2014 ACC/AHA/AATS/PCNA/SCAI/STS Focused Update of the Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease


WRITING GROUP MEMBERS*
Stephan D. Fihn, MD, MPH, Chair†; James C. Blankenship, MD, MHCMD, MACC, FAHA, Vice Chair*†; Karen P. Alexander, MD, FACC, FAHA*†; John A. Bittl, MD, FACC†; John G. Byrne, MD, FACC‡; Barbara J. Fletcher, RN, MN, FAHAS‡; Gregg C. Fonarow, MD, FACC, FAHA*∥; Richard A. Lange, MD, FACC, FAHA†; Glenn N. Levine, MD, FACC, FAHA†; Thomas M. Maddox, MD, MSc, FACC, FAHA†; Srihari S. Naidu, MD, FACC, FAHA, FSCAI∥; E. Magnus Ohman, MD, FACC*‡; Peter K. Smith, MD, FACC**

ACC/AHA TASK FORCE MEMBERS
Jeffrey L. Anderson, MD, FACC, FAHA, Chair; Jonathan L. Halperin, MD, FACC, FAHA, Chair-elect; Nancy M. Albert, PhD, RN, FAHA; Biykem Bozkurt, MD, PhD, FACC, FAHA; Ralph G. Brindis, MD, MPH, MACC; Lesley H. Curtis, PhD, FAHA; David DeMets, PhD†‡; Robert A. Guyton, MD, FACC†‡; Judith S. Hochman, MD, FACC, FAHA†‡; Richard J. Kovacs, MD, FACC, FAHA; E. Magnus Ohman, MD, FACC; Susan J. Pressler, PhD, RN, FAHA; Frank W. Sellke, MD, FACC, FAHA; Win-Kuang Shen, MD, FACC, FAHA

*Writing group members are required to recuse themselves from voting on sections to which their specific relationships with industry and other entities may apply; see Appendix I for recusal information. †ACC/AHA Representative. ‡American Association for Thoracic Surgery Representative. §Preventive Cardiovascular Nurses Association Representative. ||ACC/AHA Task Force on Performance Measures Liaison. §§Society for Cardiovascular Angiography and Interventions Representative. #ACC/AHA Task Force on Practice Guidelines Liaison. **Society of Thoracic Surgeons Representative. ††Former Task Force member; current member during the writing effort.

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Preamble

Keeping pace with emerging evidence is an ongoing challenge to timely development of clinical practice guidelines. In an effort to respond promptly to new evidence, the American College of Cardiology (ACC)/American Heart Association (AHA) Task Force on Practice Guidelines (Task Force) has created a “focused update” process to revise the existing guideline recommendations that are affected by evolving data or opinion. New evidence is reviewed in an ongoing manner to respond quickly to important scientific and treatment trends that could have a major impact on patient outcomes and quality of care. Evidence is reviewed at least twice a year, and updates are initiated on an as-needed basis and completed as quickly as possible while maintaining the rigorous methodology that the ACC and AHA have developed during their partnership of >20 years.

A focused update is initiated when new data that are deemed potentially important for patient care are published or presented at national and international meetings (Section 1.1, “Methodology and Evidence Review”). Through a broad-based vetting process, the studies included are identified as being important to the relevant patient population. The focused update is not intended to be based on a complete literature review from the date of the previous guideline publication but rather to include pivotal new evidence that may effect changes in current recommendations. Specific criteria or considerations for inclusion of new data include the following:

- Publication in a peer-reviewed journal;
- Large, randomized, placebo-controlled trial(s);
- Nonrandomized data deemed important on the basis of results affecting current safety and efficacy assumptions, including observational studies and meta-analyses;
- Strength/weakness of research methodology and findings;
- Likelihood of additional studies influencing current findings;
- Impact on current performance measures and/or likelihood of need to develop new performance measure(s);
- Request(s) and requirement(s) for review and update from the practice community, key stakeholders, and other sources free of industry relationships or other potential bias;
- Number of previous trials showing consistent results; and
- Need for consistency with a new guideline or guideline updates or revisions.

In analyzing the data and developing recommendations and supporting text, a writing committee uses evidence-based methodologies developed by the Task Force. The Class of Recommendation (COR) is an estimate of the size of the treatment effect, with consideration given to risks versus benefits as well as evidence and/or agreement that a given treatment or procedure is or is not useful/effective and in some situations may cause harm. The Level of Evidence (LOE) is an estimate of the certainty or precision of the treatment effect. The writing committee reviews and ranks evidence supporting each recommendation, with the weight of evidence ranked as LOE A, B, or C, according to specific definitions that are included in Table 1. Studies are identified as observational, retrospective, prospective, or randomized as appropriate. For certain conditions for which inadequate data are available, recommendations are based on expert consensus and clinical experience and are ranked as LOE C. When recommendations at LOE C are supported by historical clinical data, appropriate references (including clinical reviews) are cited if available. For issues about which sparse data are available, a survey of current practice among the clinicians on the writing committee is the basis for LOE C recommendations, and no references are cited. The schema for COR and LOE is summarized in Table 1, which also provides suggested phrases for writing recommendations within each COR. A new addition to this methodology is separation of the Class III recommendations to delineate whether the recommendation is determined to be of “no benefit” or is associated with “harm” to the patient. In addition, in view of the increasing number of comparative-effectiveness studies, comparator verbs and suggested phrases for writing recommendations for the comparative effectiveness of one treatment or strategy versus another have been added for COR I and IIa, LOE A or B only.

In view of the advances in medical therapy across the spectrum of cardiovascular diseases, the Task Force has designated the term guideline-directed medical therapy (GDMT) to represent medical therapy that is strongly recommended by (primarily Class I and IIa) ACC/AHA guidelines. The term, GDMT, will be used herein. It is anticipated that what
Currently, the treatment for stable ischemic heart disease (SIHD) is evolving as new therapies and evidence emerge. The ACC/AHA practice guidelines are intended to assist healthcare providers in clinical decision making by describing a range of generally acceptable approaches to the diagnosis, management, and prevention of specific diseases or conditions. The guidelines are intended to define practices that meet the needs of most patients in most circumstances. The ultimate judgment about care of a particular patient must be made by the healthcare provider and patient in light of all the circumstances presented by that patient. As a result, situations may arise in which deviations from these guidelines are appropriate. In clinical decision making, consideration should be given to the quality and availability of expertise in the area where care is provided. When these guidelines are used as the basis for regulatory or payer decisions, the goal should be improvement in quality of care.

Prescribed courses of treatment in accordance with these recommendations are effective only if they are followed. Because lack of patient understanding and adherence may adversely impact therapy effectiveness, providers should ensure that patients are actively engaged in their care and are able to understand the rationale for their treatment plan. Poor patient adherence is a major contributor to the development of complications and disease progression. The ACC/AHA practice guidelines are intended to assist healthcare providers in clinical decision making by describing a range of generally acceptable approaches to the diagnosis, management, and prevention of specific diseases or conditions.
affect outcomes, physicians and other healthcare providers should engage the patient’s active participation in prescribed medical regimens and lifestyles. In addition, patients should be informed of the risks and benefits of and alternatives to a particular treatment and should be involved in shared decision making whenever feasible, particularly for COR IIA and IIB, for which the benefit-to-risk ratio may be lower.

The Task Force makes every effort to avoid actual, potential, or perceived conflicts of interest that may arise as a result of industry relationships, professional biases, or personal interests among the members of the writing group. All writing committee members and peer reviewers of the guideline are required to disclose all current healthcare-related relationships, including those existing 12 months before initiation of the writing effort. In December 2009, the ACC and AHA implemented a new policy for relationships with industry and other entities (RWI) that requires the writing committee chair plus a minimum of 50% of the writing committee to have no relevant RWI (Appendix 1 for the ACC/AHA definition of relevance). These statements are reviewed by the Task Force and all members during each conference call and/or meeting of the writing committee and are updated as changes occur. All guideline recommendations require a confidential vote by the writing committee and must be approved by a consensus of the voting members. Members are not permitted to draft or vote on any text or recommendations pertaining to their RWI. Members of this writing group, who recused themselves from voting, are indicated, and specific section recusals are noted in Appendix 1. Authors’ and peer reviewers’ RWI pertinent to this guideline are disclosed in Appendices 1 and 2, respectively. Additionally, to ensure complete transparency, this writing group members’ comprehensive disclosure information—including RWI not pertinent to this document—is available as an online supplement. Comprehensive disclosure information for the Task Force is also available online. The work of this writing group is supported exclusively by the ACC, AHA, American Association for Thoracic Surgery (AATS), Preventive Cardiovascular Nurses Association (PCNA), Society for Cardiovascular Angiography and Interventions (SCAI), and Society of Thoracic Surgeons (STS) without commercial support. Writing group members volunteered their time for this activity.

To maintain relevance at the point of care for practicing physicians, the Task Force continues to oversee an ongoing process improvement initiative. As a result, in response to pilot projects, several changes to these guidelines will be incorporated into future revisions or updates of the full-text guideline. In April 2011, the Institute of Medicine released 2 reports: Finding What Works in Health Care: Standards for Systematic Reviews and Clinical Practice Guidelines We Can Trust. It is noteworthy that the ACC/AHA practice guidelines were cited as being compliant with many of the standards that were proposed. A thorough review of these reports and our current methodology is under way, with further enhancements anticipated.

The recommendations in this focused update are considered current until they are superseded in another focused update or the full-text guideline is revised. Guidelines are official policy of the ACC and AHA.

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

1. Introduction

These guidelines are intended to apply to adult patients with stable known or suspected ischemic heart disease (IHD), including those with new-onset chest pain (ie, low-risk unstable angina) or stable pain syndromes. Patients who have “ischemic equivalents,” such as dyspnea or arm pain with exertion, are included in the latter group. Many patients with IHD may become asymptomatic with appropriate therapy. Accordingly, the follow-up sections of this guideline pertain to patients who were previously symptomatic, including those who have undergone percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG). In this document, “coronary angiography” is understood to refer to invasive coronary angiography.

1.1. Methodology and Evidence Review

Late-breaking clinical trials presented at the 2012 scientific meetings of the ACC, AHA, and European Society of Cardiology, as well as other selected data reported through October, 2013, were reviewed by the 2012 stable ischemic heart disease (SIHD) guideline writing committee along with the Task Force and other experts to identify trials and other key data that might affect guideline recommendations. On the basis of the criteria and considerations noted previously (see Preamble), recently published trial data and other clinical information were considered important enough to prompt a focused update of the 2012 SIHD guideline. Evidence considered for deliberation by the writing group was added to evidence tables in the Data Supplement available online, although it did not result in recommendation changes. Among the topics considered for inclusion in the focused update was the use of fractional flow reserve (FFR) for assessing intermediate coronary lesions, including newer data from the FAME (Fractional Flow Reserve Versus Angiography for Multivessel Evaluation) 2 study. Although this was acknowledged to be an important new contribution to the literature, it did not alter the recommendations for FFR made in the 2012 full-text guideline.

Consult the full-text version or the executive summary of the 2012 SIHD guideline for policy on clinical areas not covered by the focused update. The individual recommendations in this focused update will be incorporated into future revisions or updates of the full-text guideline.

1.2. Organization of Committee and Relationships With Industry

For this focused update, representative members of the 2012 stable ischemic heart disease (SIHD) guideline writing committee were invited to participate, and they were joined by additional invited members to form a new writing group, referred to as the 2014 focused update writing group. Members were required to disclose all RWI relevant to the data under consideration. The writing group included representatives from the ACC, AHA, AATS, PCNA, SCAI, and STS.

1.3. Review and Approval

This document was reviewed by 5 official reviewers from the ACC and the AHA, as well as 1 reviewer each from the AATS, PCNA, SCAI, and STS; and 33 individual content reviewers.
reviewers, including members of the American College of Physicians, ACC Imaging Section Leadership Council, ACC Interventional Section Leadership Council, ACC Prevention of Cardiovascular Disease Section Leadership Council, ACC Surgeons’ Council, AHA Council on Clinical Cardiology, and the Association of International Governors. Reviewers’ RWI information was collected and distributed to the writing group and is published in this document (Appendix 2).

This document was approved for publication by the governing bodies of the ACC, AHA, and by other partner organizations, the AATS, PCNA, SCAI, and STS.

2. Diagnosis of SIHD

2.3. Invasive Testing for Diagnosis of Coronary Artery Disease in Patients With Suspected SIHD: Recommendations (New Section)

See Online Data Supplement 1 for additional information.

Class I

1. Coronary angiography is useful in patients with presumed SIHD who have unacceptable ischemic symptoms despite GDMT and who are amenable to, and candidates for, coronary revascularization. (Level of Evidence: C)

Class IIa

1. Coronary angiography is reasonable to define the extent and severity of coronary artery disease (CAD) in patients with suspected SIHD whose clinical characteristics and results of noninvasive testing (exclusive of stress testing) indicate a high likelihood of severe IHD and who are amenable to, and candidates for, coronary revascularization.7–12 (Level of Evidence: C)

2. Coronary angiography is reasonable in patients with suspected symptomatic SIHD who cannot undergo diagnostic stress testing, or have indeterminate or nondiagnostic stress tests, when there is a high likelihood that the findings will result in important changes to therapy. (Level of Evidence: C)

Class IIb

1. Coronary angiography might be considered in patients with stress test results of acceptable quality that do not suggest the presence of CAD when clinical suspicion of CAD remains high and there is a high likelihood that the findings will result in important changes to therapy. (Level of Evidence: C)

This section has been added to the 2014 SIHD focused update to fill a gap in the 2012 SIHD guideline. It specifically addresses the role of coronary angiography for the diagnosis of CAD in patients with suspected SIHD.

Coronary angiography for risk stratification has been addressed in Section 3.3 of the 2012 SIHD full-text guideline. Recommendations for use of coronary angiography in the following specific clinical circumstances have been addressed in other guidelines or statements and will not be discussed further here:

- Patients with heart failure and/or reduced ejection fraction
- Patients who have experienced sudden cardiac death or sustained ventricular arrhythmia
- Patients undergoing preoperative cardiovascular evaluation for noncardiac surgery (including solid organ transplantation)
- Evaluation of cardiac disease among patients who are kidney or liver transplantation candidates

Note that ACC/AHA guidelines for coronary angiography were published in 1999 but not updated, and they are now superseded by the above documents.

There are no high-quality data on which to base recommendations for performing diagnostic coronary angiography because no study has randomized patients with SIHD to either catheterization or no catheterization. Trials in patients with SIHD comparing revascularization and GDMT have, to date, all required angiography, most often after stress testing, as a prerequisite for subsequent revascularization. Additionally, the “incremental benefit” of detecting or excluding CAD by coronary angiography remains to be determined. The ISCHEMIA (International Study of Comparative Health Effectiveness With Medical and Invasive Approaches) trial is currently randomizing patients with at least moderate ischemia on stress testing to a strategy of optimal medical therapy alone (with coronary angiography reserved for failure of medical therapy) or routine cardiac catheterization followed by revascularization (when appropriate) plus optimal medical therapy. Before randomization, however, patients with normal renal function will undergo “blinded” computed tomography (CT) angiography to exclude them if significant left main CAD or no significant CAD is present. The writing group strongly endorses the ISCHEMIA trial, which will provide contemporary, high-quality evidence about the optimal strategy for managing patients with nonleft main SIHD and moderate-to-severe ischemia.

In the majority of patients with suspected SIHD, noninvasive stress testing for diagnosis and risk stratification is the appropriate initial study. Importantly, coronary angiography is appropriate only when the information derived from the procedure will significantly influence patient management and if the risks and benefits of the procedure have been carefully considered and understood by the patient. Coronary angiography to assess coronary anatomy for revascularization is appropriate only when it is determined beforehand that the patient is amenable to, and a candidate for, percutaneous or surgical revascularization. In patients with abnormal, noninvasive stress testing for whom a diagnosis of CAD remains in doubt, many clinicians proceed to diagnostic coronary angiography. However, in some patients, multidetector CT angiography may be appropriate and safer than routine invasive angiography for this purpose. Indications and contraindications to CT angiography, including subsets of patients for whom it can be considered, are discussed in the 2010 expert consensus document on CT angiography and the 2010 appropriate use criteria for cardiac CT.

Although coronary angiography is considered the “gold standard” for the diagnosis of CAD, it has inherent limitations and shortcomings. Angiographic assessment of stenosis severity relies on comparison to an adjacent, nondiseased reference...
In a subset of patients, clinical characteristics, symptoms, and/or results of noninvasive testing alone indicating a high likelihood of multivessel or left main disease (eg, large ischemic burden) may prompt diagnostic angiography and revascularization, instead of initial stress testing. Patients with long-standing diabetes mellitus and end-organ damage, severe peripheral vascular disease (eg, abdominal aortic aneurysm), or previous chest (mantle) radiation therapy may have severe CAD—particularly when ischemic symptoms are present.28–31 Patients with a combination of typical angina, transient heart failure, pulmonary edema, or exertional or unheralded syncope may have severe CAD. Noninvasive testing, such as rest echocardiography revealing multiple regional wall motion abnormalities or electrocardiography with diffuse ischemic changes in multiple territories, may reflect CAD with a large ischemic burden and justify diagnostic angiography without prior stress testing. The writing group has found that creating a recommendation governing the use of angiography for such high-risk patients remains controversial. The writing group recognizes, however, that many clinicians believe that prompt diagnostic angiography and revascularization, instead of initial stress testing, are appropriate for such high-risk patients who are likely to have underlying severe CAD for which revascularization would confer a survival advantage.

Coronary angiography is not routinely performed after adequate stress testing has been negative for ischemia. Still, stress tests can be falsely negative and, in a patient with high pretest likelihood of CAD, Bayes’ theorem predicts that a high posttest likelihood of CAD will remain as well. Therefore, when clinicians strongly suspect that a stress test is falsely negative (eg, a patient with typical angina who also has multiple risk factors for CAD), diagnostic angiography may be warranted. When stress testing yields an ambiguous or indeterminate result in a patient with a high likelihood of CAD, coronary angiography may be preferable to another noninvasive test and may be the most effective means to reach a diagnosis.

The frequency with which coronary angiography is performed varies across geographic regions, and in some areas it may be underutilized or overutilized.34 The optimal rate of “normal” coronary angiography in clinical practice remains undefined. In the ACC’s National Cardiovascular Data Registry CathPCI Registry, approximately 45% of elective cardiac catheterizations performed at hospitals did not detect clinically significant (defined as >50% luminal diameter) stenoses,29,35 although rates varied markedly between hospitals (ie, range, 0% to 77%).35 Hospitals with lower rates of significant CAD at catheterization were more likely to have performed angiography on younger patients; those with no

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**Coronary Angiography**

Coronary angiography is a diagnostic procedure that involves the injection of a radiopaque substance into the coronary arteries to visualize the coronary vessels on X-ray images. It is widely used in the evaluation of coronary artery disease, but its role and indications are subject to ongoing debate. While coronary angiography is considered a gold standard for diagnosing coronary artery disease, its accuracy and clinical utility can be affected by various factors. The procedure involves the placement of a catheter through an artery (usually the femoral artery), typically in the leg, and advancing it into the heart to inject contrast material into the coronary arteries. The resulting images are used to assess the presence, location, and extent of coronary artery stenoses, which are narrowing of the coronary arteries.

Despite the widespread use of coronary angiography, there are several limitations and potential complications. One of the main limitations is that angiographic findings may not always correlate with the physiological significance of coronary stenoses. Angiography provides a visual assessment of the coronary arteries and can identify narrowing, but it does not provide information about the hemodynamic impact of these stenoses. The fractional flow reserve (FFR) and the invasive coronary pressure wire have been developed to assess the physiological significance of coronary stenoses. FFR measures the ratio between the coronary perfusion pressure and the arterial pressure, providing a direct estimate of the functional significance of the stenosis. Patients with an FFR ≤0.75 are considered to have a significant lesion.

Other considerations for the use of coronary angiography include the patient's clinical characteristics, symptoms, and the results of noninvasive stress tests. When stress testing is inconclusive or yields conflicting results, coronary angiography may be helpful to determine whether there is significant coronary artery disease (CAD) that requires revascularization. The writing group acknowledges that many clinicians believe prompt diagnostic angiography and revascularization are appropriate for such high-risk patients, who may have severe CAD.

The writing group recognizes the controversy surrounding the use of coronary angiography in clinical practice. The frequency of its use varies across geographic regions, and rates at individual hospitals can range from 0% to 77%. Hospitals with lower rates of detecting significant CAD at catheterization were more likely to perform angiography on younger patients.

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**References**

4. **ACC National Cardiovascular Data Registry CathPCI Registry**. ACC’s National Cardiovascular Data Registry CathPCI Registry during the 2012 calendar year included a 1.5% incidence of procedural complications of diagnostic angiography. Complications in earlier reports included death, stroke, myocardial infarction (MI), bleeding, infection, contrast allergic or anaphylactoid reactions, vascular damage, contrast-induced nephropathy, arrhythmias, and need for emergency revascularization.
symptoms or atypical symptoms; and those with negative, equivocal, or unperformed functional status assessment. Even among those with a positive result on a noninvasive test, only 41% of patients were found to have significant CAD. In a study performed within the Veterans Health Administration, 21% of patients undergoing elective catheterization had “normal” coronary arteries (defined as having no lesions ≥20%). The median proportion of normal coronary arteries was 10.8% among hospitals in the lowest quartile and 30.3% among hospitals in the highest quartile. The authors concluded that factors causing variation in patient selection for coronary angiography exist in integrated non–fee-for-service health systems as well as in fee-for-service systems.

Angiographically normal or near-normal coronary arteries are more common among women, who are more likely than men to have myocardial ischemia due to microvascular disease. The relatively high proportion of patients with ischemia and no significant epicardial stenoses may indicate opportunities to improve patient selection for coronary angiography, or to consider the possibility of syndromes caused by abnormal coronary vasoreactivity. Nevertheless, the exclusion of significant epicardial CAD with a high level of confidence can be important for high-quality diagnosis and patient management, and therefore the reported frequencies of normal coronary findings should be understood within this context.

4. Treatment

4.4. Guideline-Directed Medical Therapy

4.4.2. Additional Medical Therapy to Prevent MI and Death: Recommendation

4.4.2.5. Additional Therapy to Reduce Risk of MI and Death
See Table 2 for the revised recommendation for chelation therapy and Online Data Supplement 2 for evidence supporting the recommendation.

4.4.2.5.4. Chelation Therapy. Chelation therapy, which consists of a series of intravenous infusions of disodium ethylene diamine tetraacetic acid (EDTA) in combination with other substances, has been touted as a putative noninvasive means of improving blood flow in atherosclerotic vessels, treating angina, and preventing cardiac events. EDTA combines with polyvalent cations, such as calcium and cadmium (a constituent of cigarette smoke that is associated with cardiovascular risk), to form soluble complexes that can be excreted. Advocates maintain that this process can result in both regression of atherosclerotic plaques and relief of angina and that EDTA reduces oxidative stress in the vascular wall. Anecdotal reports have suggested that EDTA chelation therapy can result in relief of angina in patients with SIHD. Studies in patients with intermittent claudication and SIHD have failed to demonstrate improvements in exercise measures, ankle-brachial index, or digital subtraction angiograms with chelation. A randomized controlled trial (RCT) examining the effect of chelation therapy on SIHD studied 84 patients with stable angina and a positive treadmill test for ischemia. Those randomized to active therapy received weight-adjusted disodium EDTA chelation therapy for 3 hours per treatment, twice weekly for 15 weeks, and then once monthly for an additional 3 months. There were no differences between groups in changes in exercise time to ischemia, exercise capacity, or quality-of-life scores. The National Center of Complementary and Alternative Medicine and the National Heart, Lung, and Blood Institute conducted TACT (Trial to Assess Chelation Therapy), an RCT comparing chelation with placebo in patients who had experienced MI. The primary composite endpoint of total mortality, recurrent MI, stroke, coronary revascularization, or hospitalization for angina occurred in 222 (26%) patients in the chelation group and 261 (30%) patients in the placebo group (hazard ratio: 0.82; 95% CI: 0.69 to 0.99; P=0.035 [because of multiple comparisons, statistical significance was considered at P values ≤0.036]). No individual endpoint differed significantly between groups. Among patients with diabetes mellitus, there was a 39% reduction (hazard ratio: 0.61; 95% CI: 0.45 to 0.83) in the composite endpoint for the chelation-treated patients relative to the placebo-treated patients (P=0.02 for interaction). Despite these positive findings, the TACT investigators did not recommend the routine use of chelation therapy to reduce symptoms or cardiovascular complications for all patients with SIHD, given the modest overall benefit, high proportion of patient withdrawals (18% lost to follow-up), absence of adequate scientific basis for the therapy, and possibility of a false positive outcome. The large proportion of withdrawals was especially concerning given that 50% more patients withdrew from chelation therapy than from placebo, which raised important concerns about unmasking of treatment assignments that could have influenced key outcomes (eg, revascularization or hospitalization for angina). In addition, chelation therapy is not risk free. Disodium EDTA, particularly when infused too rapidly, may cause hypocalcemia, renal failure, and death. Although disodium EDTA is approved by the US Food and Drug Administration for specific indications, such as iron overload and lead poisoning, it is not approved for use in preventing or treating cardiovascular disease. Accordingly, the writing group finds that the usefulness of chelation therapy in cardiac disease is highly questionable.

4.4.4. Alternative Therapies for Relief of Symptoms in Patients With Refractory Angina: Recommendation
See Table 3 for the recommendation on enhanced external counterpulsation (EECP) and Online Data Supplement 3 for evidence supporting the recommendation.

4.4.4.1. Enhanced External Counterpulsation
Although EECP was carefully reviewed in the 2012 SIHD guideline, comments received after the guideline’s publication prompted a re-examination of the existing literature, even though no truly new data have become available. EECP is a technique that uses inflatable cuffs wrapped around the lower extremities to increase venous return and augment diastolic blood pressure. The cuffs are inflated sequentially from the calves to the thigh muscles during diastole and are deflated instantaneously during systole. The resultant diastolic augmentation increases coronary perfusion pressure, and the systolic cuff depression decreases peripheral resistance. Treatment is associated with improved left ventricular diastolic filling, peripheral flow-mediated dilation, and endothelial function. Other putative mechanisms for improvement in symptoms include recruitment of collaterals, attenuation of oxidative stress and proinflammatory cytokines,
promotion of angiogenesis and vasculogenesis, and a peripheral training effect.\textsuperscript{46-52} EECP was approved by the US Food and Drug Administration in 1995 for the treatment of patients with CAD and refractory angina pectoris who fail to respond to standard revascularization procedures and aggressive pharmacotherapy. A treatment course typically consists of 35 sessions of 1 hour each, given 5 days a week. Contraindications include decompensated heart failure, severe peripheral artery disease, and severe aortic regurgitation.

The efficacy of EECP in treating stable angina pectoris has been evaluated in 2 RCTs and several observational registry studies. In MUST-EECP (Multicenter Study of Enhanced External Counterpulsation), 139 patients with angina, documented CAD, and evidence of ischemia on exercise testing were randomized to 35 hours of active counterpulsation or to inactive counterpulsation (with insufficient pressure to alter blood pressure).\textsuperscript{47} Time to ≥1-mm ST-segment depression on stress testing increased significantly in patients treated with active counterpulsation (from 337±18 s to 379±18 s) compared with placebo (from 326±21 s to 330±20 s; \(P=0.01\)). The groups did not differ in terms of exercise duration, change in daily nitroglycerin use, or mean frequency of angina, although the percentage reduction in frequency of anginal episodes was somewhat greater among patients who received active counterpulsation. Of patients receiving EECP, 55% reported adverse events, including leg and back pain and skin abrasions, compared with 26% in the control group (relative risk: 2.13; 95% CI: 1.35 to 3.38), with approximately half of these events categorized as device related. An additional trial of EECP was conducted in 42 symptomatic patients with CAD who were randomized (2:1 ratio) to 35 hours of either EECP (\(n=28\)) or sham EECP (\(n=14\)).\textsuperscript{51} Over the 7-week study period, average Canadian Cardiovascular Society angina class improved with EECP as compared with control (3.16±0.47 to 1.20±0.40 and 2.93±0.26 to 2.93±0.26 in EECP and sham control, respectively; \(P<0.001\)). Data from RCTs on long-term outcomes are lacking.

In a meta-analysis of 13 observational studies that tracked 949 patients, Canadian Cardiovascular Society angina class was improved by ≥1 class in 86% of EECP-treated patients (95% CI: 82% to 90%). There was, however, a high degree of heterogeneity among the studies, which lessens confidence in the results of the meta-analysis (Q statistic \(P=0.008\)).\textsuperscript{52} The EECP Consortium reported results from 2289 consecutive patients undergoing EECP therapy at 84 participating centers, including a subgroup of 175 patients from 7 centers who underwent radionuclide perfusion stress tests before and after therapy.\textsuperscript{53} Treatment was associated with improved perfusion images and increased exercise duration. Similarly, the International EECP Registry reported improvement of ≥1 Canadian Cardiovascular Society angina class in 81% of patients immediately after the last EECP treatment.\textsuperscript{54} Improvements in health-related quality of life have also been reported with EECP, but there is limited evidence with which to determine the duration of the health-related benefits of treatment.\textsuperscript{55,56}

In general, existing data, largely from uncontrolled studies, suggest a benefit from EECP among patients with angina refractory to other therapy. Additional data from well-designed RCTs are needed to better define the role of this therapeutic strategy in patients with SIHD.\textsuperscript{57} On the basis of this re-examination of the literature, the recommendation about EECP remains unchanged from the 2012 guideline.

## 5. CAD Revascularization

### 5.2. Revascularization to Improve Survival: Recommendations

See Table 4 for recommendations on CAD revascularization to improve survival and Online Data Supplement 4 for evidence supporting the recommendations.

### 5.6. CABG Versus PCI

#### 5.6.2. CABG Versus Drug-Eluting Stents

See Online Data Supplement 5 for additional evidence table. Although the results of 10 observational studies comparing CABG and drug-eluting stent (DES) implantation have been published,\textsuperscript{70-79} most of these studies had short follow-up periods (12 to 24 months). In a meta-analysis of 24,268 patients with multivessel CAD treated with CABG or DES,\textsuperscript{80} the incidences of death and MI were similar for the 2 procedures, but the frequency with which repeat revascularization was performed was roughly 4 times higher after DES implantation. Only 1 large RCT comparing CABG and DES implantation has been

---

### Table 2. Recommendation for Chelation Therapy

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<th>Comment</th>
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<td>Class II: No Benefit</td>
<td>Class IIb</td>
<td>Modified recommendation (changed Class of Recommendation from III: No Benefit to IIb and Level of Evidence from C to B).</td>
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<tr>
<td>1. Chelation therapy is not recommended with the intent of improving symptoms or reducing cardiovascular risk in patients with SIHD.\textsuperscript{38-41} (Level of Evidence: C)</td>
<td>1. The usefulness of chelation therapy is uncertain for reducing cardiovascular events in patients with SIHD.\textsuperscript{38-42} (Level of Evidence: B)</td>
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SIHD indicates stable ischemic heart disease.

### Table 3. Recommendation for EECP

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<td>1. EECP may be considered for relief of refractory angina in patients with SIHD.\textsuperscript{41} (Level of Evidence: B)</td>
<td>1. EECP may be considered for relief of refractory angina in patients with SIHD.\textsuperscript{41} (Level of Evidence: B)</td>
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EECP indicates enhanced external counterpulsation and SIHD, stable ischemic heart disease.
Table 4. Recommendations for CAD Revascularization to Improve Survival

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<td>Class I</td>
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<tr>
<td>1. CAGB 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.</td>
<td>1. A Heart Team approach to revascularization is recommended in patients with diabetes mellitus and complex multivessel CAD. (Level of Evidence: C)</td>
<td>New recommendation</td>
</tr>
<tr>
<td>2. CABG is generally recommended in preference to PCI to improve survival in patients with diabetes mellitus and multivessel CAD for which revascularization is likely to improve survival (3-vessel CAD or complex 2-vessel CAD involving the proximal LAD), particularly if a LIMA graft can be anastomosed to the LAD artery, provided the patient is a good candidate for surgery. (Level of Evidence: B)</td>
<td>2. CABG is generally recommended in preference to PCI to improve survival in patients with diabetes mellitus and multivessel CAD for which revascularization is likely to improve survival (3-vessel CAD or complex 2-vessel CAD involving the proximal LAD), particularly if a LIMA graft can be anastomosed to the LAD artery, provided the patient is a good candidate for surgery. (Level of Evidence: B)</td>
<td>Modified recommendation (Class of Recommendation changed from Ila to I, wording modified, additional RCT added).</td>
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CAGB indicates coronary artery bypass graft; CAD, coronary artery disease; LAD, left anterior descending; LIMA, left internal mammary artery; PCI, percutaneous coronary intervention; and RCT, randomized controlled trial.

published. The SYNTAX (Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery) trial randomly assigned 1800 patients (of a total of 4337 who were screened) to receive DES or CAGB. Main adverse cardiac and cerebrovascular events (MACCE)—a composite of death, stroke, MI, or repeat revascularization during the 3 years after randomization—occurred in 20.2% of patients who had received CAGB and 28.0% of those who had undergone DES implantation (P<0.001). The rates of death and stroke were not significantly different; however, MI (3.6% for CAGB, 7.1% for DES) and repeat revascularization (10.7% for CABG, 19.7% for DES) were more likely to occur with DES implantation. At 5 years of follow-up, MACCE occurred in 26.9% of patients who had received CAGB and 37.3% of those who had undergone DES implantation (P<0.0001). The combined endpoint of death, stroke, or MI was also lower in CAGB-treated patients than in DES-treated patients (16.7% versus 20.8%; P=0.03).

In SYNTAX, the extent of CAD was assessed using the SYNTAX score, which is based on the location, severity, and extent of coronary stenoses, with a low score indicating less complicated anatomic CAD. In post hoc analyses, a low score was defined as ≤22; intermediate, 23 to 32; and high, ≥33. The occurrence of MACCE correlated with the SYNTAX score for DES patients but not for those who had undergone CAGB. At 12-month follow-up, the primary endpoint was similar for CAGB and DES in those with a low SYNTAX score. In contrast, MACCE occurred more often after DES implantation than after CAGB in those with an intermediate or high SYNTAX score. At 3 years of follow-up, the mortality rate was greater in subjects with 3-vessel CAD treated with DES than in those treated with CAGB (6.2% versus 2.9%). The differences in MACCE at 5-year follow-up between those treated with DES or CAGB increased with an increasing SYNTAX score. Although the utility of the SYNTAX score in everyday clinical practice remains uncertain, it seems reasonable to conclude from SYNTAX and other data that survival rates of patients undergoing PCI or CAGB with relatively uncomplicated and lesser degrees of CAD are comparable, whereas for those with complex and diffuse CAD, CAGB appears to be preferable.
SYNTAX scores had MACCE than in the CABG group (46.5% versus 29.7%; \( P=0.003 \)).

In the LE MANS (Study of Unprotected Left Main Stenting Versus Bypass Surgery) trial,\(^7\) 105 patients with left main CAD were randomized to receive PCI or CABG. Although a low proportion of patients treated with PCI received DES (35%) and a low proportion of patients treated with CABG received internal mammary grafts (72%), the outcomes at 30 days and 1 year were similar between the groups. In the PRECOMBAT (Premier of Randomized Comparison of Bypass Surgery Versus Angioplasty Using Sirolimus-Eluting Stent in Patients With Left Main Coronary Artery Disease) trial of 600 patients with left main disease, the composite endpoint of death, MI, or stroke at 2 years occurred in 4.4% of patients treated with DES and 4.7% of patients treated with CABG, but ischemia-driven target-vessel revascularization was required more often in the patients treated with PCI (9.0% versus 4.2%).

The results from these 3 RCTs suggest (but do not definitively prove) that major clinical outcomes in selected patients with left main CAD are similar with CABG and PCI at 1- to 2-year follow-up but that repeat revascularization rates are higher after PCI than after CABG. RCTs with extended follow-up of \( \geq 5 \) years are required to provide definitive conclusions about the optimal treatment of left main CAD; 2 such studies are under way. In a meta-analysis of 8 cohort studies and 2 RCTs,\(^9\) death, MI, and stroke occurred with similar frequency in the PCI- and CABG-treated patients at 1, 2, and 3 years of follow-up. Target-vessel revascularization was performed more often in the PCI group at 1 year (OR: 4.36), 2 years (OR: 4.20), and 3 years (OR: 3.30).

Additional analyses using Bayesian methods, initiated by the Task Force, have affirmed the equivalence of PCI and CABG for improving survival in patients with unprotected left main CAD who are candidates for either strategy.\(^12\) A Bayesian cross-design and network meta-analysis was applied to 12 studies (4 RCTs and 8 observational studies) comparing CABG with PCI (\( n=4574 \) patients) and to 7 studies (2 RCTs and 5 observational studies) comparing CABG with medical therapy (\( n=3224 \) patients). The ORs of death at 1 year after PCI compared with CABG did not differ among RCTs (OR: 0.99; 95% Bayesian credible interval 0.67 to 1.43), matched cohort studies (OR: 1.10; 95% Bayesian credible interval 0.76 to 1.73), and other types of cohort studies (OR: 0.93; 95% Bayesian credible interval 0.58 to 1.35). A network meta-analysis suggested that medical therapy is associated with higher risk of death at 1 year than is the use of PCI for patients with unprotected left main CAD (OR: 3.22; 95% Bayesian credible interval 1.96 to 5.30).\(^12\) In that study, the Bayesian method generated a credible interval that has a high probability of containing the true OR. In other words, the true value for the OR has a 95% probability of lying within the interval of 0.68 to 1.45. Because the value 1 is included in the credible interval, which is also symmetrical, the results show no evidence of a difference between PCI and CABG for 1-year mortality rate. The possibility that PCI is associated with increased or decreased 1-year mortality over CABG is small (<2.5% for a possible 45% increase or for a 32% decrease, according to the definition of the 95% Bayesian credible interval).

5.12. Special Considerations

In addition to patients’ coronary anatomy, left ventricular function, and history of prior revascularization, clinical features such as the existence of coexisting chronic conditions might influence decision making. However, the paucity of information about special subgroups is one of the greatest challenges in developing evidence-based guidelines applicable to large populations. As is the case for many chronic conditions, studies specifically geared toward answering clinical questions about the management of SIHD in women, older adults, and persons with chronic kidney disease are lacking. The “ACCF/AHA guidelines for the management of patients with unstable angina/non–ST-elevation myocardial infarction”\(^10,91\) address special subgroups. The present section echoes those management recommendations. Although this section will briefly review some special considerations for diagnosis and therapy in certain groups of patients, the general approach should be to apply the recommendations in this guideline consistently among groups.

5.12.3. Diabetes Mellitus

See Online Data Supplement 6 for additional evidence table.

In the FREEDOM (Future Revascularization Evaluation in Patients With Diabetes Mellitus: Optimal Management of Multivessel Disease) trial, 1900 patients with multivessel CAD were randomized to either PCI with DES or CABG.\(^68\) The primary outcome—a composite of death, nonfatal MI, or nonfatal stroke—occurred less frequently in the CABG group (\( P=0.005 \)), with 5-year rates of 18.7% in the CABG group and 26.6% in the DES group. The benefit of CABG was related to differences in rates of both MI (\( P<0.001 \)) and death from any cause (\( P=0.049 \)). Stroke was more frequent in the CABG group, with 5-year rates of 5.2% in the CABG group and 2.4% in the DES group (\( P=0.03 \)).

Other studies have provided mixed evidence, but none has suggested a survival advantage of PCI. The 5-year update from the SYNTAX trial did not show a significant advantage in survival after CABG compared with survival after DES in patients with diabetes mellitus and multivessel CAD (12.9% versus 19.5%; \( P=0.065 \)).\(^53\) A meta-analysis of 4 trials showed no significant advantage in survival after CABG compared with survival after PCI for patients with diabetes mellitus (7.9% versus 12.4%; \( P=0.09 \)).\(^52\) In a pooled analysis, it was found that patients with diabetes mellitus assigned to CABG had improved survival (23% versus 29%; \( P=0.008 \) for the interaction between presence of diabetes mellitus and type of revascularization procedure after adjustment).\(^93\)

The strongest evidence supporting the use of CABG over PCI for patients with diabetes mellitus and multivessel CAD comes from a published meta-analysis of 8 trials (including FREEDOM).\(^58\) The study of 3131 patients showed that at 5-year or longest follow-up, patients with diabetes mellitus randomized to CABG had a lower all-cause mortality rate than did those randomized to PCI with either DES or bare metal stent (relative risk 0.67; 95% CI: 0.52 to 0.86; \( P=0.002 \)).\(^34\)

In summary, patients with SIHD and diabetes mellitus should receive GDMT. For patients whose symptoms compromise their quality of life, revascularization should be considered. CABG appears to be associated with lower risk of mortality than is PCI in most patients with diabetes mellitus and complex
multivessel disease, although the Heart Team may identify exceptions. To address the important issue of deciding between PCI and CABG in patients with diabetes mellitus and complex multivessel CAD, a Heart Team approach would be beneficial. This was an integral component of the FREEDOM, SYNTAX, and BARI trials and is therefore emphasized in this setting. The Heart Team is a multidisciplinary team composed of an interventional cardiologist and a cardiac surgeon who jointly 1) review the patient’s medical condition and coronary anatomy, 2) determine that PCI and/or CABG are technically feasible and reasonable, and, 3) discuss revisionalization options with the patient before a treatment strategy is selected. Future research may be facilitated by including a field in the National Cardiovascular Data Registry and the STS database to identify cases “turned down” for the alternative revascularization strategy.

Presidents and Staff

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Shalom Jacobovitz, Chief Executive Officer
William J. Oetgen, MD, MBA, FACC, Executive Vice President, Science, Education, and Quality
Amelia Scholtz, PhD, Publications Manager, Clinical Policy and Pathways

American College of Cardiology/American Heart Association
Lisa Bradfield, CAE, Director, Clinical Policy and Guidelines
Ezaldeen Ramadhan III, Project Management Team Leader, Science and Clinical Policy

American Heart Association
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Gayle R. Whitman, PhD, RN, FAHA, FAAN, Senior Vice President, Office of Science Operations
Marco Di Buono, PhD, Vice President, Science, Research, and Professional Education, Office of Science Operations
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References
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Key Words: AHA Scientific Statements | cardiac catheterization | cardiovascular | chelation therapy | coronary angiography | coronary artery bypass | counterpulsation | diagnostic techniques | focused update | myocardial ischemia | percutaneous coronary intervention.
Appendix 1. Author Relationships With Industry and Other Entities (Relevant)—2014 ACC/AHA/AATS/PCNA/SCAI/STS Focused Update of the Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease

<table>
<thead>
<tr>
<th>Committee Member</th>
<th>Employment</th>
<th>Consultant</th>
<th>Speaker’s Bureau</th>
<th>Ownership/Partnership/Principal</th>
<th>Personal Research</th>
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<th>Expert Witness</th>
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<tr>
<td>Stephan D. Fihn (Chair)</td>
<td>Department of Veterans Affairs—Director, Office of Analytics and Business Intelligence</td>
<td>None</td>
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<td>James C. Blankenship (Vice Chair)</td>
<td>Geisinger Medical Center—Staff Physician; Director, Cardiac Catheterization Laboratory</td>
<td>None</td>
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<td>Karen P. Alexander</td>
<td>Duke University Medical Center—Associate Professor of Medicine/Cardiology</td>
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<td>John A. Bittl</td>
<td>Munroe Regional Medical Center—Invasive Cardiologist</td>
<td>None</td>
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<td>John G. Byrne</td>
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<td>Barbara J. Fletcher</td>
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<td>Richard A. Lange</td>
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<td>• AstraZeneca</td>
<td>• Gilead Sciences†</td>
<td>None</td>
<td>• Daiichi-Sankyo†</td>
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Appendix 2. Reviewer Relationships With Industry and Other Entities (Relevant)—2014 ACC/AHA/AATS/PCNA/SCAI/STS Focused Update of the Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease

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<tr>
<td>Judith S. Hochman</td>
<td>Official Reviewer—ACC/AHA Task Force on Practice Guidelines</td>
<td>New York University School of Medicine—Clinical Chief of Cardiology</td>
<td>None</td>
<td>None</td>
<td>• NIH (PI–ISCHEMIA trial)*</td>
<td>None</td>
</tr>
<tr>
<td>Bruce W. Lytle</td>
<td>Official Reviewer—AHA</td>
<td>Cleveland Clinic Foundation—Chairman, Thoracic and Cardiovascular Surgery</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Margo B. Minissian</td>
<td>Official Reviewer—ACC Board of Governors</td>
<td>Cedars-Sinai’s Heart Institute—Cardiology Nurse Practitioner; University of California Los Angeles—Assistant Clinical Professor</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>• Gilead Sciences*</td>
</tr>
<tr>
<td>C. Michael Valentine</td>
<td>Official Reviewer—ACC Board of Trustees</td>
<td>Centra Lynchburg General Hospital—Director, Cardiac Progressive Care Unit; Centra Stroobants Heart Center—Director of Clinical Quality</td>
<td>None</td>
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<tr>
<td>Lani M. Zimmerman</td>
<td>Official Reviewer—AHA</td>
<td>University of Nebraska Medical Center—Professor, College of Nursing</td>
<td>None</td>
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</tr>
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## Data Supplement 1. Studies of Flow Reserve Assessment for Intermediate Coronary Lesions

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<th>Primary Endpoint</th>
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<td><strong>DEFER (1)</strong></td>
<td>RCT</td>
<td>325 pts</td>
<td>Elective PCI 3 groups based on (&lt;=0.75) FFR (deferral, performance, and reference groups)</td>
<td>Absence of death, MI, PCI, CABG by 24 mo</td>
<td>Same event in pts with FFR (\geq 0.75) with PCI or deferred</td>
<td>In pts with SVCAD and no documented ischemia, FFR identifies those who benefit from PTCA.</td>
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<td><strong>DEFER (2)</strong></td>
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<td>325 pts</td>
<td>Elective PCI SVD with 3 groups (deferral, performance, and reference groups) based on (&lt;=0.75) FFR</td>
<td>Absence of death, MI, PCI, CABG by 60 mo</td>
<td>Similar to 2-y follow-up No benefit with PCI if FFR (\geq 0.75)</td>
<td>In pts with SVCAD and no documented ischemia, FFR identifies those who benefit from PTCA.</td>
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<td><strong>FAME (3)</strong></td>
<td>RCT</td>
<td>1,005 pts (DES)</td>
<td>MVD PCI with angiography PCI only vs. angiography and FFR (&lt;=0.80)</td>
<td>1-y death, MI, or repeat revasc</td>
<td>18.3% in angiography group; 13.2% in FFR group (p=0.02)</td>
<td>FFR-guided PCI in pts with MVD improves 1-y composite endpoints: death, MI, or revasc.</td>
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<td><strong>FAME (4)</strong></td>
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<td>1,005 pts (DES)</td>
<td>Pts with MVD with angiography PCI only or angiography and FFR (&lt;=0.80)</td>
<td>1-y death, MI, or repeat revasc</td>
<td>22.4% in angiography group; 17.9% in FFR group (p=0.08)</td>
<td>FFR-guided PCI in pts with MVD improves 2-y composite endpoints: death, MI, or revasc.</td>
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<td><strong>(FFR vs. IVUS) (5)</strong></td>
<td>NR</td>
<td>167 pts</td>
<td>40% to 70% PCI of stenosis with IVUS MLA (\leq 4.0) cm(^2) or FFR (&lt;=0.80)</td>
<td>1-y death, MI, or repeat revasc</td>
<td>No difference: 3.6% FFR vs. 3.2% IVUS</td>
<td>In pts with SVCAD and no documented ischemia, FFR identifies those who benefit from PTCA.</td>
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<td><strong>(LM)</strong></td>
<td>NR</td>
<td>142 consecutive pts</td>
<td>LM 30% to 60% or indeterminate. FFR (&lt;0.75) revasc recommended, (&lt;0.80) medical therapy recommended, or (0.75-0.80) either recommended</td>
<td>14-mo follow-up death, MI, CABG, PCI</td>
<td>13% medical vs. 7% revasc; Death or MI 6% vs. 7%, respectively</td>
<td>FFR may be helpful, but DM and dose of adenosine may influence decision.</td>
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<td><strong>(LM)</strong></td>
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<td>213 pts (209 with follow-up)</td>
<td>Equivalent LM FFR (&lt;0.80) surgery; 0.80 medical therapy</td>
<td>Event-free survival 3-y follow-up; 5 y estimated</td>
<td>74.2% medical therapy vs. 82.8% surgery (p=0.48)</td>
<td>FFR is beneficial for equivocal LM lesions in deciding need for revasc.</td>
</tr>
<tr>
<td><strong>FAME 2 (8)</strong></td>
<td>RCT</td>
<td>888 randomized pts</td>
<td>FFR (0.80-80) randomized to PCI vs. GDMT</td>
<td>Death, MI, or urgent revasc</td>
<td>12.7% medical therapy vs. 4.3% PCI (p=0.001)</td>
<td>Upfront stenting may prevent future urgent stenting; no decrease in death or MI with FFR-guided PCI.</td>
</tr>
</tbody>
</table>

CABG indicates coronary artery bypass graft; DEFER, Deferral Versus Performance of Balloon Angioplasty in Patients Without Documented Ischemia; DES, drug-eluting stent; DM, diabetes mellitus; FAME, Fractional Flow Reserve Versus Angiography for Multivessel Evaluation; FFR, fractional flow reserve; GDMT, guideline-directed medical therapy; IVUS, intravascular ultrasound; LM, left main; MI, myocardial infarction; MLA, minimal luminal area; mo, month(s); MVD, multivessel CAD; NCA, non-culprit artery; PCI, percutaneous coronary intervention; PEO, pyroglutamic acid treatment; PPCI, primary percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty; RCT, randomized controlled trial; SVCAD, severe vascular coronary artery disease; SVCS, severe vascular coronary stenosis; SVD, single vessel disease; TVC, total vascular coronary disease; WBC, white blood cells.
Data Supplement 2. Chelation Therapy

<table>
<thead>
<tr>
<th>Study Name, Author, Year</th>
<th>Aim of Study</th>
<th>Study Type</th>
<th>Study Size (N)</th>
<th>Study Intervention Group (n)</th>
<th>Study Comparator Group (n)</th>
<th>Study Intervention</th>
<th>Study Comparator</th>
<th>Patient Population</th>
<th>Endpoints</th>
<th>Safety Endpoint and Results</th>
<th>Secondary Endpoint and Results</th>
<th>P Values, OR; HR; RR and 95% CI</th>
<th>Study Limitations and Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guldager 1992 (9) 1556523</td>
<td>To assess the effect of chelation therapy on severe IC</td>
<td>RCT</td>
<td>153</td>
<td>75</td>
<td>78</td>
<td>Vascular surgery within the last 12 mo; ischemic rest pain or gangrene; moderate or severe venous insufficiency; renal insufficiency; DM; thyroid and parathyroid disorders; hepatic dysfunction; significant cardiopulmonary failure (e.g., MI in prior year); coexistent carcinomas; tuberculosis; within last year; pregnancy; other conditions that</td>
<td>20 IV infusions of 3 g disodium EDTA</td>
<td>Before treatment, a physical examination was performed together with the following serum and urine analyses: hemoglobin, thrombocytes, hematocrit APTT, prothrombin (Factors 11, VII, and X), fasting glucose, fibrinogen, creatinine, albumin, calcium, phosphate, alkaline phosphatase, LDH, and urinary stick-test for protein, blood, and</td>
<td>3-mo pain-free walking distance (RR: 0.98; 95% CI: 0.85, 1.13); 6-mo pain-free walking distance (RR: 1.04; 95% CI: 0.91, 1.19); 3-mo max walking distance (RR: 0.94; 95% CI: 0.82, 1.08); 6-mo max walking distance (RR: 0.96; 95% CI: 0.79, 1.16)</td>
<td>Lab tests on entry to study were in the normal range, and only alkaline phosphatase activity changed significantly during the study period. Alkaline phosphatase in EDTA-treated group decreased from mean value + SD of 175±55 U 1-1 to 148 +/-+42 U 1-1 (p&lt;0.001). Because of symptoms of hypocalcemia, 8 pts received IV calcium gluconate (EDTA 5 pts; PC 3 pts). 1 pt (EDTA group) showed subnormal calcium levels. In 3 pts (EDTA, 1 pt: PC 2 pts), creatinine levels increased after the 10th infusion, but normalized 8 d after cessation of treatment. In 11 pts (EDTA, 4 pts: PC, 7 pts), creatinine levels increased after the 20th infusion. Side effects were observed but were generally nonspecific and showed no</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
could limit the pt walking distance or reliable interpretation of study; pts receiving anticoagulants, nitroglycerine, or lithium; EDTA chelation therapy within last 24 mo

<table>
<thead>
<tr>
<th>van Rij 1994 (10)</th>
<th>To assess the effect of chelation therapy in pts with IC</th>
<th>RCT</th>
<th>32</th>
<th>15</th>
<th>17</th>
</tr>
</thead>
</table>
| Pts with angiographica lly confirmed PAD who did not have indications for invasive procedures; variation of <20% in measured walking distance over 3 separate assessments | Other debilitating disease affecting walking; younger than 45 y; DM; renal disease | 20 IV infusions of 3 g disodium EDTA + IV vitamin supplements | PC + IV vitamin supplement s | Measured walking distance (end of treatment chelation 208±135 m vs. PC 223±149 m; 3-mo chelation 233±135 m vs. PC 230±130 m); subjective walking distance (end of treatment chelation 413±775 m vs. PC 327±461 m; 3-mo chelation 448±556 m vs. PC 381 m ±473 m); ABI at rest (end of treatment chelation 0.7±0.36 vs. PC 0.6±0.15; 3-mo chelation 0.62±0.15 vs. PC 0.58±0.13) and Lab monitoring of UA, hematology parameters, renal function, and serum Ca, Zn, Mg, and Fe; BP and heart rate monitoring during infusion therapy | Effect of chelation therapy on behavior and attitudes, as assessed by pt questionnair es (no significant difference noted between chelation and PC groups) | All p values for each primary outcome were >0.05, except for 3 mo resting ABI measure |}

No complications were noted in either the chelation or placebo groups.
### 2014 SIHD Focused Update Data Supplements

| Knudtson 2002 (11) 11798370 | To determine if current EDTA protocols have a favorable impact on exercise ischemia threshold and quality-of-life measures in pts with SIHD | RCT | 84 | 41 | 43 | Participants ≥21 y and have CAD proven by coronary angiography or documented MI and stable angina while receiving optimal MT. To qualify for randomization, pts were required to have a treadmill test, using a gradual ramping protocol, demonstrating at least 1 mm of horizontal or downsloping ST-segment depression from the isoelectric line 80 ms after | Exclusion criteria included planned revascularization, previous chelation therapy, evidence of HF, inability to walk on the treadmill, resting ECG changes that would interfere with ischemic assessment, abnormal renal or liver function, or untreated lipid abnormality at the time of randomization. | 33 IV infusions of 3 g disodium EDTA + IV vitamin supplements | Placebo + IV vitamin supplements | The primary endpoint was the change in time to reach ≥1 mm of ST-segment depression at the 27-wk evaluation (chelation 572±172 s vs. PC 589±176 s). | Laboratory monitoring (renal function, Ca levels) | Peak VO₂ (chelation change between baseline and 27 wk 84 mL/min (95% CI: 10, 159) vs. PC 40 mL/min (95% CI: 53, 134), time to reach anaerobic threshold (chelation change between baseline and 27 wk 31 s [95% CI: -11, 72] vs. PC 16 s [95% CI: -27, 59]). | All between-group comparison were nonsignificant (p>0.05) | 1 chelation pt was withdrawn from therapy because of elevation in serum creatinine. During first 10 treatments, pt serum creatinine level increased from 1.5 to 2.1 mg/dL (129 to 186 μmol/L, respectively). Treatment was stopped, and serum creatinine level decreased to 1.6 mg/dL (138 μmol/L) after 10 wk. No other cause for the elevation in creatinine was found. In addition to the nonischemic events leading to discontinuation of therapy, 3 additional PC pts were hospitalized for nonischemic events: gout, lumbar back pain from a herniated disk, and GI bleeding. These events did not interfere with completion of the treatment phase. There were no electrolyte results out of normal range during the study. |
2014 SIHD Focused Update Data Supplements

<table>
<thead>
<tr>
<th>TACT Lamas 2013</th>
<th>To determine if an EDTA-based chelation regimen reduces CV events</th>
<th>RCT</th>
<th>1,708</th>
<th>839</th>
<th>869</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible pts were ≥50 y and experienced MI ≥6 wk before enrollment.</td>
<td>Pts ineligible if they were women of childbearing potential, had a serum creatinine level ≥2.0 mg/dL, platelet count &lt;100,000/L, abnormal liver function studies, BP &gt;160/100 mm Hg, past intolerance to the chelation or vitamin components, chelation therapy within 5 y, coronary or carotid revascularization planned or having taken place within 6 mo, cigarette smoking within 2-14 min from the onset of exercise.</td>
<td>IV and PO placebos</td>
<td>Primary endpoint was a composite of death from any cause, reinfarction, stroke, coronary revascularization, or hospitalization for angina over a 5-y period, chelation (32.8% [95% CI: 29.1-36.5%]) vs. PC (38.5% [95% CI: 34.6-42.3%]).</td>
<td>Safety monitoring included periodic physical examinations and laboratory assessments: glucose, calcium, renal function, hepatic function, and hematologic parameters. Pts had body weight assessed before infusions to determine whether there was fluid retention.</td>
<td>The composite of CV death, reinfarction, or stroke was a prespecified secondary endpoint (96 chelation pts [11%] and 113 PC pts [13%]).</td>
</tr>
</tbody>
</table>
### 2014 SIHD Focused Update Data Supplements

3 mo, active HF or HF hospitalization within 6 mo, or inability to tolerate 500-mL infusions/wk

ABI indicates ankle/brachial indices; APTT, activated partial thromboplastin time; BP, blood pressure; CAD, coronary artery disease; CI, confidence interval; CV, cardiovascular; DM, diabetes mellitus; ECG, electrocardiographic; ED, emergency department; EDTA, ethylenediaminetetraacetic acid; GI, gastrointestinal; HF, heart failure; HR, hazard ratio; IC, intermittent claudication; IV, intravenous; LDH, lactic dehydrogenase; m, meter(s); MI, myocardial infarction; mo, month(s); MT, medical therapy; OR, odds ratio; PAD, peripheral artery disease; PC, placebo; PO, per oral; pt(s), patient(s); RCT, randomized controlled trial; RR, relative risk; s, seconds; SIHD, stable ischemic heart disease; UA, unstable angina; wk, week(s); and y, year(s).

### Data Supplement 3. External Enhanced Counterpulsation

<table>
<thead>
<tr>
<th>Study Name, Author, Year</th>
<th>Aim of Study</th>
<th>Study Type</th>
<th>Study Size (N)</th>
<th>Study Intervention Group (n)</th>
<th>Study Comparator Group (n)</th>
<th>Patient Population</th>
<th>Study Intervention</th>
<th>Study Comparator</th>
<th>Endpoints</th>
<th>P Values, OR: HR: RR and 95% CI</th>
<th>Study Limitations and Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arora 1999 (13) 10362181</td>
<td>Evaluate ECCP in pts with angina</td>
<td>RCT</td>
<td>N=139</td>
<td>EECP (n=72)</td>
<td>Sham Control (n=67)</td>
<td>Age 21-81 y Canadian CV Class I, II, or III angina Documented CAD Positive ETT</td>
<td>MI or CABG in preceding 3 mo, cardiac catheterization in the preceding 2 wk, UA, CHF, or LVEF &lt;30%, significant valvular disease, BP &gt;180/100 mm Hg, permanent pacemaker or ICD, left main stenosis &gt;50%, severe symptomatic PVD, history of varicosities, DVT, AF</td>
<td>Evaluate ECCP in pts with angina</td>
<td>RCT</td>
<td>N=139</td>
<td>EECP (n=72)</td>
</tr>
<tr>
<td>Braith 2010 (14) 20921442</td>
<td>To investigate the</td>
<td>RCT</td>
<td>N=42</td>
<td>EECP n=28</td>
<td>Sham Control n=14</td>
<td>Refractory chronic angina with Absence of ST-segment depression during exercise testing; &gt;75 y.</td>
<td>To investigate the</td>
<td>RCT</td>
<td>N=42</td>
<td>EECP n=28</td>
<td>Sham Control n=14</td>
</tr>
</tbody>
</table>

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### Extracardiac Effects of EECP on Peripheral Artery Flow-Mediated Dilation

Multivessel CAD

Recent catheterization, CABG or PCI; arrhythmia; CHF; LVEF <30%; valvular disease; ICD discharge within past 6 mo, history of DVT, uncontrolled HTN, pregnancy, pulmonary congestion, hypotension

Extracardiac effects of EECP on peripheral artery flow-mediated dilation

Multivessel CAD

Recent catheterization, CABG, or PCI, arrhythmia; CHF, LVEF <30%, valvular disease, ICD discharge within past 6 mo, history of DVT, uncontrolled HTN, pregnancy, pulmonary congestion, hypotension were excluded.

---

### Data Supplement 4. Evidence for Survival Benefit After PCI or CABG (With LIMA Grafting to the LAD) in Patients With SIHD Who Are Receiving Medical Therapy and Are Suitable Candidates for Revascularization

<table>
<thead>
<tr>
<th>Anatomic Subgroups</th>
<th>Evidence Supporting CABG for Survival</th>
<th>Evidence Supporting PCI for Survival</th>
<th>Evidence Supporting Superiority of Either CABG or PCI for Survival</th>
<th>Evidence Supporting Equivalence of CABG and PCI for Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unprotected left main CAD</td>
<td>CASS Registry* (15,16) 7729018 2785870</td>
<td>CABG better: Wu* (23) 19805115</td>
<td>SYNTAX† (25) 20530001</td>
<td>SYNTAX† (24) 21697170</td>
</tr>
<tr>
<td></td>
<td>CASS† (17) 7025604</td>
<td>Bittl et al. (22) 23674397</td>
<td>LE MANS† (26) 18237682</td>
<td>LE MANS† (25) 20630452</td>
</tr>
<tr>
<td></td>
<td>VA Cooperative† (18,19) 7914958</td>
<td>PCI better: None found</td>
<td>Boudriot et al.† (27) 21272743</td>
<td>Lee et al.‡ (30) 16487857</td>
</tr>
<tr>
<td></td>
<td>Yusuf et al.† (20) 7914958</td>
<td></td>
<td>Chieffo et al. (28,29) 16717151</td>
<td>Lee et al.‡ (31) 20723848</td>
</tr>
<tr>
<td></td>
<td>Dzavik et al.† (21) 11431667</td>
<td></td>
<td>Naik et al.‡ (32) 19965542</td>
<td>Naik et al.‡ (31) 19965542</td>
</tr>
<tr>
<td></td>
<td>Bittl et al. (22) 23674397</td>
<td></td>
<td>White et al. (33) 19463306</td>
<td>White et al. (33) 19463306</td>
</tr>
<tr>
<td></td>
<td>Bittl et al. (22) 23674397</td>
<td></td>
<td>Palmerini et al. (34) 16784920</td>
<td>Palmerini et al. (34) 16784920</td>
</tr>
<tr>
<td></td>
<td>Bittl et al. (22) 23674397</td>
<td></td>
<td>Park et al.* (35) 20451344</td>
<td>Park et al. (35) 20451344</td>
</tr>
<tr>
<td></td>
<td>Bittl et al. (22) 23674397</td>
<td></td>
<td>Sanmartín et al.* (36) 17826380</td>
<td>Sanmartín et al.* (36) 17826380</td>
</tr>
<tr>
<td></td>
<td>Bittl et al. (22) 23674397</td>
<td></td>
<td>Brener et al.* (37) 19187041</td>
<td>Brener et al.* (37) 19187041</td>
</tr>
<tr>
<td></td>
<td>Bittl et al. (22) 23674397</td>
<td></td>
<td>Makkalillo et al.* (38) 19608116</td>
<td>Makkalillo et al.* (38) 19608116</td>
</tr>
</tbody>
</table>

AF indicates atrial fibrillation; BP, blood pressure; CABG, coronary artery bypass graft; CAD, coronary artery disease; CHF, congestive heart failure; CI, confidence interval; CV, cardiovascular; DVT, deep vein thrombosis; EECP, external enhanced counterpulsation; ETT, exercise treadmill testing; HR, hazard ratio; HTN, hypertension; ICD, implantable cardioverter-defibrillator; LVEF, left ventricular ejection fraction; MI, myocardial infarction; mo, month(s); OR, odds ratio; PCI, percutaneous coronary intervention; pts, patients; PVD, peripheral vascular disease; RCT, randomized controlled trial; RR, relative risk; UA, unstable angina; wk, week(s); and y, year(s).

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8-vessel disease with or without proximal LAD disease

For:
- Dzavik et al.* (21) 11431667
- ECSS† (39) 3260659
- Jones et al.* (40) 8622299
- Myers et al.‡ (42) 2848078
- Smith et al.* (43) 16996946
- SYNTAX†(24) 21697170
- Weintraub (44) 72452338
- Yusuf et al.† (20) 7914958

Against:
- Boden et al.† (45) 17387127

CABG better:
- Bair et al.‡ (46) 17846308
- Booth et al.† (47) 18069919

For:
- Dzavik et al.* (21) 11431667
- Smith et al.* (43) 16996946

CABG better:
- Hannan et al.* (48) 9935010
- Hannan et al.‡ (57) 15917382
- Jones et al.* (40) 8622299

Against:
- Boden et al.† (45) 17387127
- Ceci et al.† (59) 18690768
- Pitt et al.† (60) 10395630

2-vessel disease with proximal LAD disease

For:
- ECSS† (39) 3260659
- Jones et al.* (40) 8622299
- Smith et al.* (43) 16996946
- Yusuf et al.† (20) 7914958

Against:
- Boden et al.† (45) 17387127

CABG better:
- Hannan et al.* (48) 9935010
- Hannan et al.‡ (57) 15917382
- Jones et al.* (40) 8622299

For:
- Dzavik et al.* (21) 11431667
- Jones et al.* (40) 8622299
- Smith et al.* (43) 16996946

CABG better:
- Hannan et al.* (48) 9935010
- Hannan et al.‡ (57) 15917382
- Jones et al.* (40) 8622299

Against:
- Boden et al.† (45) 17387127
- Ceci et al.† (59) 18690768
- Pitt et al.† (60) 10395630

2-vessel disease without proximal LAD disease

For:
- Smith et al.* (43) 16996946

Against:
- Greenbaum et al.* (61) 11113406

CABG better:
- Bair et al.‡ (46) 17846308
- Booth et al.† (47) 18069919

For:
- Jones et al.* (40) 8622299
- Smith et al.* (43) 16996946

CABG better:
- Hannan et al.* (48) 9935010
- Hannan et al.‡ (57) 15917382
- Jones et al.* (40) 8622299

Against:
- Boden et al.† (45) 17387127
- Ceci et al.† (59) 18690768
- Pitt et al.† (60) 10395630

1-vessel proximal LAD disease

For:
- Smith et al.* (43) 16996946

Against:
- Greenbaum et al.* (61) 11113406

CABG better:
- Hannan et al.* (48) 9935010

For:
- Jones et al.* (40) 8622299
- Smith et al.* (43) 16996946

CABG better:
- Hannan et al.* (48) 9935010

Against:
- Greenbaum et al.* (61) 11113406

Towards:
- Aziz et al.‡ (62) 17337458
- Bern-Gal et al.* (63) 17126111
- Bravata et al.† (51) 17938385
- Cisowski et al.§ (64) 15531937
- Diegeler et al.§ (65) 12192015
- Drenth et al.§ (66) 15566914
- Drenth et al.† (66) 15566914
- Frau et al.† (67) 15797063
- Goy et al.† (68,69) 7911175 18755343
- Greenbaum et al.* (61) 11113406
- Hong et al.† (70) 15619278
- Jaffery et al.† (71) 17300948
- Jones et al.* (40) 8622299
- Kapoor et al.† (72) 19463349
- MASS II† (73) 7584962

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### Data Supplement 5. RCTs Comparing CABG and DES

<table>
<thead>
<tr>
<th>Trial</th>
<th>No.</th>
<th>Age (y)</th>
<th>Female</th>
<th>CAD</th>
<th>Enrollment Period</th>
<th>CAGB/PCI</th>
<th>CAGB/PCI</th>
<th>CAGB/PCI</th>
<th>Primary Endpoint %</th>
<th>RR and 95% CI</th>
<th>Follow-Up in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong et al. (70)</td>
<td>189</td>
<td>61</td>
<td>36%</td>
<td>SV</td>
<td>2003</td>
<td>2.9/0</td>
<td>2.9/1.7</td>
<td>5.9/1.7</td>
<td>D, MI, Rep Revasc</td>
<td>11.7/4.3</td>
<td>N/A</td>
</tr>
<tr>
<td>Leipzig (88)</td>
<td>130</td>
<td>68</td>
<td>30%</td>
<td>SV</td>
<td>2003-2007</td>
<td>0/0</td>
<td>7.7/1.5*</td>
<td>0/6.2</td>
<td>D + MI + Rep Revasc</td>
<td>7.77.7</td>
<td>N/A</td>
</tr>
<tr>
<td>SYNTAX (89.90)</td>
<td>1800</td>
<td>65</td>
<td>22%</td>
<td>MV</td>
<td>2005-2007</td>
<td>6.7/8.6</td>
<td>3.6/7.1</td>
<td>10.7/19.7</td>
<td>D + MI + CVA + Rep Revasc</td>
<td>20.2/28.0</td>
<td>Primary endpoint 12-mo follow-up; RR: 1.44; 95% CI: 1.15–1.81</td>
</tr>
</tbody>
</table>

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## 2014 SIHD Focused Update Data Supplements

### FREEDOM (91)

<table>
<thead>
<tr>
<th>Year</th>
<th>No.</th>
<th>Multivessel (%)</th>
<th>Type</th>
<th>Recruitment Period</th>
<th>No. of Patients</th>
<th>Primary Endpoint</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>63</td>
<td>29%</td>
<td>MV</td>
<td>2005-2010</td>
<td>6.0/13.9</td>
<td>3+MI+CVA</td>
<td>RR: 0.74; 95% CI: 0.61–0.89</td>
</tr>
</tbody>
</table>

*Statistically significant.

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; CI, confidence interval; CVA, cerebrovascular accident; D, death; FREEDOM, Future Revascularization Evaluation in Patients with Diabetes Mellitus: Optimal Management of Multivessel Disease; DES, drug-eluting stent; MI, myocardial infarction; mo, month(s); MV, multivessel; N/A, not applicable; No., number of patients; PCI, percutaneous coronary intervention; RCT, randomized controlled trial; RR, relative risk; Rep Revasc, repeat revascularization; SV, single vessel; and SYNTAX, Synergy Between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery.

---

### Data Supplement 6. Trials of PCI With CABG in Patients With Multivessel CAD and Diabetes Mellitus

<table>
<thead>
<tr>
<th>Author</th>
<th>Type of Study and Years of Recruitment</th>
<th>Number of Patients PCI/CABG</th>
<th>Primary Endpoint for PCI and CABG</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNTAX (92,93)</td>
<td>Randomized 2005-2007</td>
<td>Overall 963/897 DM 231/222</td>
<td>DM: 12-mo death, stroke, MI, or revasc: 26.0% vs. 14.2% (HR: 1.83; 95% CI: 1.22-2.15; p=0.003)</td>
<td>Criterion for noninferiority of PCI to CABG was not met in overall study.</td>
</tr>
<tr>
<td>CARDia (87)</td>
<td>Randomized 2002-2007</td>
<td>DM 256/254</td>
<td>DM: 1-y death, stroke, or MI: 13.0% vs. 10.5% (OR: 1.25; 95% CI: 0.75-2.06; p=0.39)</td>
<td>Criterion for noninferiority of PCI to CABG was not met.</td>
</tr>
<tr>
<td>BARI 2D (76)</td>
<td>Prestratified/randomized to revasc-medical therapy, 2001-2005</td>
<td>DM 798/807</td>
<td>Death from any cause: Medical: 87.8%; Revasc: 88.3% p&lt;0.0001</td>
<td>5-y freedom from death, MI, repeat revasc: PCI vs. medical (77.0% vs. 78.9%; p=0.15) CABG vs. medical (77.6% vs. 69.5%; p=0.01) Interaction p=0.002</td>
</tr>
<tr>
<td>ARTS I (85,94,95)</td>
<td>Randomized 1997-1998</td>
<td>Overall 600/605 DM 112/96</td>
<td>Overall: 5-y composite endpoint of death, stroke, or MI 18.2% vs. 14.9% (RR: 1.22; 95% CI: 0.95-1.68; p=0.14)</td>
<td>N/A</td>
</tr>
<tr>
<td>MASS II (74)</td>
<td>Randomized 1995-2000</td>
<td>Overall 205/203 DM 56/59</td>
<td>DM: 1-y death 5.3% vs. 6.8% (p=0.5)</td>
<td>N/A</td>
</tr>
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<td>FREEDOM (91)</td>
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ARTS indicates Arterial Revascularization Therapies Study; BARI 2D, Bypass Angioplasty Revascularization Investigation 2 Diabetes; CABG, coronary artery bypass graft; CAD, coronary artery disease; CARDia, Coronary Artery Revascularization in Diabetes; CI, confidence interval; DM, diabetes mellitus; FREEDOM, Future Revascularization Evaluation in Patients with Diabetes Mellitus: Optimal Management of Multivessel Disease; HR; hazard ratio; MASS II, Medicine, Angioplasty, or Surgery Study II; MI, myocardial infarction; mo, month(s); OR, odds ratio; PCI, percutaneous coronary intervention; revasc, revascularization; RR, relative risk; SYNTAX, Synergy Between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery; and y, year(s).
References


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<th>Committee Member</th>
<th>Employment</th>
<th>Consultant</th>
<th>Speakers Bureau</th>
<th>Ownership/Partnership/Principal</th>
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<td>Stephan D. Fihn</td>
<td>Department of Veterans Affairs—Director, Office of Analytics and Business Intelligence</td>
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<td>James C. Blankenship</td>
<td>Geisinger Medical Center—Staff Physician; Director, Cardiac Catheterization Laboratory</td>
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<td>Karen P. Alexander</td>
<td>Duke University Medical Center—Associate Professor of Medicine/Cardiology</td>
<td>• Gilead*</td>
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<td>John A. Bittl</td>
<td>Munroe Regional Medical Center—Invasive Cardiologist</td>
<td>None</td>
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<td>John G. Byrne</td>
<td>Brigham and Women’s Hospital—Chief, Division of Cardiac Surgery</td>
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<td>Barbara J. Fletcher</td>
<td>University of North Florida—Clinical Associate Professor, School of Nursing</td>
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<td>Gregg C. Fonarow</td>
<td>UCLA Cardiomyopathy Center—Professor of Medicine</td>
<td>• Boston Scientific • Gambro* • Johnson &amp; Johnson • The Medicines</td>
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<td>Richard A. Lange</td>
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<td>Glenn N. Levine</td>
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<td>Thomas M. Maddox</td>
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<td>Srihari S. Naidu</td>
<td>Winthrop University Hospital—Director, Cardiac Catheterization Laboratory</td>
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<td>E. Magnus Ohman</td>
<td>Duke Medicine—Professor of Medicine</td>
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<td>Peter K. Smith</td>
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