preferred over the other for improved survival, this consideration, in general, takes precedence over improved symptoms. When discussing options for revascularization with the patient, he or she should understand when the procedure is being performed in an attempt to improve symptoms and/or to improve survival.

Revascularization recommendations are predominantly based on studies of patients with symptomatic stable ischemic heart disease (SIHD), and they should be interpreted in this context. When appropriate, specific recommendations are given for patients with unstable angina/non-ST-elevation myocardial infarction (UA/NSTEMI) or ST-elevation myocardial infarction (STEMI).

Historically, most studies regarding revascularization have been based on and reported according to angiographic criteria. Most studies have defined a "significant" stenosis as ≥70% diameter narrowing; therefore, for revascularization decisions and recommendations in this section, a "significant" stenosis has been defined as ≥70% diameter narrowing (≥50% for left main CAD). More recently, physiologic criteria, such as an assessment of fractional flow reserve (FFR), has been used in deciding when revascularization is indicated. Thus, for recommendations in this section regarding revascularization, coronary stenoses with FFR ≤0.80 can also be considered to be "significant."

The ACCF/AHA classifications of recommendations and levels of evidence are utilized, and described in more detail in *Table 1*.

Table 1. Applying Classification of Recommendation 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**
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
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
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
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
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

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* Procedure/Test — Treatment COR III: No benefit — Not Helpful — No Proven Benefit COR III: Harm — Excess Cost w/o Benefit or Harmful — Harmful to Patients
■ 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
■ 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
■ 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

may/might be considered	COR III: No Benefit	COR III: Harm
may/might be reasonable	is not recommended	potentially harmful
usefulness/effectiveness is unknown/unclear/uncertain or not well established	is not indicated	causes harm
	should not be performed/ administered/ other	associated with excess morbidity/mortality
	is not useful/ beneficial/ effective	should not be performed/ administered/ other

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.

2. The Heart Team Approach

Table 2. Evaluating Revascularization Options for Patient With Left Main and Complex CAD

Coronary Anatomy	COR	LOE
Unprotected left main and complex CAD	I–Heart Team approach recommended	C
Unprotected left main and complex CAD	IIa–Calculation of the STS and SYNTAX scores	B

CAD indicates coronary artery disease; COR, class of recommendation; LOE, level of evidence; STS, Society of Thoracic Surgeons; SYNTAX, Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery.

Class I

1. A Heart Team approach to revascularization is recommended in patients with unprotected left main or complex CAD. (Level of Evidence: C)

Class IIa

1. Calculation of the Society of Thoracic Surgeons (STS) and SYNTAX (Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery) scores is reasonable in patients with unprotected left main and complex CAD. (Level of Evidence: B)

A Heart Team approach involves a multidisciplinary team, composed of an interventional cardiologist and a cardiac surgeon, that 1) reviews the patient's medical condition and coronary anatomy, 2) agrees that either percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG) is technically feasible and reasonable, and 3) discusses revascularization options with the patient before a treatment strategy is selected. Support for using a Heart Team approach comes from reports that patients with complex CAD referred specifically for PCI or CABG in concurrent trial registries have lower mortality rates than those randomly assigned to PCI or CABG in controlled trials. A Heart Team approach is recommended in patients with unprotected left main CAD and/or complex CAD in whom the optimal revascularization strategy is not straightforward.

3. Recommendations for Revascularization to Improve Survival

A. Left Main CAD

Table 3. Revascularization to Improve Survival in Patients with Significant (≥50% diameter stenosis) Unprotected Left Main CAD

Revascularization Method	COR	LOE
CABG	I	B
PCI	IIa–For SIHD when *both* of the following are present: • Anatomic conditions associated with a low risk of PCI procedural complications and a high likelihood of good long-term outcome (e.g., a low SYNTAX score of ≤22, ostial or trunk left main CAD) • Clinical characteristics that predict a significantly increased risk of adverse surgical outcomes (e.g., STS-predicted risk of operative mortality ≥5%)	B
	IIa–For UA/NSTEMI if not a CABG candidate	B
	IIa–For STEMI when distal coronary flow is TIMI flow grade <3 and PCI can be performed more rapidly and safely than CABG	C
	IIb–For SIHD when *both* of the following are present: • 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) • Clinical characteristics that predict an increased risk of adverse surgical outcomes (e.g., moderate-severe COPD, disability from prior stroke, or prior cardiac surgery; STS-predicted risk of operative mortality >2%)	B
	III: Harm–For SIHD in patients (versus performing CABG) with unfavorable anatomy for PCI and who are good candidates for CABG	B

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; COR, class of recommendation; LOE, level of evidence; 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; and UPLM, unprotected left main disease.

Class I	**1.** CABG to improve survival is recommended for patients with significant (≥50% diameter stenosis) left main coronary artery stenosis. (Level of Evidence: B)
Class IIa	**1.** 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 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%). (Level of Evidence: B) **2.** 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. (Level of Evidence: B)

3. 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 less than TIMI (Thrombolysis In Myocardial Infarction) grade 3, and PCI can be performed more rapidly and safely than CABG. (Level of Evidence: C)

Class IIb

1. 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%). (Level of Evidence: B)

Class III: Harm

1. 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. (Level of Evidence: B)

Although CABG has been considered the "gold standard" for unprotected left main CAD revascularization, more recently PCI has emerged as a possible alternative mode of revascularization in carefully selected patients. Lesion location is an important determinant when considering PCI for unprotected left main CAD. Stenting of the left main ostium or trunk is more straightforward than treating distal bifurcation or trifurcation stenoses, which generally require a greater degree of operator experience and expertise. In addition, PCI of bifurcation disease is associated with higher restenosis rates than when disease is confined to the ostium or trunk. Although lesion location influences technical success and long-term outcomes after PCI, location exerts a negligible influence on the success of CABG. In subgroup analyses, patients with left main CAD and a SYNTAX score $\geq$33 with more complex or extensive CAD had a higher mortality rate with PCI than with CABG. Physicians can estimate operative risk for all CABG candidates using a standard instrument, such as the risk calculator from the STS database (http://209.220.160.181/STSWebRiskCalc261/de.aspx).

Experts have recommended immediate PCI for unprotected left main CAD in the setting of STEMI. The impetus for such a strategy is greatest when left main CAD is the site of the culprit lesion, antegrade coronary flow is diminished (e.g., TIMI flow grade 0, 1, or 2), the patient is hemodynamically unstable, and it is believed that PCI can be performed more quickly than CABG.

B. Single and Multivessel CAD

Table 4. Revascularization to Improve Survival With Significant Anatomic (≥70% diameter non–left main CAD) or Physiologic (FFR ≤0.80) Non-Left Main Coronary Artery Stenoses

Revascularization Method*	COR	LOE
3-vessel disease with or without proximal LAD artery disease*		
CABG	I	B
	IIa–It is reasonable to choose CABG over PCI in patients with complex 3-vessel CAD (e.g., SYNTAX score >22) who are good candidates for CABG	B
PCI	IIb–Of uncertain benefit	B
2-vessel disease with proximal LAD artery disease*		
CABG	I	B
PCI	IIb–Of uncertain benefit	B
2-vessel disease without proximal LAD artery disease*		
CABG	IIa–With extensive ischemia	B
	IIb–Of uncertain benefit without extensive ischemia	C
PCI	IIb–Of uncertain benefit	B
1-vessel proximal LAD artery disease		
CABG	IIa–With LIMA for long-term benefit	B
PCI	IIb–Of uncertain benefit	B

Revascularization Method*	COR	LOE
1-vessel without proximal LAD artery involvement		
CABG	III: Harm	B
PCI	III: Harm	B
LV dysfunction		
CABG	IIa–EF 35% to 50%	B
CABG	IIb–EF <35% without significant left main CAD	B
PCI	Insufficient data	
Survivors of sudden cardiac death with presumed ischemia-mediated VT		
CABG	I	B
PCI	I	C
No anatomic or physiologic criteria for revascularization		
CABG	III: Harm	B
PCI	III: Harm	B

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

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; COR, class of recommendation; EF, ejection fraction; LIMA, left internal mammary artery; LOE, level of evidence; PCI, percutaneous coronary intervention; SYNTAX, Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery; and UPLM, unprotected left main disease.

Class I

1. 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 left anterior descending [LAD] artery) or in the proximal LAD plus 1 other major coronary artery. (Level of Evidence: B)

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

Class IIa

1. 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. (Level of Evidence: B)

2. CABG to improve survival is reasonable in patients with mild-moderate left ventricular (LV) systolic dysfunction (ejection fraction [EF] 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. (Level of Evidence: B)

3. CABG with a left internal mammary artery (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. (Level of Evidence: B)

4. 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. (Level of Evidence: B)

5. 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. (Level of Evidence: B)

Class IIb

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

2. 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. (Level of Evidence: B)

3. 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. (Level of Evidence: B)

4. The usefulness of CABG or PCI to improve survival is uncertain in patients with previous CABG and extensive anterior wall ischemia on noninvasive testing. (Level of Evidence: B)

Class III: Harm

1. 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, FFR >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. (Level of Evidence: B)

A 1994 meta-analysis of 7 studies that randomized patients to medical therapy or CABG showed that CABG offered a survival advantage over medical therapy for patients with left main or 3-vessel CAD. The studies also established that CABG is more effective than medical therapy for relieving anginal symptoms. Surgical techniques and medical therapy have improved substantially during the intervening years. As a result, if CABG were to be compared with guideline-directed medical therapy (GDMT) in RCTs today, the relative benefits for survival and angina relief observed several decades ago might no longer be observed. Conversely, the concurrent administration of GDMT may substantially improve long-term outcomes in patients treated with CABG in comparison with those receiving medical therapy alone.

Although contemporary PCI treatments have lowered the risk of restenosis compared with earlier techniques, meta-analyses have failed to show that the introduction of bare-metal stents (BMS) confers a survival advantage over balloon angioplasty or that the use of drug-eluting stents (DES) confers a survival advantage over BMS. No study to date has demonstrated that PCI improves survival rates in patients with SIHD.

The findings from individual studies and systematic reviews of PCI versus medical therapy can be summarized as follows:

- PCI reduces the incidence of angina.
- PCI has not been demonstrated to improve survival in stable patients.
- PCI may increase the short-term risk of myocardial infarction (MI).
- PCI does not lower the long-term risk of MI.

A systematic review of RCTs comparing CABG with balloon angioplasty or BMS concluded the following:

- Survival was similar for CABG and PCI (with either balloon angioplasty or BMS) at 1 year.
- Survival was similar for CABG and PCI in subjects with 1-vessel CAD (including those with disease of the proximal portion of the LAD artery) or multivessel CAD.

- The incidence of MI was similar at 5 years after randomization.
- Procedural stroke occurred more commonly with CABG than with PCI.
- Relief of angina was accomplished more effectively with CABG than with PCI 1 year after randomization and 5 years after randomization.
- Repeat coronary revascularization was performed almost 10 times less often during the first year and almost 5 times less often during the first 5 years following CABG than following PCI. This difference was more pronounced with balloon angioplasty than with BMS.

The SYNTAX trial compared CABG and DES and found the following after 3 years of follow-up:

- Overall survival was similar for CABG and DES.
- Rates of MI were lower after CABG than after DES.
- Rates of repeat revascularization were lower after CABG than after DES.
- Although procedural stroke was higher after CABG than after DES, cumulative rates of stroke were similar after CABG and DES at 3 years.

4. Recommendations for Revascularization to Improve Symptoms

Table 5. Revascularization to Improve Symptoms With Significant Anatomic (≥50% diameter left main or ≥70% diameter non-left main) or Physiologic (FFR ≤0.80) Coronary Artery Stenoses

Clinical Setting	COR	LOE
≥1 significant stenoses amenable to revascularization and unacceptable angina despite GDMT	I–CABG I–PCI	A
≥1 significant stenoses and unacceptable angina in whom GDMT cannot be implemented because of medication contraindications, adverse effects, or patient preferences	IIa–CABG IIa–PCI	C
Previous CABG with ≥1 significant stenoses associated with ischemia and unacceptable angina despite GDMT	IIa–PCI	C
	IIb–CABG	C
Complex 3-vessel CAD (e.g., SYNTAX score >22) with or without involvement of the proximal LAD artery and a good candidate for CABG	IIa–CABG preferred over PCI	B
Viable ischemic myocardium that is perfused by coronary arteries that are not amenable to grafting	IIb–TMR as an adjunct to CABG	B
No anatomic or physiologic criteria for revascularization	III: Harm–CABG III: Harm–PCI	C

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; COR, class of recommendation; GDMT, guideline-directed medical therapy; FFR, fractional flow reserve; LOE, level of evidence; N/A, not applicable; PCI, percutaneous coronary intervention; SYNTAX, Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery; and TMR, transmyocardial laser revascularization.

Class I

1. 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. (Level of Evidence: A)

Class IIa

1. 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. (Level of Evidence: C)

2. 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. (Level of Evidence: C)

3. 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. (Level of Evidence: B)

Class IIb	**1.** 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. (Level of Evidence: C)
	2. 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. (Level of Evidence: B)
Class III: Harm	**1.** CABG or PCI to improve symptoms should not be performed in patients who do not meet anatomic (≥50% diameter left main or ≥70% non–left main stenosis diameter) or physiologic (e.g., abnormal FFR) criteria for revascularization. (Level of Evidence: C)

5. Clinical Factors That May Influence the Choice of Revascularization

A. Diabetes Mellitus

In subjects requiring revascularization for multivessel CAD, current evidence supports diabetes mellitus as an important variable when deciding on a revascularization strategy, particularly when complex and/or extensive CAD is present. In patients with multivessel disease who also have diabetes, it is reasonable to choose CABG (with LIMA) over PCI.

B. Chronic Kidney Disease

Some, but not all, observational studies or subgroup analyses have demonstrated an improved survival with revascularization compared with medical therapy in patients with chronic kidney disease (CKD) and multivessel CAD despite the fact that the incidence of periprocedural complications (i.e., death, MI, stroke, infection, renal failure) is increased in patients with CKD when compared to those without renal dysfunction. Some studies have shown that CABG is associated with a greater survival benefit than PCI among patients with severe renal dysfunction.

C. Completeness of Revascularization

Most patients undergoing CABG receive complete or nearly complete revascularization, which appears to influence long-term prognosis in a positive fashion. In contrast, complete revascularization is accomplished less often in subjects receiving PCI (e.g., in <70% of patients), but the extent to which the absence of complete initial revascularization influences outcome is less clear. Late survival and survival free of MI appear to be similar in patients with and without complete revascularization after PCI. However, the need for subsequent CABG is usually higher in those whose initial revascularization procedure was incomplete (as compared with those with complete revascularization) after PCI.

D. LV Systolic Dysfunction

The data that exist at present on revascularization in patients with CAD and LV systolic dysfunction are more robust for CABG than for PCI, although data from contemporary RCTs in this patient population are lacking. Therefore, the choice of revascularization in patients with CAD and LV systolic dysfunction is best based on clinical variables (e.g., coronary anatomy, presence of diabetes mellitus, presence of CKD), magnitude of LV systolic dysfunction, patient preferences, clinical judgment, and consultation between the interventional cardiologist and the cardiac surgeon.

E. Previous CABG

Cohort studies comparing PCI and CABG among post-CABG patients report similar rates of mid- and long-term survival after the 2 procedures. In the patient with previous CABG who is referred for revascularization for medically refractory ischemia, factors that may support the choice of repeat CABG include vessels unsuitable for PCI, number of diseased bypass grafts, availability of the internal mammary artery for grafting chronically occluded coronary arteries, and good distal targets for bypass graft placement. Factors favoring PCI over CABG include limited areas of ischemia causing symptoms, suitable PCI targets, a patent graft to the LAD artery, poor CABG targets, and comorbid conditions.

F. UA/NSTEMI

The main difference between the management of the patient with SIHD and the individual with UA/NSTEMI is that the impetus for revascularization is stronger in the setting of UA/NSTEMI, since myocardial ischemia occurring as part of an acute coronary syndrome (ACS) is potentially life threatening, and associated anginal symptoms are more likely to be reduced with a revascularization procedure than with GDMT. Thus, the indications for revascularization are strengthened by the acuity of presentation, the extent of ischemia, and the ability to achieve full revascularization. The choice of method of revascularization is generally dictated by the same considerations used to decide on PCI or CABG for patients with SIHD.

G. DAPT Compliance

The risk of stent thrombosis is increased dramatically in patients who prematurely discontinue dual antiplatelet therapy (DAPT), and stent thrombosis is associated with a mortality rate of 20% to 45%. Therefore, the ability of the patient to tolerate and to comply with DAPT is an important consideration in deciding whether to treat patients with CAD with PCI. 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 **(Class III: Harm; LOE: B)**.

6. Post-PCI Management

Table 6. Post-PCI Management

Recommendations	COR	LOE
Aspirin		
After PCI, use of aspirin should be continued indefinitely.	I	A
After PCI, it is reasonable to use aspirin 81 mg/d in preference to higher maintenance doses.	IIa	B
$P2Y_{12}$ inhibitors		
In patients receiving a stent (BMS or DES) during PCI for ACS, $P2Y_{12}$ inhibitor therapy should be given for at least 12 mo. Options include clopidogrel 75 mg/d, prasugrel 10 mg/d, and ticagrelor 90 mg twice daily.	I	B
In patients receiving DES for a non-ACS indication, clopidogrel 75 mg/d should be given for at least 12 mo if patients are not at high risk of bleeding.	I	B
In patients receiving BMS for a non-ACS indication, clopidogrel should be given for a minimum of 1 mo and ideally up to 12 mo (unless the patient is at increased risk of bleeding; then it should be given for a minimum of 2 wk).	I	B
Patients should be counseled on the importance of compliance with DAPT and that therapy should not be discontinued before discussion with their cardiologist.	I	C
PPIs should be used in patients with a history of prior GI bleeding who require DAPT.	I	C
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 mo) of $P2Y_{12}$ inhibitor therapy is reasonable.	IIa	C
Use of PPIs is reasonable in patients with an increased risk of GI bleeding (e.g., advanced age, concomitant use of warfarin, steroids, NSAIDs, *Helicobacter pylori* infection) who require DAPT.	IIa	C
Continuation of clopidogrel, prasugrel, or ticagrelor beyond 12 mo may be considered in patients undergoing placement of DES.	IIb	C
Routine use of a PPI is not recommended for patients at low risk of GI bleeding, who have much less potential to benefit from prophylactic therapy.	III: No Benefit	C

Recommendations	COR	LOE
Exercise testing		
For patients entering a formal cardiac rehabilitation program after PCI, treadmill exercise testing is reasonable.	IIa	C
Routine periodic stress testing of asymptomatic patients after PCI without specific clinical indications should not be performed.	III: No Benefit	C
Cardiac rehabilitation		
Medically supervised exercise programs (cardiac rehabilitation) should be recommended to patients after PCI, particularly for patients at moderate to high risk, for whom supervised exercise training is warranted.	I	A

ACS indicates acute coronary syndrome; BMS, bare-metal stents; COR, class of recommendation; DAPT, dual antiplatelet therapy; DES, drug-eluting stents; GI, gastrointestinal; HDL, high-density lipoprotein; LDL, low-density lipoprotein; LOE, level of evidence; N/A, not applicable; NSAID, nonsteroidal anti-inflammatory drug; PCI, percutaneous coronary intervention; and PPI, proton pump inhibitor.

Class I

1. After PCI, use of aspirin should be continued indefinitely. (Level of Evidence: A)

2. 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. (Level of Evidence: B)

b. In patients receiving DES for a non-ACS indication, clopidogrel 75 mg daily should be given for at least 12 months if the patient is not at high risk of bleeding. (Level of Evidence: B)

c. In patients receiving 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). (Level of Evidence: B)

3. Patients should be counseled on the importance of compliance with DAPT, and that therapy should not be discontinued before discussion with their cardiologist. (Level of Evidence: C)

4. Proton pump inhibitors (PPIs) should be used in patients with a history of prior gastrointestinal (GI) bleeding who require DAPT. (Level of Evidence: C)

5. 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. (Level of Evidence: A)

Class IIa

1. After PCI, it is reasonable to use aspirin 81 mg per day in preference to higher maintenance doses. (Level of Evidence: B)

2. 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. (Level of Evidence: C)

3. Use of PPIs is reasonable in patients with an increased risk of GI bleeding (e.g., advanced age, concomitant use of warfarin, steroids, nonsteroidal anti-inflammatory drugs, *Helicobacter pylori* infection) who require DAPT. (Level of Evidence: C)

4. In patients entering a formal cardiac rehabilitation program after PCI, treadmill exercise testing is reasonable. (Level of Evidence: C)

Class IIb

1. Continuation of clopidogrel, prasugrel, or ticagrelor beyond 12 months may be considered in patients undergoing placement of DES. (Level of Evidence: C)

Class III: No Benefit

1. Routine use of a PPI is not recommended for patients at low risk of GI bleeding, who have much less potential to benefit from prophylactic therapy. (Level of Evidence: C)

2. Routine periodic stress testing of asymptomatic patients after PCI without specific clinical indications should not be performed. (Level of Evidence: C)

7. Post-CABG Management

Class I

1. If aspirin (100 mg to 325 mg daily) was not initiated preoperatively, it should be initiated within 6 hours postoperatively and then continued indefinitely to reduce the occurrence of saphenous vein graft closure and adverse cardiovascular events. (Level of Evidence: A)

2. Beta blockers should be reinstituted as soon as possible after CABG in all patients without contraindications to reduce the incidence or clinical sequelae of atrial fibrillation. (Level of Evidence: B)

3. Beta blockers should be prescribed to all CABG patients without contraindications at the time of hospital discharge. (Level of Evidence: C)

4. Angiotensin converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs) given before CABG should be reinstituted postoperatively once the patient is stable, unless contraindicated. (Level of Evidence: B)

5. ACE inhibitors or ARBs should be initiated postoperatively and continued indefinitely in CABG patients who were not receiving them preoperatively, who are stable, and who have an LVEF less than or equal to 40%, hypertension, diabetes mellitus, or CKD, unless contraindicated. (Level of Evidence: A)

Class IIa

1. For patients undergoing CABG, clopidogrel 75 mg daily is a reasonable alternative in patients who are intolerant of or allergic to aspirin. (Level of Evidence: C)

2. It is reasonable to initiate ACE inhibitors or ARBs postoperatively and to continue them indefinitely in all CABG patients who were not receiving them preoperatively and are considered to be at low risk (i.e., those with a normal LVEF in whom cardiovascular risk factors are well controlled), unless contraindicated. (Level of Evidence: B)

8. Secondary Prevention

Revascularization may treat a lesion but does not "cure" the patient. Secondary prevention measures are an integral part of patient management.

Table 7. Secondary Prevention Post-Revascularization (from the 2011 AHA/ACCF Secondary Prevention and Risk Reduction Therapy Guideline)

Recommendations		COR	LOE
Lipid management with lifestyle modification and lipid-lowering pharmacotherapy	Lifestyle modification	I	B
	Statin therapy	I	A
	Statin therapy which lowers LDL cholesterol to <100 mg/dL and achieves at least a 30% lowering of LDL cholesterol	I	C
	Statin therapy which lowers LDL cholesterol to <70 mg/dL in very high-risk* patients	IIa	C
Blood pressure control (with a blood pressure goal of <140/90 mm Hg)	Lifestyle modification	I	B
	Pharmacotherapy	I	A
Diabetes management (e.g., lifestyle modification and pharmacotherapy) coordinated with the patient's primary care physician and/or endocrinologist		I	C
Complete smoking cessation		I	A

* Presence of established cardiovascular disease plus 1) multiple major risk factors (especially diabetes), 2) severe and poorly controlled risk factors (especially continued cigarette smoking), 3) multiple risk factors of the metabolic syndrome (especially high triglycerides ≥200 mg/dL plus non--HDL cholesterol ≥130 mg/dL with low HDL cholesterol [<40 mg/dL]), and 4) acute coronary syndromes.

COR indicates class of recommendation; HDL, high-density lipoprotein; LDL, low-density lipoprotein; and LOE, level of evidence.

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