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PERFORMANCE AND QUALITY MEASURES

2023 AHA/ACC Clinical Performance and Quality Measures for Coronary Artery Revascularization: A Report of the American College of Cardiology/ American Heart Association Joint Committee on Performance Measures

Developed in Collaboration With the American Association for Thoracic Surgery and the Society for Cardiovascular Angiography and Interventions

Endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation, American Society for Preventive Cardiology, American Society of Health-System Pharmacists, Association of Black Cardiologists, Heart Failure Society of America, Heart Rhythm Society, International Society for Heart and Lung Transplantation, Outpatient Endovascular and Interventional Society, and the Preventive Cardiovascular Nurses Association

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Key Words: AHA Scientific Statements ▪ coronary artery revascularization ▪ performance measures ▪ quality indicators ▪ quality measures

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TOP 10 TAKE-HOME MESSAGES FOR CORONARY ARTERY REVASCULARIZATION

1. This document describes performance measures for coronary revascularization that are appropriate for public reporting or pay-for-performance programs.

2. This is the first joint American Heart Association/American College of Cardiology document developing measures related to coronary artery revascularization.

3. Most performance measures were developed from the "2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization" and are selected from the strongest recommendations (Class 1 or 3).

4. Quality measures are included as metrics that may be useful for local quality improvement programs but are not yet appropriate for public reporting or pay-for-performance programs.

5. Structural measures are useful to assess infrastructure, systems, and processes of care. Two structural measures were developed. One structural measure is related to the presence and function of the Heart

Team and the other structural measure is related to registry participation.

6. For all measures, if the clinician determines the guideline-recommended care is inappropriate for the patient, that patient is excluded from the measure.

7. For all measures, patients who decline treatment or care are excluded.

8. Where possible, these measures were aligned with those developed by other organizations such as the National Quality Forum, Centers for Medicare & Medicaid Services, and the Society of Thoracic Surgeons.

9. Performance measurement sets serve as vehicles to accelerate translation of scientific evidence into clinical practice and are intended to provide practitioners and institutions with tools to measure the quality of care provided and identify opportunities for improvement.

10. Coronary artery revascularization is not static but continues to evolve as new techniques, therapies, and treatment strategies emerge, which will require ongoing review and revision of these measures.

PREAMBLE

The American Heart Association (AHA)/American College of Cardiology (ACC) performance measurement sets serve as vehicles to accelerate translation of scientific evidence into clinical practice. Measure sets developed by the AHA/ACC are intended to provide practitioners and institutions that deliver cardiovascular services with tools to measure the quality of care provided and identify opportunities for improvement.

Writing committees are instructed to consider the methodology of performance measure development[1,2] and to ensure that the measures developed are aligned with AHA/ACC clinical practice guidelines. The writing committees are also charged with constructing measures that maximally capture important aspects of care quality, including timeliness, safety, effectiveness, efficiency, equity, and patient-centeredness, while minimizing, when possible, the reporting burden imposed on hospitals, practices, and practitioners.

Potential challenges from measure implementation may lead to unintended consequences. The manner in which challenges are addressed is dependent on several factors, including the measure design, data collection method, performance attribution, baseline performance rates, reporting methods, and incentives linked to these reports.

The ACC/AHA Joint Committee on Performance Measures (Joint Committee) distinguishes performance measures from quality measures. Performance measures are generally selected from the highest level of evidence,

usually from Class 1 or 3 recommendations of clinical practice guidelines. They are commonly used for national quality improvement efforts, public reporting, and pay-for-performance programs. In contrast, quality measures may not have as much evidence base and generally comprise metrics that may be useful for local quality improvement but are not yet appropriate for public reporting or pay-for-performance programs. New measures are initially evaluated for potential inclusion as performance measures. In some cases, a measure is insufficiently supported by the clinical practice guidelines. In other instances, when the clinical practice guidelines support a measure, the writing committee may feel it is necessary to have the measure tested to identify the consequences of measure implementation. Quality measures then may be promoted to the status of performance measures as supporting evidence becomes available.

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Performance Measures

1. INTRODUCTION

In 2022, the Joint Committee convened the writing committee to begin developing performance and quality measures for coronary artery revascularization. The writing committee was charged with developing new measures to evaluate the use of coronary artery revascularization in accordance with the "2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization."[3]

This performance measure set addresses in-hospital and continuing care in the outpatient setting. All Class 1 (strong) and 3 (no benefit or harmful, process to be avoided) guideline-recommended processes were considered for inclusion as performance measures. The current Class of Recommendation and Level of Evidence guideline classification scheme used by the AHA and ACC in their clinical practice guidelines is shown in Table 1.

The writing committee developed a comprehensive coronary artery revascularization measure set that includes 22 measures comprising 15 performance measures, 5 quality measures, and 2 structural measures, as reflected in Table 2 and Appendix A. The measures are briefly summarized in Table 2, which provides information on the measure number, measure title, and care setting. The detailed measure specifications in Appendix A provide information included in Table 2 and more detailed information, including the measure description, numerator, denominator, denominator exclusions and exceptions, measurement period, data sources, attribution, rationale, and guideline recommendations that support the measure.

The value (benefit and cost) of a process of care was also considered. If high-quality, published,

Table 1. Applying American College of Cardiology/American Heart Association Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care* (Updated May 2019)

CLASS (STRENGTH) OF RECOMMENDATION	LEVEL (QUALITY) OF EVIDENCE‡
CLASS 1 (STRONG) — Benefit >>> Risk **Suggested phrases for writing recommendations:** • Is recommended • Is indicated/useful/effective/beneficial • Should be performed/administered/other • Comparative-Effectiveness Phrases†: – Treatment/strategy A is recommended/indicated in preference to treatment B – Treatment A should be chosen over treatment B	**LEVEL A** • High-quality evidence‡ from more than 1 RCT • Meta-analyses of high-quality RCTs • One or more RCTs corroborated by high-quality registry studies
CLASS 2a (MODERATE) — Benefit >> Risk **Suggested phrases for writing recommendations:** • Is reasonable • Can be useful/effective/beneficial • Comparative-Effectiveness Phrases†: – Treatment/strategy A is probably recommended/indicated in preference to treatment B – It is reasonable to choose treatment A over treatment B	**LEVEL B-R** (Randomized) • Moderate-quality evidence‡ from 1 or more RCTs • Meta-analyses of moderate-quality RCTs
CLASS 2b (WEAK) — Benefit ≥ Risk **Suggested phrases for writing recommendations:** • May/might be reasonable • May/might be considered • Usefulness/effectiveness is unknown/unclear/uncertain or not well-established	**LEVEL B-NR** (Nonrandomized) • Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies • Meta-analyses of such studies
CLASS 3: No Benefit (MODERATE) — Benefit = Risk (Generally, LOE A or B use only) **Suggested phrases for writing recommendations:** • Is not recommended • Is not indicated/useful/effective/beneficial • Should not be performed/administered/other	**LEVEL C-LD** (Limited Data) • Randomized or nonrandomized observational or registry studies with limitations of design or execution • Meta-analyses of such studies • Physiological or mechanistic studies in human subjects
CLASS 3: Harm (STRONG) — Risk > Benefit **Suggested phrases for writing recommendations:** • Potentially harmful • Causes harm • Associated with excess morbidity/mortality • Should not be performed/administered/other	**LEVEL C-EO** (Expert Opinion) • Consensus of expert opinion based on clinical experience

COR and LOE are determined independently (any COR may be paired with any LOE).

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

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

† For comparative-effectiveness recommendations (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely-used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

cost-effectiveness studies indicated that a Class 1 guideline recommendation for a process of care is considered a poor value by AHA/ACC standards, then it was not included as a performance measure.[4] No Class 1 recommended processes of care were judged to be of poor value. All AHA/ACC clinical practice guideline recommendations (including a limited number of Class 2 recommendations) were considered as potential quality measures. Ultimately, measures were selected based on their importance for health, the strength of data supporting the recommendations, existing gaps in patient care, ease of implementation, and risk for unintended consequences. The writing committee believes that implementation of this measure set by clinicians and health care facilities will enhance safe, cost-efficient, patient-centered, and culturally sensitive care for individual patients.

1.1. Scope of the Problem

More than 20 million Americans are affected by coronary artery disease (CAD), with a prevalence of 7.2% in adults ≥20 years of age having CAD.[5,6] Data from the National Center for Health Statistics on trends in CAD death rates from 1999 to 2009 showed an overall decrease in the rate of CAD death in the United States, with the greatest decline in urban areas.[7] Over the next 10-year interval (2009–2019), the annual death rate attributable to CAD

Table 2. 2023 AHA/ACC Coronary Artery Revascularization Measures

Measure No.	Measure Title	Care Setting	Attribution	Measure Domain	COR/LOE
Performance Measures					
PM-1	Use of Coronary Physiology	Inpatient, Outpatient	Individual practitioner, Facility	Diagnostic	COR: 1, LOE: A
PM-2	DAPT Use With PCI	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-R; COR: 1, LOE: C-LD
PM-3	Antiplatelets and Anticoagulation After PCI	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-R
PM-4	P2Y12 Inhibitors With Fibrinolytic Therapy	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: C-LD
PM-5	Aspirin in Patients Undergoing CABG	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-R; COR: 1, LOE: A
PM-6	Lipid Management	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A; COR:1, LOE: B-NR
PM-7	Glycemic Control and CABG Surgery	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-R
PM-8	Use of the IMA in CABG	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-NR
PM-9	Patients With Diabetes and Multivessel Disease	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A
PM-10	Arterial Access for PCI	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A
PM-11	Non-Infarct Artery Revascularization in STEMI	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A
PM-12	Non-Infarct PCI in STEMI With Shock	Inpatient	Individual practitioner, Facility	Treatment	COR: 3 Harm, LOE: B-R
PM-13	Management of Ventricular Arrhythmias	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-NR
PM-14a	Cardiac Rehabilitation Referral From Inpatient Setting	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A
PM-14b	Cardiac Rehabilitation Referral Outpatient Setting	Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A
Quality Measures					
QM-1	Shared Decision-Making and Informed Consent	Inpatient, Outpatient (in the case of an office visit to discuss options)	Individual practitioner	Monitoring	COR: 1, LOE: C-LD
QM-2	Periprocedural Hydration in Cardiovascular Angiography	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B; COR: 1, LOE: C-LD
QM-3	Smoking Cessation After Revascularization	Inpatient, Outpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: A
QM-4	Risk Assessment Before CABG	Inpatient, Outpatient	Individual practitioner, Facility	Monitoring	COR: 1, LOE: B-NR
QM-5	Reduction of AF After CABG	Inpatient	Individual practitioner, Facility	Treatment	COR: 1, LOE: B-R
Structural Measures					
SM-1	Preprocedural Assessment and the Heart Team	Inpatient, Outpatient	Individual practitioner, Facility	Structure	COR: 1, LOE: B-NR
SM-2	Registry Participation	Inpatient, Outpatient	Facility	Monitoring	COR: 1, LOE: B-NR

ACC indicates American College of Cardiology; AF, atrial fibrillation; AHA, American Heart Association; CABG, coronary artery bypass graft; COR, Class of Recommendation; DAPT, dual antiplatelet therapy; IMA, internal mammary artery; LOE, Level of Evidence; PCI, percutaneous coronary intervention; PM, performance measure; QM, quality measure; SM, structural measure; and STEMI, ST-segment–elevation myocardial infarction.

declined further, with the actual number of deaths in the United States decreasing by 6.6%.[6] Many factors have contributed to the declining death rate from CAD, including optimization of medications for the control of risk factors such as dyslipidemia and a persistent decrease in adult and youth cigarette use in the United States.[6,8] Unfortunately, other forms of tobacco use are becoming increasingly common, especially among young individuals, as the incidence of obesity and diabetes in the population continues to increase.[6,9,10] Despite the decline in

CAD deaths, and a substantial number of deaths related to the COVID-19 (coronavirus disease-2019) pandemic, CAD was the leading cause of death in the United States in 2020.[11]

Large, randomized studies in patients with stable ischemic heart disease have shown that an initial strategy of revascularization by percutaneous coronary intervention (PCI) or coronary artery bypass graft plus guideline-directed medical therapy was not different than guideline-directed medical therapy alone in reducing ischemic cardiovascular events such as myocardial infarction, heart failure, hospitalization for unstable angina or all-cause death, but PCI was associated with improved angina frequency and quality of life, especially in patients with a higher baseline angina burden.[12,13] However, a substantial number of patients present with acute coronary syndromes for which invasive evaluation followed by revascularization has been shown to reduce death and nonfatal myocardial infarction and, thus, is typically recommended. In 2014, an estimated 480 000 PCIs and 371 000 coronary artery bypass procedures were performed.[6] More recent data estimate the number of PCIs in the United States at >600 000 per year with the inclusion of more complex cases,[14] and the number of coronary artery bypass graft operations at almost 400 000 per year.[15]

With the large number of patients undergoing revascularization procedures annually, initiatives that improve the quality of care of patients undergoing coronary artery revascularization procedures are needed. One possible approach is the development of well-formulated performance and quality measures for coronary artery revascularization. Performance measures for adults undergoing PCI were last published in 2013.[16] The Society of Thoracic Surgeons has developed several performance measures related to cardiac surgery, many of which are endorsed by the National Quality Forum.[17] Performance measures have been useful for assessing the quality of care, promoting accountability for care that includes patient responsibility for their own care, and improving the outcomes and care for patients with acute and chronic medical conditions. Given the substantial burden of CAD and the recent publication of the "2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization,"[3] it was deemed appropriate to develop a new set of performance and quality measures related to coronary artery revascularization.

1.2. Disclosure of Relationships With Industry and Other Entities

The Joint Committee makes every effort to avoid actual, potential, or perceived conflicts of interest that could arise as a result of relationships with industry or other entities (RWI). Information about the AHA/ACC policy on RWI can be found online. All members of the writing committee, as well as those selected to serve as peer reviewers of this document, were required to disclose all current relationships and those existing within the 12 months before the initiation of this writing effort. AHA/ACC policy also requires that the writing committee chair and at least 50% of the writing committee have no relevant RWI. Writing committee members are excluded from writing or voting on sections to which their specific RWI may apply.

The work of the writing committee was supported exclusively by the AHA and the ACC without commercial support. The American Association for Thoracic Surgery and the Society for Cardiovascular Angiography and Interventions served as collaborators on this project. Members of the writing committee volunteered their time for this effort. Meetings of the writing committee were confidential and attended only by writing committee members and staff from the AHA and ACC.

Table 3.   Associated AHA/ACC Clinical Practice Guidelines and Other Clinical Guidance Documents

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
2020 ACC Expert Consensus Decision Pathway for Anticoagulant and Antiplatelet Therapy in Patients With Atrial Fibrillation or Venous Thromboembolism Undergoing Percutaneous Coronary Intervention or With Atherosclerotic Cardiovascular Disease[18]
2020 Update to the 2016 ACC/AHA Clinical Performance and Quality Measures for Adults With Atrial Fibrillation or Atrial Flutter[19]
2018 ACC Expert Consensus Decision Pathway on Tobacco Cessation Treatment[20]
2018 ACC/AHA Clinical Performance and Quality Measures for Cardiac Rehabilitation[21]
2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol[22]
2017 ACC Expert Consensus Decision Pathway for Periprocedural Management of Anticoagulation in Patients With Nonvalvular Atrial Fibrillation[23]
2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease[24]
2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery[25]
2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention[26]

AACVPR indicates American Association of Cardiovascular and Pulmonary Rehabilitation; AAPA, American Academy of Physician Associates; AATS, American Association for Thoracic Surgery; ABC, Association of Black Cardiologists; ACC, American College of Cardiology; ACCF, American College of Cardiology Foundation; ACP, American College of Physicians; ACPM, American College of Preventive Medicine; ADA, American Diabetes Association; AGS, American Geriatrics Society; AHA, American Heart Association; APhA, American Pharmacists Association; ASPC, American Society for Preventive Cardiology; NLA, National Lipid Association; PCNA, Preventive Cardiovascular Nurses Association; SCAI, Society for Cardiovascular Angiography and Interventions; and STS, Society of Thoracic Surgeons.

2. METHODOLOGY

2.1. Literature Review

In developing the coronary revascularization measure set, the writing committee reviewed evidence-based guidelines and statements that would potentially impact the construct of the measures. The clinical practice guidelines and scientific statements that most directly contributed to the development of these measures are shown in Table 3.

2.2. Definition and Selection of Measures

The writing committee considered several additional factors, which are listed in Table 4. The potential impact, appropriateness for public reporting and pay for performance, validity, reliability, and feasibility were considered. The writing committee examined available information on current gaps in care.

3. AHA/ACC CORONARY ARTERY REVASCULARIZATION MEASURE SET

3.1. Discussion of Coronary Artery Revascularization Measure Set

After reviewing the existing clinical practice guidelines, the writing committee discussed which measures required revision to reflect updated science related to coronary artery revascularization and identified which guideline recommendations could serve as the basis for new performance or quality measures. The writing committee also reviewed existing publicly available measure sets.

These subsections serve as a synopsis of the revisions that were made to previous measures and a description of why the new measures were created for both the inpatient and outpatient setting.

3.1.1. Retired Measures

The writing committee decided to retire the 2013 performance measures for adults undergoing PCI.[16] This was done to provide updated measures based on the most current science, because the previous measures were approximately 10 years old. The measures, along with a brief rationale for excluding the measures, are included in Table 5.

3.1.2. Revised Measures

The writing committee reviewed and made changes to the cardiac rehabilitation patient referral measures from the 2018 cardiac rehabilitation measure set[21] and the registry participation measure from the 2013 performance measures for adults undergoing PCI,[16] as summarized in Table 6. Table 6 provides information on the updated measures, including the care setting, title, and a brief rationale for revisions made to the measures.

Table 4. ACC/AHA Joint Committee on Performance Measures: Attributes for Performance Measures[27]

1.	Evidence Based		
High-impact area that is useful in improving patient outcomes	a)	For structural measures, the structure should be closely linked to a meaningful process of care that in turn is linked to a meaningful patient outcome.
	b)	For process measures, the scientific basis for the measure should be well established, and the process should be closely linked to a meaningful patient outcome.
	c)	For outcome measures, the outcome should be clinically meaningful. If appropriate, performance measures based on outcomes should adjust for relevant clinical characteristics through the use of appropriate methodology and high-quality data sources.
2.	**Measure Selection**		
Measure definition	a)	The patient group to whom the measure applies (denominator) and the patient group for whom conformance is achieved (numerator) are clearly defined and clinically meaningful.
Measure exceptions and exclusions	b)	Exceptions and exclusions are supported by evidence.
Reliability	c)	The measure is reproducible across organizations and delivery settings.
Face validity	d)	The measure appears to assess what it is intended to.
Content validity	e)	The measure captures most meaningful aspects of care.
Construct validity	f)	The measure correlates well with other measures of the same aspect of care.
3.	**Measure Feasibility**		
Reasonable effort and cost	a)	The data required for the measure can be obtained with reasonable effort and cost.
Reasonable time period	b)	The data required for the measure can be obtained within the period allowed for data collection.
4.	**Accountability**		
Actionable	a)	Those held accountable can affect the care process or outcome.
Unintended consequences avoided	b)	The likelihood of negative unintended consequences with the measure is low.

ACC indicates American College of Cardiology; and AHA, American Heart Association.

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Table 5. Retired Coronary Artery Revascularization Measures (From the "ACC/AHA/SCAI/AMA–Convened PCPI/NCQA 2013 Performance Measures for Adults Undergoing Percutaneous Coronary Intervention"[16])

Measure No.	Care Setting	Measure Title	Rationale for Retiring the Measure
1	Outpatient, Inpatient	Comprehensive Documentations of Indications for PCI	Captured in EHRs and national databases, but there is subjectivity in the description of symptoms that could affect the indications for PCI.
2	Inpatient, Outpatient	Appropriate Indication for Elective PCI	High rate of capture in EHRs and national databases; included in SDM and informed consent.
3	Inpatient, Outpatient	Assessment of Candidacy for Dual-Antiplatelet Therapy	Outdated; more detailed recommendations exist for different circumstances.
4	Inpatient, Outpatient	Use of Embolic Protection Devices in the Treatment of Saphenous Vein Bypass Graft Disease	No longer Class 1 recommendation; now Class 2a, LOE B-R in 2021 coronary artery revascularization guideline.[3]
5	Inpatient, Outpatient	Documentation of Preprocedural Glomerular Filtration Rate and Contrast Dose Used During the Procedure	No longer in guidelines; moved to table of best practices.
6	Inpatient, Outpatient	Radiation Dose Documentation	Now required by federal agencies.
7	Inpatient, Outpatient	Postprocedural Optimal Medical Therapy Composite	Optimal medical therapy is difficult to define; variable among individual patients.
10	Inpatient, Outpatient	Annual Operator PCI Volume	Relationship between volume and outcomes is controversial and debated.
11	Inpatient, Outpatient	Annual Hospital PCI Volume	Relationship between volume and outcomes is controversial and debated.

ACC indicates American College of Cardiology; AHA, American Heart Association; AMA, American Medical Association; EHR, electronic health record; LOE, Level of Evidence; PCI, percutaneous coronary intervention; PCPI, Physician Consortium for Performance Improvement; NCQA, National Committee for Quality Assurance; SCAI, Society for Cardiovascular Angiography and Interventions; and SDM, shared decision-making.

3.1.3. New Measures

The writing committee created a comprehensive list of measures addressing the use of coronary revascularization. This set includes 15 performance measures, 5 quality measures, and 2 structural measures. Table 7 includes a list of the measures with information on the care setting and a brief rationale. Performance measures are typically those measures that target meaningful gaps in the quality of care and that are based on Class 1 clinical practice guidelines. Other measures that are important but are not based on Class 1 clinical practice guidelines or are lacking in other important characteristics (eg, questions of feasibility, validity) are recommended as quality measures. If additional evidence supports the importance of the proposed quality measures, they may be changed to performance measures in the future. Performance and quality measures are designed to help health care providers reduce gaps in the quality of care that they provide to their patients.

The "2023 AHA/ACC Clinical Performance and Quality Measures for Coronary Artery Revascularization" address several processes of care identified in earlier measure sets published by other organizations, such as the National Quality Forum, The Joint Commission, Society of Thoracic Surgeons, and Centers for Medicare & Medicaid Services, but which have been developed through the use of the AHA/ACC methodology for developing performance measure sets.[2] The writing committee is cognizant of previous efforts of other organizations and sought to enhance and clarify measures in ways that reflect the advancement of the underlying science, the complexity of care, and the challenges of accurate and complete data collection. As such, the writing committee has made every attempt to align these measures with those developed by these other organizations. In addition, the writing committee reviewed areas of potential nonalignment. Wherever possible, the writing committee incorporated changes to achieve alignment. Although the specific inclusion or exclusion criteria for some of the measures are not identical to previous measures, the measures remain conceptually aligned. The writing committee acknowledges that differences in the description of some components of measures specifications might be modified to facilitate implementation.

Table 6. Revised Coronary Artery Revascularization Measures

Measure No.	Measure Title	Description of Revision	Rationale for Revision
PM-1 and PM-3 (from the 2018 cardiac rehabilitation measure set[21])	Cardiac Rehabilitation Patient Referral	Separate recommendation for referral from inpatient and outpatient settings.	Most current recommendations used.
9 (from the 2013 performance measures for adults undergoing PCI[16])	Regional or National PCI Registry Participation	Participation from NCDR, STS, VA CART, or other regional or national databases included.	Expanded measure to include both PCI and CABG data.

CABG indicates coronary artery bypass graft; NCDR, National Cardiovascular Disease Registry; PCI, percutaneous coronary intervention; STS, Society of Thoracic Surgeons; and VA CART, Veterans Affairs Clinical Assessment Reporting and Tracking.

Table 7. New Measures

Measure No.	Care Setting	Measure Title	Rationale for Creating New Measure	Rationale for Designating as a Quality Measure Versus a Performance Measure
PM-1	Inpatient, Outpatient	Use of Coronary Physiology	Places emphasis on importance of physiological measurements rather than visual assessment of an intermediate severity lesion.	N/A
PM-2	Inpatient, Outpatient	DAPT Use With PCI	Cornerstone of therapy for the prevention of thrombotic complications and reduction in ischemic events.	N/A
PM-3	Inpatient, Outpatient	Antiplatelets and Anticoagulation After PCI	Important outcome benefit and existing gap in care, especially in patients with AF.	N/A
PM-4	Inpatient	P2Y12 Inhibitors With Fibrinolytic Therapy	Proper therapy with clopidogrel needed to reduce recurrent ischemia and avoid increased risk of bleeding relative to aspirin.	N/A
PM-5	Inpatient	Aspirin in Patients Undergoing CABG	Important outcome benefit to reduce ischemic events and minimize risk of bleeding.	N/A
PM-6	Inpatient, Outpatient	Lipid Management	Important outcome benefit, especially related to long-term risk reduction.	N/A
PM-7	Inpatient	Glycemic Control and CABG Surgery	Important outcome benefit to reduce complications.	N/A
PM-8	Inpatient	Use of the IMA in CABG	Important outcome benefit to improve survival and reduce ischemic events.	N/A
PM-9	Inpatient, Outpatient	Patients With Diabetes and Multivessel Disease	Important outcome benefit and existing gap in care.	N/A
PM-10	Inpatient, Outpatient	Arterial Access for PCI	Important outcome benefit and existing gap in care.	N/A
PM-11	Inpatient, Outpatient	Non-Infarct Artery Revascularization in STEMI	Important outcome benefit and existing gap in care.	N/A
PM-12	Inpatient	Non-Infarct PCI in STEMI With Shock	Important outcome benefit and existing gap in care.	N/A
PM-13	Inpatient	Management of Ventricular Arrhythmias	Important outcome benefit and existing gap in care.	N/A
PM-14a	Inpatient	Cardiac Rehabilitation Referral From Inpatient Setting	RCTs and observational studies have demonstrated that cardiac rehabilitation is effective in reducing hospital readmissions, secondary events, and deaths in patients with CVD.	N/A
PM-14b	Outpatient	Cardiac Rehabilitation Referral From Outpatient Setting	RCTs and observational studies have demonstrated that cardiac rehabilitation is effective in reducing hospital readmissions, secondary events, and deaths in patients with CVD.	N/A
QM-1	Inpatient, Outpatient (in the case of an office visit to discuss options)	Shared Decision-Making and Informed Consent	Important for the delivery of patient-centered equitable and culturally sensitive care.	Effective shared decision-making may be difficult to capture in EHR. Best method for implementation is unclear.
QM-2	Inpatient, Outpatient	Periprocedural Hydration in Cardiovascular Angiography	Important outcome benefit and existing gap in care.	No clear consensus on best protocols for periprocedural hydration.
QM-3	Inpatient, Outpatient	Smoking Cessation After Revascularization	Smoking is a major risk factor for cardiovascular disease.	Timing of cessation program and methods used are not standardized. Outcome difficult to track.
QM-4	Inpatient, Outpatient	Risk Assessment Before CABG	STS risk score has been validated in several studies and demonstrates excellent predictive value for estimating risk of adverse events.	Documentation is variable and may not reflect discussion with patient.
QM-5	Inpatient	Reduction of AF After CABG	Important outcome event and existing gap in care.	Lack of universal agreement as to the best preventive therapy. Randomized trials and a meta-analysis show no difference in morbidity or mortality.
SM-1	Inpatient, Outpatient	Preprocedural Assessment and the Heart Team	Fosters collaborative efforts among cardiovascular specialists.	Supported primarily by observational studies.
SM-2	Inpatient, Outpatient	Registry Participation	Registries are a useful structure for measuring performance.	Additional data needed to determine the impact of registry participation on quality.

AF indicates atrial fibrillation; CABG, coronary artery bypass graft; CVD, cardiovascular disease; DAPT, dual antiplatelet therapy; EHR, electronic health record; IMA, internal mammary artery; N/A, not applicable; PCI, percutaneous coronary intervention; PM, performance measure; QM, quality measure; RCT, randomized clinical trial; SM, structural measure; STEMI, ST-segment–elevation myocardial infarction; and STS, Society of Thoracic Surgeons.

The measures are structured in a typical format with the goal to seek a higher performance score, ideally nearing 100%. For more detailed information on each measure's construct, refer to the specifications in Appendix A.

4. AREAS FOR FURTHER RESEARCH

The field of coronary artery revascularization continues to evolve rapidly. Areas presenting opportunities for further research include determining the optimal role and timing for revascularization in cardiogenic shock, research on conduits and techniques for coronary artery bypass graft, the use of mechanical support for high-risk PCI, defining the role of drug-coated balloons, and the optimal duration of antiplatelet therapy after PCI and in the setting of atrial fibrillation. New devices for PCI are continuing to enter the marketplace, and more research is needed to better define their safety and effectiveness in real-world populations. Whereas many chronic total occlusions were once thought too difficult to treat, newer techniques for the recanalization of these vessels are being developed, but more research is needed to determine the role of chronic total occlusion therapies on long-term outcomes such as death, heart failure events, and optimal case selection.

Several studies have shown that an initial strategy of guideline-directed medical therapy alone, compared with guideline-directed medical therapy plus revascularization, in selected patients with chronic coronary disease has similar effects on cardiovascular outcomes such as death, myocardial infarction, heart failure, and hospitalization for unstable angina. More investigations are needed to compare the long-term effects of these 2 therapies and identify subgroups of stable patients that may have a mortality benefit from early revascularization as well as the effects of these 2 therapeutic strategies on symptoms and quality of life. Invasive techniques to identify the presence of flow-limiting stenoses, such as fractional flow reserve and its derivative instantaneous wave-free ratio, have shown that, for some stenoses, coronary revascularization may be safely deferred. However, more research is needed to define the role of noninvasive techniques using computed tomographic coronary angiography to assess coronary flow reserve and its effectiveness for predicting long-term outcomes. Although coronary artery bypass surgery was developed well before the first PCI was performed, there is still need for continuing research on techniques for better myocardial preservation during surgery, use of alternative conduits in patients undergoing repeat procedures, and hybrid procedures. Finally, more research is needed to identify gender-based differences in the responses to the available therapies.

ACC/AHA JOINT COMMITTEE ON PERFORMANCE MEASURES

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ARTICLE INFORMATION

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Appendix A. Coronary Artery Revascularization Measure Set

Performance Measures for Coronary Artery Revascularization

Short Title: PM-1: Use of Coronary Physiology

PM-1: Use of Coronary Physiology to Guide Revascularization With PCI

Measure Description: Percentage of patients, age ≥18 y, with angina or an anginal equivalent, undocumented ischemia, and angiographically intermediate stenosis who undergo FFR or iFR to guide the decision to proceed with PCI	
Numerator	Patients with angiographically intermediate stenosis, angina or anginal equivalent, and undocumented ischemia for whom PCI is being considered who undergo FFR or iFR measurement*†‡§ *An angiographic intermediate coronary artery stenosis is defined as a diameter stenosis severity of ≥40% and ≤70% by visual assessment. †Other validated invasive or contrast-based CT methods of determining hemodynamic significance can be substituted (eg, CCTA-derived FFR CT), RFR, DFR, and Pd/Pa ratio. ‡An anginal equivalent is suggested by symptoms such as dyspnea, dizziness, diaphoresis (sweating), extreme fatigue, syncope, pulmonary edema, or pain at a site other than the chest occurring in a patient at high-risk that is later confirmed by electrocardiographic criteria. §Undocumented ischemia means no objective findings of ischemia are present such as shown by a stress test.
Denominator	Patients age ≥18 y with an angiographic intermediate stenosis angina or an anginal equivalent and undocumented ischemia for whom PCI is being considered
Denominator Exclusions	Angiographically significant left main coronary artery disease, patent bypass graft to the interrogated vessel and need for testing to evaluate a stenosis in the distal vessel proximal or distal to the graft anastomosis, cardiogenic shock, NSTEMI culprit artery and technical challenges precluding assessment such as extremely tortuous or calcified coronary arteries
Denominator Exceptions	Documentation of a patient reason(s) (eg, patient inability to cooperate for the FFR/iFR procedure) Documentation of a system reason(s) (eg, plan to perform pre-PCI noninvasive physiologic assessment [stress test imaging] of the myocardium served by the angiographically intermediate coronary artery stenosis)
Measurement Period	Period of care: Index procedure or hospitalization‖ Period of observation: All cases accumulated over a 12-mo period ‖Index procedure or hospitalization refers to the procedure currently under evaluation or the hospitalization associated with the procedure.
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

Randomized clinical trials showed low rates of MACE with the deferral of PCI when the FFR is >0.80 or the iFR is >0.89.

In a cohort of patients with single-vessel disease, the DEFER trial showed similar MACE rates at 2-y and 5-y follow-up when PCI was deferred for angiographically intermediate lesions with FFR >0.75.[28] Pooled analysis of the DEFINE-FLAIR and the iFR-SWEDEHEART trials showed 4.05% and 4.12% rates of MACE, respectively (fully adjusted HR, 1.13; 95% CI, 0.72-1.79; P=0.60), in patients who had PCI deferred on the basis of an FFR >0.80 or an iFR >0.89.[29]

In patients with multivessel disease, the FUTURE trial compared a treatment strategy for revascularization directed by FFR measurements in all stenoses >50% versus a traditional strategy based on visual assessment of stenosis severity from the angiogram. The primary endpoint was a composite of MACE or cerebrovascular events at 1 y. At 1-y follow-up, by intention to treat, no significant differences were observed in MACE or cerebrovascular events rates between groups.[30]

In the FLOWER-MI trial, patients who had successful PCI of the infarct-related artery were randomized to undergo PCI of significant nonculprit artery stenoses based on either FFR measurements or angiographic assessment. The study showed an FFR-guided strategy did not have a significant benefit over an angiography-guided strategy with respect to the risk of death, myocardial infarction, or urgent revascularization at 1 y. However, given the wide CIs for the estimate of effect, the findings did not allow for a conclusive interpretation.[31]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]

1. In patients with angina or an anginal equivalent, undocumented ischemia, and angiographically intermediate stenoses, the use of fractional flow reserve (FFR) or instantaneous wave-free ratio (iFR) is recommended to guide the decision to proceed with PCI.[32–37] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; AHA, American Heart Association; CCTA, coronary computed tomography angiography; CI, confidence interval; CT, computed tomography; DEFER, Deferral of Percutaneous Intervention trial; DEFINE-FLAIR, Functional Lesion Assessment of Intermediate Stenosis to Guide Revascularisation trial; DFR, diastolic pressure ratio; EHR, electronic health record; FFR, fractional flow reserve; FLOWER-MI, Multivessel PCI Guided by FFR or Angiography for Myocardial Infarction; FUTURE, FUnctional Testing Underlying coronary Revascularization; HR, hazard ratio; iFR, instantaneous wave-free ratio; iFR-SWEDEHEART, Instantaneous Wave-free Ratio versus Fractional Flow Reserve in Patients with Stable Angina Pectoris or Acute Coronary Syndrome trial; MACE, major adverse cardiovascular events; NSTEMI, non–ST-segment–elevation myocardial infarction; PCI, percutaneous coronary intervention; Pd/Pa, pressure distal/pressure arterial; PM, performance measure; RFR, resting full-cycle ratio; SCAI, Society for Cardiovascular Angiography and Interventions; and STEMI, ST-segment–elevation myocardial infarction.

Appendix A.   Continued

Short Title: PM-2: DAPT Use With PCI

PM-2: Use of Aspirin and Oral P2Y12 Inhibitors in PCI

Measure Description: Percentage of patients, age ≥18 y, undergoing PCI with stent placement treated with DAPT during the index procedure or hospitalization	
Numerator	Patients with CCD or ACS receiving a stent and treated with DAPT during the index procedure or hospitalization*† *Depending on the circumstances, starting DAPT before PCI, at some point during PCI, or immediately after PCI, are all acceptable. †Cangrelor may be considered in patients who have not been pretreated with a P2Y12 inhibitor, in patients whose absorption of oral medications may be inhibited, or in patients who are unable to take oral medications.
Denominator	Patients age ≥18 y with CCD or ACS undergoing PCI with stent placement
Denominator Exclusions	Patients who leave during hospitalization against medical advice before receiving discharge instructions and prescriptions, patients who die during hospitalization
Denominator Exceptions	Documentation of a medical reason(s) (eg, use of therapeutic oral anticoagulation such as in the setting of AF with elevated CHA_2DS_2-VASc score, deep venous thrombosis, pulmonary embolism or where a P2Y12 inhibitor alone is prescribed in addition to vitamin K antagonists or non–vitamin K anticoagulant to lower the bleeding risk or occurrence of a major bleeding event. Other exceptions include patients undergoing emergent surgery after a failed PCI and patients with aspirin allergy not amenable to desensitization)
Measurement Period	Period of care: Index procedure or hospitalization‡ Period of observation: All cases accumulated over a 12-mo period ‡Index procedure or hospitalization refers to the procedure currently under evaluation or the hospitalization associated with the procedure.
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient
Rationale	
Aspirin decreases the risk of coronary thrombosis with coronary angioplasty.[38] The combination of at least 81 mg of aspirin daily with an oral P2Y12 inhibitor (ie, clopidogrel, prasugrel, and ticagrelor) reduces the risk of stent thrombosis. In patients with ACS, treatment with DAPT reduces the risk of MACE in addition to reducing stent thrombosis.[3,39–43]	
Clinical Recommendation(s)	

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]

1. In patients undergoing PCI, a loading dose of aspirin, followed by daily dosing, is recommended to reduce ischemic events.[38,39,44,45] §(Class 1, Level of Evidence: B-R)
2. In patients with ACS undergoing PCI, a loading dose of P2Y12 inhibitor, followed by daily dosing, is recommended to reduce ischemic events.[40,41,46–54] (Class 1, Level of Evidence: B-R)
3. In patients with SIHD‖ undergoing PCI, a loading dose of clopidogrel, followed by daily dosing, is recommended to reduce ischemic events.[41,42,49,54–57] (Class 1, Level of Evidence: C-LD)

§Contraindications to ticagrelor: previous intracranial hemorrhage or ongoing bleeding. Contraindications to prasugrel: previous intracranial hemorrhage, previous ischemic stroke or transient ischemic attack, or ongoing bleeding. Prasugrel should be used with caution at a lower dose in patients ≥75 years of age or with a body weight <60 kg.
‖Based on the "AHA/ACC/ACCP/ASPC/NLA/PCNA Guideline for Chronic Coronary Disease,"[58] SIHD has been replaced with "CCD."

ACC indicates American College of Cardiology; ACS, acute coronary syndrome; AF, atrial fibrillation; AHA, American Heart Association; CCD, chronic coronary disease; CHA_2DS_2-VASc, congestive heart failure, hypertension, age ≥75 y (doubled), diabetes, prior stroke or transient ischemic attack or thromboembolism (doubled), vascular disease, age 65 to 74 y, sex category; DAPT, dual antiplatelet therapy; EHR, electronic health record; MACE, major adverse cardiovascular events; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; and SIHD, stable ischemic heart disease.

Appendix A.   Continued

Short Title: PM-3: Antiplatelets and Anticoagulation After PCI

PM-3: Antiplatelet Therapy in Patients With AF Receiving Anticoagulation After PCI

Measure Description: Percentage of patients, age ≥18 y, with AF who are undergoing PCI and are taking oral anticoagulant therapy in addition to DAPT who are advised to discontinue aspirin after 1–4 wk while maintaining P2Y12 inhibitors in addition to a non–vitamin K oral anticoagulant (rivaroxaban, dabigatran, apixaban, or edoxaban) or vitamin K antagonists	
Numerator	Patients with AF who undergo PCI and are taking oral anticoagulant therapy in addition to DAPT who are advised to discontinue aspirin after 1–4 wk* while maintaining P2Y12 inhibitors in addition to a non–vitamin K oral anticoagulant (rivaroxaban, dabigatran, apixaban, or edoxaban) or vitamin K antagonists This PM is specific to patients with AF and a return to the use of an anticoagulant if they were taking an anticoagulant before the PCI or were started on an anticoagulant during their hospitalization before the PCI or after the PCI. *Discontinuation of aspirin earlier than 1 wk or no aspirin therapy is acceptable when the patient is taking a P2Y12 inhibitor and has resumed taking a non–vitamin K oral anticoagulant (rivaroxaban, dabigatran, apixaban, or edoxaban) or when vitamin K antagonist is therapeutic with an INR ≥2.0. Triple therapy up to 4 wk is reasonable for patients with high thrombotic and low bleeding risk, but the default should be dual antithrombotic therapy P2Y12 plus a DOAC from the outset.
Denominator	Patients age ≥18 y with AF who are undergoing PCI and are taking oral anticoagulant therapy in addition to DAPT
Denominator Exclusions	Patients who leave during hospitalization against medical advice, patients who die during hospitalization
Denominator Exceptions	Documentation of a medical reason(s) (eg, patients with contraindications to anticoagulants, active bleeding, coagulopathy, recent major surgery, acute intracranial hemorrhage, recent major trauma, active peptic ulcer, esophageal varices, aortic aneurysm, proliferative retinopathy, pregnancy, and severe hypertension)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data from chart review Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

Recent trials, including the AUGUSTUS[59] trial and the ENTRUST-AF-PCI[60] trial, support earlier findings[61,62] of lower bleeding rates in patients with AF who were treated with a non–vitamin K oral anticoagulant and a P2Y12 inhibitor than those treated with triple therapy (aspirin, P2Y12 inhibitor, and anticoagulation) after PCI. Pooled data[63] have shown rates of death, MI, and stent thrombosis are similar with dual and triple therapy. In patients at high risk of stent thrombosis, aspirin could be maintained for up to 30 d.[64] An article presenting the North American perspective for antithrombotic therapy in patients with AF treated with oral anticoagulation undergoing PCI has been published.[65]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients with atrial fibrillation who are undergoing PCI and are taking oral anticoagulant therapy, it is recommended to discontinue aspirin treatment after 1 to 4 weeks while maintaining P2Y12 inhibitors in addition to a non–vitamin K oral anticoagulant (rivaroxaban, dabigatran, apixaban, or edoxaban) or warfarin to reduce the risk of bleeding.[59-64,66] (Class 1, Level of Evidence: B-R)

ACC indicates American College of Cardiology; AF, atrial fibrillation; AHA, American Heart Association; AUGUSTUS, Safety and Efficacy of Apixaban Versus Vitamin K Antagonist and Aspirin Versus Aspirin Placebo in Patients With Atrial Fibrillation and ACS and/or PCI trial; DAPT, dual antiplatelet therapy; DOAC, direct-acting oral anticoagulants; EHR, electronic health record; ENTRUST-AF-PCI, Edoxaban-Based Versus Vitamin K Antagonist-Based Antithrombotic Regimen After Successful Coronary Stenting in Patients With Atrial Fibrillation trial; INR, international normalized ratio; MI, myocardial infarction; PCI, percutaneous coronary intervention; PM, performance measure; and SCAI, Society for Cardiovascular Angiography and Interventions.

Appendix A.   Continued

Short Title: PM-4: P2Y12 Inhibitors With Fibrinolytic Therapy

PM-4: Oral P2Y12 Inhibitors in Patients Undergoing PCI After Fibrinolytic Therapy

Measure Description: Percentage of patients, age ≥18 y, who receive fibrinolytic therapy and undergo PCI within 24 h who were prescribed a loading dose of 300 mg of clopidogrel followed by 75 mg daily	
Numerator	Patients who undergo PCI within 24 h after fibrinolytic therapy and receive a loading dose of 300 mg of clopidogrel followed by 75 mg daily* *Based on trial protocols, clopidogrel should be administered before PCI is performed.
Denominator	Patients age ≥18 y who undergo PCI within 24 h after fibrinolytic therapy
Denominator Exclusions	Patient refusal, patients who leave against medical advice on day of or day after arrival, patients who die after receiving fibrinolytic therapy before PCI being performed
Denominator Exceptions	Documentation of a medical reason(s) (eg, intolerant of, or allergy to clopidogrel, patients who die after receiving fibrinolytic therapy before PCI being performed, patients with or who develop a significant risk of bleeding after fibrinolysis such as hemorrhagic CNS bleeding, pulmonary hemorrhage after fibrinolytic therapy)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient

Rationale

The PCI-CLARITY study was a prospectively planned analysis of the 1863 patients undergoing PCI after mandated angiography in CLARITY–TIMI 28, a randomized, double-blind, placebo-controlled trial of clopidogrel in patients receiving fibrinolytics for STEMI. Patients between age 18 and 75 y, presenting with STEMI who received fibrinolytic therapy were randomized to receive either clopidogrel (300-mg loading dose, then 75 mg once daily) or placebo until PCI. All patients received aspirin. PCI occurred on average 3 d later. The primary outcome was a composite of cardiovascular death, recurrent myocardial infarction, or stroke within 30 d. Clopidogrel pretreatment in conjunction with fibrinolytic therapy resulted in a 46% reduction in the rate of cardiovascular death, recurrent myocardial infarction, or stroke within 30 d after PCI.[46] In addition, no significant excess in the rates of TIMI major or minor bleeding between the groups was observed. Overall, clopidogrel pretreatment significantly reduced the incidence of cardiovascular death or ischemic complications both before and after PCI. These data support the strategy of early dosing of clopidogrel with fibrinolytic therapy.[46] Ticagrelor after fibrinolytic therapy was compared with clopidogrel in the randomized TREAT[67]; it was noninferior to clopidogrel and did not cause more intracranial bleeding.[68] However, ticagrelor is not FDA approved for this specific indication.

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]

1. In patients undergoing PCI within 24 hours after fibrinolytic therapy, a loading dose of 300 mg of clopidogrel, followed by daily dosing, is recommended to reduce ischemic events.[46] (Class 1, Level of Evidence: C-LD)

ACC indicates American College of Cardiology; AHA, American Heart Association; CLARITY, Clopidogrel as Adjunctive Reperfusion Therapy trial; CNS, central nervous system; EHR, electronic health record; FDA, US Food and Drug Administration; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; STEMI, ST-segment–elevation myocardial infarction; TIMI, thrombolysis in myocardial infarction; and TREAT, Trial to Reduce Cardiovascular Events With Aranesp Therapy.

Appendix A.   Continued

Short Title: PM-5: Aspirin in Patients Undergoing CABG

PM-5: Preoperative and Postoperative Aspirin for Patients Undergoing CABG

Measure Description: Percentage of patients, age ≥18 y, who undergo CABG and meet 1 of the following 2 criteria: (1) are taking aspirin preoperatively, continue aspirin through the perioperative period, and are discharged on aspirin, or (2) are started on aspirin as a new medication within 6 h postoperatively and instructed to continue aspirin after discharge*	
*"Preoperatively" in this context refers to taking aspirin before arrival to the hospital for surgery or aspirin started earlier during the hospitalization as part of the treatment regime. Perioperative period has several definitions but typically lasts from the time the patient goes into the hospital for surgery until the time the patient goes home.	

Numerator	Patients undergoing CABG who meet 1 of the following 2 criteria: (1) are taking aspirin preoperatively, continue aspirin through the perioperative period, and are discharged on aspirin, or (2) are started on aspirin as a new medication within 6 h postoperatively and instructed to continue aspirin after discharge*
Denominator	Patients age ≥18 y undergoing CABG
Denominator Exclusions	Inability to afford or refusal to take aspirin, patients who leave during hospitalization against medical advice, patients who die during hospitalization
Denominator Exceptions	Documentation of a medical reason(s) (eg, contraindication for aspirin after CABG such as allergy, prohibitive bleeding risk, patients who die during hospitalization)
Measurement Period	Period of care: Index procedure or hospitalization† Period of observation: All cases accumulated over a 12-mo period †Index procedure or hospitalization refers to the procedure currently under evaluation or the hospitalization associated with the procedure.
Sources of Data	EHR data–inpatient and discharge medication lists Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient

Rationale
Most patients who undergo CABG are already taking aspirin for primary or secondary prevention of new cardiovascular events. Early observational data showed an association between preoperative aspirin administration and reduced in-hospital death.[69,70] Although more recent meta-analyses of randomized and nonrandomized trials have yielded somewhat conflicting results, continuation of existing preoperative aspirin is likely associated with a reduction in the risk of MI but not death.[71–73] Continuation of aspirin until the time of surgery is associated with an increased risk of perioperative bleeding and transfusion, although this does not appear to increase the likelihood of surgical reoperation.[71–75] Patients at risk of significant bleeding (eg, redo operations or underlying bleeding dyscrasias) may warrant individualized consideration but are underrepresented in the literature.
Surgical bleeding remains a concern in the perioperative and immediate postoperative periods, and therefore bleeding risk is an important consideration in the use of antiplatelet therapy. Older data have shown that aspirin improves vein graft patency.[76–79] Although 1 small study showed higher rates of bleeding with aspirin after CABG,[80] the totality of evidence supports the early use[39,76-79,81] of aspirin to improve SVG patency and reduce ischemic complications.
The "2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization"[3] specifies an aspirin dose of 100-325 mg because this dose range was studied in literature supporting this recommendation. Aspirin (81 mg) is widely used by many clinicians after CABG and PCI because this dose is associated with less bleeding.[82] CMS measures for aspirin do not specify a dose. The NQF measure (0068) lists an aspirin dose of 100-325 mg for CABG but lower doses for other conditions. It is the opinion of this writing committee that a dose of aspirin 81 mg daily meets the requirements for this performance measure.
In patients undergoing elective CABG who are not already taking aspirin, the initiation of daily aspirin in the immediate preoperative period (<24 h before surgery) is not recommended.

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients undergoing CABG who are already taking daily aspirin preoperatively, it is recommended that they continue taking aspirin until the time of surgery to reduce ischemic events.[69–75] (Class 1, Level of Evidence: B-R)
2. In patients undergoing CABG, aspirin (100-325 mg daily) should be initiated within 6 hours postoperatively and then continued indefinitely to reduce the occurrence of SVG closure and adverse cardiovascular events.[39,76-79,81,83] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; CAD, coronary artery disease; CMS, Centers for Medicare & Medicaid Services; EHR, electronic health record; MI, myocardial infarction; NQF, National Quality Forum; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; and SVG, saphenous vein graft.

Appendix A. Continued

Short Title: PM-6: Lipid Management

PM-6: Lipid Management After Revascularization

Measure Description: Percentage of patients, age ≥18 y, undergoing coronary revascularization prescribed high-intensity statin therapy	
Numerator	Patients undergoing revascularization who are prescribed high-intensity statin therapy* *High-intensity statin therapy is defined as a dose expected to reduce LDL-C by ≥50% and includes these medications: atorvastatin 40-80 mg daily or rosuvastatin 20-40 mg daily.
Denominator	Patients age ≥18 y undergoing revascularization
Denominator Exclusions	Patient refusal, patients who leave during hospitalization against medical advice, patients who die during hospitalization
Denominator Exceptions	Documentation of a patient reason(s) (eg, patient ≥75 y,† patient claim of intolerance to statin therapy) Documentation of a medical reason(s) (eg, drug-drug interactions) †High-intensity statin therapy may be used in patients ≥75 y (Class 2a indication).
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient
Rationale	
Controlled clinical trials of lipid-lowering drug therapy have shown that lowering of LDL-C is associated with a reduced risk of adverse cardiovascular events.[22,24]	
Clinical Recommendation(s)	

2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol[22]

1. In patients who are 75 years of age or younger with clinical ASCVD‡ high-intensity statin therapy should be initiated or continued with the aim of achieving a 50% or greater reduction in LDL-C levels.[84–88] (Class 1, Level of Evidence: A)

    ‡Clinical atherosclerotic cardiovascular disease (ASCVD) includes acute coronary syndrome (ACS), those with history of myocardial infarction (MI), stable or unstable angina or coronary or other arterial revascularization, stroke, transient ischemic attack (TIA), or peripheral artery disease (PAD) including aortic aneurysm, all of atherosclerotic origin.
2. In patients with clinical ASCVD in whom high-intensity statin therapy is contraindicated or who experience statin-associated side effects, moderate-intensity statin therapy should be initiated or continued with the aim of achieving a 30% to 49% reduction in LDL-C levels.[87,89–96] (Class 1, Level of Evidence: A)
3. In patients with clinical ASCVD who are judged to be very high risk and considered for PCSK9 inhibitor therapy, maximally tolerated LDL-C lowering therapy should include maximally tolerated statin therapy and ezetimibe.[97,98] (Class 1, Level of Evidence: B-NR)

AACVPR indicates American Association of Cardiovascular and Pulmonary Rehabilitation; AAPA, American Academy of Physician Associates; ABC, Association of Black Cardiologists; ACC, American College of Cardiology; ACPM, American College of Preventive Medicine; ACS, acute coronary syndrome; ADA, American Diabetes Association; AGS, American Geriatrics Society; AHA, American Heart Association; APhA, American Pharmacists Association; ASCVD, atherosclerotic cardiovascular disease; ASPC, American Society for Preventive Cardiology; EHR, electronic health record; LDL-C, low-density lipoprotein cholesterol; MI, myocardial infarction; NLA, National Lipid Association; PAD, peripheral artery disease; PCNA, Preventive Cardiovascular Nurses Association; PM, performance measure; and TIA, transient ischemic attack.

Appendix A. Continued

Short Title: PM-7: Glycemic Control and CABG Surgery

PM-7: Optimizing Glycemic Control During and After CABG to Reduce Perioperative Complications

Measure Description: Percentage of patients, age ≥18 y, with diabetes or stress hyperglycemia undergoing CABG surgery who have an intraoperative insulin infusion started and maintained in the early postoperative period with a goal of blood glucose <180 mg/dL* *Stress hyperglycemia refers to a transient increase in plasma glucose levels (usually >150 mg/dL) during acute illness or physical or psychological stress that subsides when the stressful condition resolves. Intraoperative is defined as occurring or performed during the course of a surgical operation.	
Numerator	Patients with diabetes or stress hyperglycemia undergoing CABG surgery who are treated with an intraoperative and early postoperative insulin infusion with a goal of a blood glucose maintained at <180 mg/dL
Denominator	Patients age ≥18 y with diabetes or stress hyperglycemia undergoing CABG surgery
Denominator Exclusions	Patient refusal of insulin infusion, active infection at the time of surgery, patients who leave against medical advice, patients who suffer cardiopulmonary arrest or die within 12 h of anesthesia end time
Denominator Exceptions	Documentation of a medical reason(s) (eg, persistent hypoglycemia, other medical contraindication to intravenous insulin infusion, patients whose blood glucose remains <180 mg/dL without an insulin infusion, patients requiring steroids for treatment of another condition such as COPD exacerbation, patients enrolled in clinical trials that could affect blood glucose, patients who die for other reasons during their hospitalization)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient claims) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient

Rationale

Outcomes of patients with diabetes who undergo surgical revascularization have been shown to be inferior to those of their counterparts without diabetes.[99,100] In an RCT, Lazar and colleagues randomized 141 patients with diabetes undergoing CABG surgery to a target serum glucose of 125-200 mg/dL (achieved mean glucose, 138±4 mg/dL), using a glucose-insulin-potassium solution beginning before anesthesia and continuing for 12 h after surgery, versus a usual care target serum glucose <250 mg/dL (achieved mean glucose 260±6 mg/dL; P<0.0001).[101] Patients randomized to the lower glucose target had fewer infections (0% versus 13%; P=0.01), a lower incidence of AF (16.6% versus 42.0%; P=0.002), and a shorter mean length of stay (6.5 d versus 9.2 d; P=0.003). At 2 y, survival was 10% (95% CI, 2%-18%) lower in the patients randomized to usual care. Longitudinal studies have examined complication rates before and after implementation of protocols targeting specific levels of perioperative glucose.

Furnary et al showed implementation of a continuous intravenous insulin protocol was associated with a significant reduction in perioperative blood glucose levels and a significant reduction in the incidence of deep sternal wound infection (2.0% before versus 0.8% after; P=0.01).[102] Similarly, Hruska et al reported on the effects of a continuous insulin infusion protocol targeting serum glucose of 120-160 mg/dL in the immediate postoperative period, which was instituted in 1998. Before the protocol, the deep sternal wound infection rate was significantly higher in patients with diabetes than in patients without diabetes (P=0.0007). After initiation of the protocol, the infection rate for patients with diabetes was reduced to that of patients without diabetes. No statistically significant differences were observed in the mortality rate or length of stay.[103] Optimal glycemic targets have not been fully elucidated. One RCT of 300 patients did not show a statistically significant reduction in postoperative complications after CABG for patients randomized to a glucose target of 100-140 mg/dL with a glucose target of 141-180 mg/dL after CABG surgery.[104]

Furnary et al also reported results from a large registry cohort (n=5500) showing that increasing glucose levels were associated with increasing rates of death, deep sternal wound infections, and increased length of hospital stay.[105] In this study, use of continuous insulin infusion for 3 d postoperatively with a target serum glucose of <150 mg/dL was associated with markedly lower risks of death and sternal wound infections (P<0.001 for each). However, the observational nature of those data increases the likelihood of unmeasured confounding. Based on these data, guidelines now include glycemic management targets in this context, and standard of care has evolved over the past 2 decades to target maintaining blood glucose levels <180 mg/dL, with a goal of reducing postoperative complications, such as infection or arrhythmia, to improve survival, and to shorten length of stay.

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients undergoing CABG, an intraoperative continuous insulin infusion should be initiated to maintain serum glucose level <180 mg/dL to reduce sternal wound infection.[101–103] (Class 1, Level of Evidence: B-R)
2. In patients undergoing CABG, the use of continuous intravenous insulin to achieve and maintain an early postoperative blood glucose concentration of <180 mg/dL while avoiding hypoglycemia is indicated to reduce the incidence of adverse events, including deep sternal wound infection.[101,104–106] (Class 1, Level of Evidence: B-R)

ACC indicates American College of Cardiology; AF, atrial fibrillation; AHA, American Heart Association; CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; EHR, electronic health record; PM, performance measure; RCT, randomized controlled trial; and SCAI, Society for Cardiovascular Angiography and Interventions.

Appendix A.   Continued

Short Title: PM-8: Use of the IMA in CABG

PM-8: Use of the IMA to Bypass the LAD in Patients Undergoing CABG

Measure Description: Percentage of patients, age ≥18 y, with an indication for bypass of the LAD who receive an IMA graft (preferably a left IMA)	
Numerator	Percentage of patients with an indication for bypass of the LAD who receive an IMA graft* *Although the left IMA is preferable, use of the right IMA is acceptable if the left IMA is not a viable option.
Denominator	Patients age ≥18 y with an indication for bypass of the LAD
Denominator Exclusions	Patient refusal to have IMA graft, unusable internal mammary arteries
Denominator Exceptions	Documentation of a patient reason(s) (eg, patient refusal) Documentation of a medical reason(s) (eg, prior sternotomy or left thoracotomy, no LAD disease, LAD unable to accept a bypass or unable to be grafted, significant chest deformity, previous radiation to the chest, significant proximal left subclavian stenosis, upper extremity aortic valve fistula in ipsilateral arm, previous cardiac surgery, emergency, or salvage CABG)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient

Rationale

Data supporting the LIMA versus an SVG for grafting of the LAD are derived almost exclusively from observational studies reported 25-35 y ago.[107–109] In the CASS registry, survival was improved in patients who received the LIMA-LAD compared with the SVG group after multivariable adjustment.[108] In another series of nearly 6000 patients undergoing CABG, LIMA grafting reduced deaths, recurrent infarction, rehospitalization for cardiac events, and repeat revascularization.[109] In this study, postoperative angiography revealed substantially higher LIMA patency. A single small RCT also found improved cardiac event–free survival at 10 y in the LIMA arm.[107,110]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients undergoing CABG, an IMA, preferably the left, should be used to bypass the LAD when bypass of the LAD is indicated to improve survival and reduce recurrent ischemic events.[107–112] (Class 1, Level of Evidence: B-NR)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; CASS, Coronary Artery Surgery Study; EHR, electronic health record; IMA, internal mammary artery; LAD, left anterior descending; LIMA, left internal mammary artery; PM, performance measure; RCT, randomized controlled trial; SCAI, Society for Cardiovascular Angiography and Interventions; and SVG, saphenous vein graft.

Appendix A.   Continued

Short Title: PM-9: Patients With Diabetes and Multivessel Disease

PM-9: CABG for Revascularization in Patients With Diabetes and Multivessel CAD

Measure Description: Percentage of patients, age ≥18 y, with diabetes and multivessel disease including hemodynamically significant LAD disease, who are appropriate candidates for CABG, who undergo revascularization with CABG* The "2021 ACC/AHA/SCAI Guidelines for Coronary Artery Revascularization"3 defines multivessel disease as "significant stenosis in 3 major coronary arteries (with or without proximal LAD)." *The evidence supporting the use of CABG is strongest for proximal LAD stenosis.	
Numerator	Patients with diabetes and multivessel disease including hemodynamically significant LAD disease who undergo CABG with a LIMA to the LAD† †Although much less common, the RIMA can be used to bypass the LAD and would be considered equivalent to a LIMA graft.
Denominator	Patients age ≥18 y with diabetes and multivessel disease including hemodynamically significant LAD disease who undergo revascularization
Denominator Exclusions	Refusal to have CABG, patients who leave during hospitalization against medical advice
Denominator Exceptions	Documentation of a medical reason(s) (eg, surgical risk prohibitive, previous CABG, MELD score >14, STS Short-Term Risk Calculator [formerly known as PROM] score >5%, diffuse disease of the LAD or stenosis confined to the distal segment or a branch of the LAD, poor targets for bypass, previous STEMI with occlusion of the LAD and no evidence of viability in the anterior wall, emergency or salvage CABG)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

While revascularization decisions are complex and dependent on multiple factors, including patient preferences and procedural risks, clinical trials[113,114] comparing PCI and CABG in patients with multivessel coronary artery disease (including the LAD) consistently show a survival benefit and decreased repeat revascularizations in those who undergo CABG with a LIMA to the LAD. Multiple RCTs comparing PCI with CABG in patients with multivessel CAD have included patients with diabetes[113,115,116] or have prespecified patients with diabetes as a subgroup of interest.[114,117,118] The FREEDOM trial compared CABG with PCI in 1900 patients with diabetes and multivessel disease but not left main disease.[114,117,118] The LAD had significant disease in 91% of the patients included in the study. After 5 y, the all-cause mortality rate was higher in the PCI group than in the CABG group, but cardiovascular mortality rate was not different between the groups. The benefit of CABG appeared to be unrelated to the complexity of disease.[115] In a follow-up study of the FREEDOM cohort, the all-cause mortality rate up to 8 y remained higher with PCI. A meta-analysis showed consistent results, with a nearly 50% higher 5-y mortality rate among patients treated with PCI compared with CABG.[114,117,118] Patients with diabetes and a high surgical risk are now often treated with PCI.[119] In a registry that included patients with refractory ischemia and high surgical risk, 5-y survival rates were similar among CABG and PCI patients.[120] For these reasons, CABG is the preferable option for patients with diabetes and multivessel disease, including the LAD, who have acceptable surgical risk.

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1.   In patients with diabetes and multivessel CAD with the involvement of the LAD who are appropriate candidates for CABG, CABG (with a LIMA to the LAD) is recommended in preference to PCI to reduce mortality and repeat revascularizations.[113-118,121,122] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; CAD, coronary artery disease; EHR, electronic health record; FREEDOM, Future Revascularization Evaluation in Patients with Diabetes Mellitus: Optimal Management of Multivessel Disease trial; LAD, left anterior descending; LIMA, left internal mammary artery; MELD, Model for End-Stage Liver Disease; PCI, percutaneous coronary intervention; PM, performance measure; PROM, Predicted Risk of Mortality; RCT, randomized controlled trial; RIMA, right internal mammary artery; SCAI, Society for Cardiovascular Angiography and Interventions; STEMI, ST-segment–elevation myocardial infarction; and STS, Society of Thoracic Surgeons.

Appendix A. Continued

Short Title: PM-10: Arterial Access for PCI

PM-10: Radial Artery Access for PCI

Measure Description: Percentage of patients, age ≥18 y, undergoing PCI for either CCD or ACS who receive a radial arterial access	
Numerator	Patients with CCD or ACS undergoing PCI using radial arterial access* *Use of the ulnar artery for access is an acceptable substitute for radial artery access.
Denominator	Patients age ≥18 y with CCD or ACS undergoing PCI
Denominator Exclusions	Patient refusal of radial or ulnar arterial access, radial artery or brachiocephalic artery anatomy precludes radial arterial access for PCI, absence of bilateral radial artery pulses confirmed with ultrasound
Denominator Exceptions	Documentation of a medical reason(s) (eg, peripheral artery disease or vaso-occlusive disease such as thromboangiitis obliterans, Takayasu arteritis, Raynaud disease, concomitant plan for other procedure such as TAVR that requires femoral access, presence of arteriovenous fistula or dialysis graft in the arm to be used, plan to access both right and left mammary bypass grafts, failed attempt of radial access on 1 side†) †Depending on the clinical setting, attempting radial access on the contralateral side or ulnar artery access may be considered but is at the discretion of the operator. If CABG is a potential future treatment and no saphenous vein or other conduit is available for future procedures, use of both radial arteries for access should be avoided and considered an exception.
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale
Studies have shown multiple benefits of transradial artery access versus transfemoral arterial access for PCI both in CCD and ACS. These benefits include lower rates of access site bleeding and vascular complications in patients with CCD and ACS.[123–125] In patients with ACS, radial artery access PCI leads to improved cardiovascular outcomes.[126]   The MATRIX trial[127] showed lower rate of net adverse clinical events (30-d death, nonfatal infarction and stroke, and non-CABG major bleeding) in patients with ACS who were randomized to the transradial approach compared with those randomized to the transfemoral approach. The difference was driven by lower rates of bleeding and the 30-d mortality rate.   Each health care institution can set an institution-specific goal regarding the percentage of radial arterial access PCI, which should be done annually by each interventional cardiologist at the institution and by the institution's cardiac catheterization laboratory as a whole.

Clinical Recommendation(s)
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]   1. In patients with ACS undergoing PCI, a radial approach is indicated in preference to a femoral approach to reduce the risk of death, vascular complications, or bleeding.[123,124,126,127] (Class 1, Level of Evidence: A)   2. In patients with SIHD‡ undergoing PCI, the radial approach is recommended to reduce access site bleeding and vascular complications.[123,128–130] (Class 1, Level of Evidence: A)   ‡Based on the "AHA/ACC/ACCP/ASPC/NLA/PCNA Guideline for Chronic Coronary Disease,"[58] SIHD has been replaced with "CCD."

ACC indicates American College of Cardiology; ACS, acute coronary syndrome; AHA, American Heart Association; CABG, coronary artery bypass graft; CCD, chronic coronary disease; EHR, electronic health record; MATRIX, Minimizing Adverse Haemorrhagic Events by TRansradial Access Site and Systemic Implementation of angioX Access trial; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; SIHD, stable ischemic heart disease; and TAVR, transcatheter aortic valve replacement.

Appendix A. Continued

Short Title: PM-11: Non-Infarct Artery Revascularization in STEMI

PM-11: Revascularization of Non-Infarct Artery in Stable Patients With STEMI

Measure Description: Percentage of patients, age ≥18 y, who present with a STEMI, have multivessel CAD, and are hemodynamically stable after PCI of the culprit stenosis who undergo PCI of a significant non-infarct artery stenosis after primary PCI*

*As defined in the COMPLETE trial[131] the criteria to define a significant non-culprit stenosis were: "stenosis severity of ≥70% (or 50%-69% with fractional flow reserve ≤0.80), diameter of ≥2.5 mm, and amenable to successful treatment with PCI."

Numerator	Patients with multivessel CAD who are hemodynamically stable after successful primary PCI for STEMI who undergo staged PCI of non-culprit artery(s)† †Although the COMPLETE trial[131] specifies a 45-d window for performance of the non-culprit artery PCI, this timeframe is not included in the 2021 coronary artery revascularization guideline[1] recommendation. This allows for a longer time interval if, in the judgment of the operator, a longer waiting period is in the best interest of the patient.
Denominator	Patients age ≥18 y with multivessel CAD who are hemodynamically stable after successful primary PCI for STEMI and have non-culprit vessels suitable for PCI
Denominator Exclusions	Patient refusal, patients who leave against medical advice, failed primary PCI, patients who die during admission
Denominator Exceptions	Documentation of a medical reason(s) (eg, acute renal insufficiency, active bleeding, coronary anatomy not amenable to further revascularization, CABG performed for revascularization of non-infarct arteries, do not resuscitate status, patient remains unstable after primary PCI of culprit stenosis)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

RCTs have shown benefit for staged PCI (in-hospital or after discharge) versus culprit vessel−only PCI in reducing MACE after STEMI. The benefit is driven mainly by a reduction in risk of repeat revascularization and reinfarction.[131–134]
The COMPLETE trial showed a 3-y reduction in the composite endpoint of death or MI with staged PCI of the non-infarct artery performed within 45 d of STEMI, compared with conservative care.[131]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In selected hemodynamically stable patients with STEMI and multivessel disease, after successful primary PCI, staged PCI of a significant non-infarct artery stenosis is recommended to reduce the risk of death or MI.[131–134] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; CAD, coronary artery disease; COMPLETE, Complete versus Culprit-Only Revascularization Strategies to Treat Multivessel Disease after Early PCI for STEMI trial; EHR, electronic health record; MACE, major adverse cardiovascular events; MI, myocardial infarction; PCI, percutaneous coronary intervention; PM, performance measure; RCT, randomized controlled trial; SCAI, Society for Cardiovascular Angiography and Interventions; and STEMI, ST-segment−elevation myocardial infarction.

Appendix A.   Continued

Short Title: PM-12: Non-Infarct PCI in STEMI With Shock

PM-12: Non-Infarct Vessel PCI in Patients With Cardiogenic Shock After STEMI

Measure Description: Percentage of patients, age ≥18 y, with STEMI complicated by cardiogenic shock who undergo PCI of only the infarct-related artery at the time of the primary PCI procedure	
Numerator	Patients with STEMI complicated by cardiogenic shock who undergo PCI of only the infarct-related artery at the time of the primary PCI procedure
Denominator	Patients age ≥18 y with STEMI complicated by cardiogenic shock who undergo PCI of the infarct-related artery and other coronary arteries at the time of the primary PCI procedure
Denominator Exclusions	None
Denominator Exceptions	Documentation of a medical reason(s) (eg, evidence of ongoing ischemia, worsening shock state despite successful culprit vessel PCI)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient
Rationale	
CULPRIT-SHOCK was a randomized trial of 706 patients with multivessel CAD, AMI, and cardiogenic shock. Patients were randomized to 1 of 2 revascularization strategies: culprit vessel-only PCI or immediate multivessel PCI. At 30 d, the composite primary endpoint of death or severe renal failure requiring renal replacement therapy was lower in the culprit vessel-only group. At 1 y, no difference in the mortality rate between the 2 groups was observed.[135,136]	
Clinical Recommendation(s)	
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3] 1. In patients with STEMI complicated by cardiogenic shock, routine PCI of a non-infarct artery at the time of primary PCI should not be performed because of the higher risk of death or renal failure.[135–137] (Class 3: Harm, Level of Evidence: B-R)	

ACC indicates American College of Cardiology; AHA, American Heart Association; AMI, acute myocardial infarction; CAD, coronary artery disease; CULPRIT-SHOCK, Culprit Lesion Only PCI Versus Multivessel PCI in Cardiogenic Shock trial; EHR, electronic health record; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; and STEMI, ST-segment–elevation myocardial infarction.

Appendix A. Continued

Short Title: PM-13: Management of Ventricular Arrhythmias

PM-13: Revascularization for the Management of Ventricular Arrhythmias

Measure Description: Percentage of patients, age ≥18 y, with VF, PMVT, or cardiac arrest and significant CAD who undergo revascularization with CABG or PCI during the index hospitalization

Numerator	Patients who undergo revascularization of significant CAD* during index hospitalization, who also experience or present with VF, PMVT, or cardiac arrest *Significant CAD is defined as "a visually estimated diameter stenosis severity of ≥70% for non−left main and ≥50% for left main disease."
Denominator	Patients age ≥18 y with VF, PMVT, or cardiac arrest and significant CAD who are candidates for revascularization
Denominator Exclusions	Patient refusal, coronary angiography not performed, monomorphic VT, reversible precipitant or cause of arrhythmia (eg, Class III antiarrhythmic toxicity, history of LQTS), no significant CAD present
Denominator Exceptions	Documentation of a medical reason(s) (eg, active bleeding or high bleeding risk, acute renal insufficiency, coronary anatomy not amenable to revascularization, significant neurological damage, do not resuscitate status, ventricular arrhythmias occurring during performance of a concomitant procedure such as TAVR)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient

Rationale

In patients who survive cardiac arrest or have VF or PMVT, observational studies have shown that revascularization with CABG[138] or PCI[139] is associated with arrhythmia reduction and a lower likelihood of death.[140,141]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients with ventricular fibrillation, polymorphic ventricular tachycardia (VT), or cardiac arrest, revascularization of significant CAD is recommended to improve survival.[138-140,142] (Class 1, Level of Evidence: B-NR)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; CAD, coronary artery disease; EHR, electronic health record; LQTS, long QT syndrome; PCI, percutaneous coronary intervention; PM, performance measure; PMVT, polymorphic ventricular tachycardia; SCAI, Society for Cardiovascular Angiography and Interventions; TAVR, transcatheter aortic valve replacement; VF, ventricular fibrillation; and VT, ventricular tachycardia.

Appendix A.   Continued

Short Title: PM-14a: Cardiac Rehabilitation Referral From Inpatient Setting

PM-14a: Cardiac Rehabilitation Patient Referral From an Inpatient Setting After Revascularization (The cardiac rehabilitation performance measures are from the "2018 ACC/AHA Performance Measures for Cardiac Rehabilitation."[21])

Measure Description: Percentage of patients, age ≥18 y, hospitalized with a qualifying event or diagnosis for CR having undergone CABG or PCI are to be referred to an outpatient CR program	
Numerator	Patients with a qualifying event who have been referred to an outpatient CR program before hospital discharge. Referral is defined as: 1. Documented communication* between the health care provider and the patient to recommend an outpatient CR program AND 2a. Official referral order is sent to outpatient CR program OR 2b. Documentation of patient refusal of a referral to a CR program Note: Performance is met if steps 1 AND either 2a or 2b (patient refusal documented in the patient's medical record) are completed and documented. *All communications must maintain appropriate confidentiality as outlined by the HIPAA. All patient information required for enrollment should be transmitted to the CR program. Necessary patient information may be found in the hospital discharge summary. Patients who refuse a CR referral should not have their data transmitted to the receiving CR program against their will.
Denominator	Patients age ≥18 y with coronary artery revascularization during the previous 12 mo, who are discharged from hospital during the reporting period
Denominator Exclusions	Patients who die during hospitalization, patients who are transferred to another hospital, patients who are already participating in a CR program before hospitalization, patients who leave during hospitalization against medical advice
Denominator Exceptions	Documentation of a patient reason(s) that precludes referral to CR (eg, no traditional CR program available to the patient within 60 min travel time from the patient's home, patient has no means to get to a CR program or patient does not have access to an alternative model of CR delivery that meets all criteria for a CR program) Documentation of a medical reason(s) (eg, patient deemed by a medical provider to have a medically unstable, life-threatening condition or has other cognitive or physical impairments that preclude CR participation, death during hospitalization) Documentation of a health care reason(s) (eg, patient lacks medical coverage for CR)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient
Rationale	

CR services have been associated with lower morbidity and mortality rates in persons who have experienced a recent coronary artery disease event, but these services are used in <30% of eligible patients.[143,144]

A key component to outpatient CR program utilization is the appropriate and timely referral of patients. Generally, the most important time for this referral to take place is while the patient is hospitalized for a qualifying event or diagnosis (MI, CSA, CABG, PCI, and cardiac valve repair or replacement).[21]

This performance measure has been developed to help health care systems implement effective steps in their systems of care that will optimize the appropriate referral of a patient to an outpatient CR program.[21]

This measure is designed to serve as a stand-alone measure or, preferably, to be included within other performance measurement sets that involve disease states or other conditions for which CR services have been found to be appropriate and beneficial (eg, after MI, CABG surgery). This measure is provided in a format that is meant to allow easy and flexible inclusion into such performance measurement sets.[21]

Effective referral of appropriate inpatients to an outpatient CR program is the responsibility of the health care team within a health care system that is primarily responsible for providing cardiovascular care to the patient during the hospitalization.[21]

Published evidence suggests that automatic referral systems accompanied by strong and supportive advice and guidance from a health care professional can significantly help improve CR referral and enrollment.[21]

Appendix A. Continued

Short Title: PM-14a: Cardiac Rehabilitation Referral From Inpatient Setting Continued

PM-14a: Cardiac Rehabilitation Patient Referral From an Inpatient Setting After Revascularization (The cardiac rehabilitation performance measures are from the "2018 ACC/AHA Performance Measures for Cardiac Rehabilitation."[21])

Clinical Recommendation(s)
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients who have undergone revascularization, a comprehensive cardiac rehabilitation program (home based or center based) should be prescribed either before hospital discharge or during the first outpatient visit to reduce deaths and hospital readmissions and improve quality of life.[145–148] (Class 1, Level of Evidence: A)
2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes[149]
1. All eligible patients with NSTE-ACS should be referred to a comprehensive cardiovascular rehabilitation program either before hospital discharge or during the first outpatient visit.[150–153] (Class 1, Level of Evidence: B)
2013 ACCF/AHA Guideline for the Management of Patients With ST-Elevation Myocardial Infarction[154]
1. Exercise-based cardiac rehabilitation/secondary prevention programs are recommended for patients with STEMI.[152,155–157] (Class 1, Level of Evidence: B)
AHA/ACCF Secondary Prevention and Risk Reduction Therapy for Patients With Coronary and Other Atherosclerotic Vascular Disease: 2011 Update[158]
1. All eligible patients with ACS or whose status is immediately post coronary artery bypass surgery or post-PCI should be referred to a comprehensive outpatient cardiovascular rehabilitation program either prior to hospital discharge or during the first follow-up office visit.[152,159–161] (Class 1, Level of Evidence: A)
Effectiveness-Based Guidelines for the Prevention of Cardiovascular Disease in Women–2011 Update[162]
1. A comprehensive CVD risk-reduction regimen such as cardiovascular or stroke rehabilitation or a physician-guided home- or community-based exercise training program should be recommended to women with a recent acute coronary syndrome or coronary revascularization, new-onset or chronic angina, recent cerebrovascular event, peripheral arterial disease (Class 1, Level of Evidence: A), or current/prior symptoms of heart failure and an LVEF ≤35%. (Class 1, Level of Evidence: B)
2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery[25]
1. Cardiac rehabilitation is recommended for all eligible patients after CABG.[152,159-161,163,164] (Class 1, Level of Evidence: A)
2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention[26]
1. 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.[151,152,155,159-161,165–167] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; ACCF, American College of Cardiology Foundation; ACS, acute coronary syndrome; AHA, American Heart Association; CABG, coronary artery bypass graft; CR, cardiac rehabilitation; CSA, central sleep apnea; CVD, cardiovascular disease; EHR, electronic health record; HIPAA, Health Insurance Portability and Accountability Act of 1996; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NSTE-ACS, non–ST-segment–elevation acute coronary syndrome; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; and STEMI, ST-segment–elevation myocardial infarction.

Appendix A. Continued

Short Title: PM-14b: Cardiac Rehabilitation Referral From Outpatient Setting

PM-14b: Cardiac Rehabilitation Patient Referral From an Outpatient Setting After Revascularization (The cardiac rehabilitation performance measures are from the "2018 ACC/AHA Performance Measures for Cardiac Rehabilitation."[21])

Measure Description: Percentage of patients, age ≥18 y, with a qualifying event or diagnosis for CR having undergone CABG surgery or PCI are to be referred to an outpatient CR program	
Numerator	Patients in an outpatient clinical practice who have had a qualifying event or diagnosis during the previous 12 mo, who have been referred to an outpatient CR program Referral is defined as: 1. Documented communication* between the health care provider and the patient to recommend an outpatient CR program AND 2a. Official referral order is sent to outpatient CR program OR 2b. Documentation of patient refusal of a referral to a CR program Note: Performance is met if steps 1 AND either 2a or 2b (patient refusal documented in the patient's medical record) are completed and documented. *All communications must maintain appropriate confidentiality as outlined by the HIPAA. All patient information required for enrollment should be transmitted to the CR program. Necessary patient information may be found in the hospital discharge summary. Patients who refuse a CR referral should not have their data transmitted to the receiving CR program against their will.
Denominator	Patients age ≥18 y with coronary artery revascularization during the previous 12 mo, who are discharged from hospital during the reporting period
Denominator Exclusions	Patients who leave clinic visit against medical advice, patients who have completed a CR program or are currently participating in a CR program
Denominator Exceptions	Documentation of a patient reason(s) (eg, no traditional CR program available to the patient within 60 min travel time from the patient's home, or patient does not have access to an alternative model of CR delivery that meets all criteria for a CR program) Documentation of a medical reason(s) (eg, patient deemed by a medical provider to have a medically unstable, life-threatening condition or has other cognitive or physical impairments that preclude CR participation) Documentation of a system reason(s) (eg, patient resides in a nursing care or long-term care facility, patient lacks medical coverage for CR)
Measurement Period	Encounter Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Outpatient
Rationale	

CR services have been associated with lower morbidity and mortality rates in persons who have experienced a recent coronary artery disease event, but these services are used in <30% of eligible patients.[143,144]

A key component to outpatient CR program utilization is the appropriate and timely referral of patients. Generally, the most important time for this referral to take place is while the patient is hospitalized for a qualifying event or diagnosis (MI, CSA, CABG, PCI, and cardiac valve repair or replacement).[21]

This performance measure has been developed to help health care systems implement effective steps in their systems of care that will optimize the appropriate referral of a patient to an outpatient CR program.[21]

This measure is designed to serve as a stand-alone measure or, preferably, to be included within other performance measurement sets that involve disease states or other conditions for which CR services have been found to be appropriate and beneficial (eg, after MI, CABG surgery). This measure is provided in a format that is meant to allow easy and flexible inclusion into such performance measurement sets.[21]

Effective referral of appropriate inpatients to an outpatient CR program is the responsibility of the health care team within a health care system that is primarily responsible for providing cardiovascular care to the patient during the hospitalization.[21]

Published evidence suggests that automatic referral systems accompanied by strong and supportive advice and guidance from a health care professional can significantly help improve CR referral and enrollment.[21]

Appendix A.   Continued

Short Title: PM-14b: Cardiac Rehabilitation Referral From Outpatient Setting Continued

PM-14b: Cardiac Rehabilitation Patient Referral From an Outpatient Setting After Revascularization (The cardiac rehabilitation performance measures are from the "2018 ACC/AHA Performance Measures for Cardiac Rehabilitation."[21])

Clinical Recommendation(s)
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1.   In patients who have undergone revascularization, a comprehensive cardiac rehabilitation program (home based or center based) should be prescribed either before hospital discharge or during the first outpatient visit to reduce deaths and hospital readmissions and improve quality of life.[145–148] (Class 1, Level of Evidence: A)
2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes[149]
1.   All eligible patients with NSTE-ACS should be referred to a comprehensive cardiovascular rehabilitation program either before hospital discharge or during the first outpatient visit.[150–153] (Class 1, Level of Evidence: B)
2013 ACCF/AHA Guideline for the Management of Patients With ST-Elevation Myocardial Infarction[154]
1.   Exercise-based cardiac rehabilitation/secondary prevention programs are recommended for patients with STEMI.[152,155–157] (Class 1, Level of Evidence: B)
AHA/ACCF Secondary Prevention and Risk Reduction Therapy for Patients With Coronary and Other Atherosclerotic Vascular Disease: 2011 Update[158]
1.   All eligible patients with ACS or whose status is immediately post coronary artery bypass surgery or post-PCI should be referred to a comprehensive outpatient cardiovascular rehabilitation program either prior to hospital discharge or during the first follow-up office visit.[152,159–161] (Class 1, Level of Evidence: A)
Effectiveness-Based Guidelines for the Prevention of Cardiovascular Disease in Women–2011 Update[162]
1.   A comprehensive CVD risk-reduction regimen such as cardiovascular or stroke rehabilitation or a physician-guided home- or community-based exercise training program should be recommended to women with a recent acute coronary syndrome or coronary revascularization, new-onset or chronic angina, recent cerebrovascular event, peripheral arterial disease (Class 1, Level of Evidence: A) or current/prior symptoms of heart failure and an LVEF $\leq$35%. (Class 1, Level of Evidence: B)
2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery[25]
1.   Cardiac rehabilitation is recommended for all eligible patients after CABG.[152,159-161,163,164] (Class 1, Level of Evidence: A)
2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention[26]
1.   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.[151,152,155,159-161,165–167] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; ACCF, American College of Cardiology Foundation; ACS, acute coronary syndrome; AHA, American Heart Association; CABG, coronary artery bypass graft; CR, cardiac rehabilitation; CSA, central sleep apnea; CVD, cardiovascular disease; EHR, electronic health record; HIPAA, Health Insurance Portability and Accountability Act of 1996; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NSTE-ACS, non–ST-segment–elevation acute coronary syndrome; PCI, percutaneous coronary intervention; PM, performance measure; SCAI, Society for Cardiovascular Angiography and Interventions; and STEMI, ST-segment–elevation myocardial infarction.

Appendix A.   Continued

Quality Measures for Coronary Artery Revascularization

Short Title: QM-1: Shared Decision-Making and Informed Consent

QM-1: Shared Decision-Making and Informed Consent

Measure Description: Percentage of patients, age ≥18 y, with significant coronary artery disease should be engaged in a patient-centered, culturally sensitive SDM process about treatment options before obtaining informed consent	
Numerator	Patients with significant CAD who are engaged in patient-centered, culturally sensitive SDM (including discussion of risks and benefits of all treatment options) as part of the decision process
Denominator	Patients age ≥18 y with significant CAD who are being considered for a revascularization procedure (CABG or PCI)
Denominator Exclusions	Patients who have a clear and unwavering preference for 1 treatment option versus another, patients who leave against medical advice, death during hospitalization
Denominator Exceptions	Documentation of a medical reason(s) (eg, emergency situation such that the patient or their designated health care advocate cannot participate in SDM)
Measurement Period	Period of care: Index procedure, hospitalization, or pre-revascularization office visit Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner
Care Setting	Inpatient Outpatient (in the case of an office visit to discuss options)

Rationale
SDM is vital to patient-centered care. SDM improves patients' understanding of treatment options, increases realistic expectations of benefits and harms, stimulates engagement in decision-making, and improves concordance between patients' values and treatment choices.[168–171] Cultural sensitivity is crucial to SDM because cultural values influence patient preferences and decisions. Incorporating patient preferences into the decision-making process improves patient well-being through better treatment adherence and higher satisfaction with health outcomes.[172–174] Completing the Seattle Angina Questionnaire[175] may help patients understand their level of impairment before revascularization and improvement after revascularization. Physicians must provide evidence-based estimates of risks, benefits, and costs of therapeutic options.[24,176,177] Procedure-related and long-term risks and benefits such as survival, quality of life, the need for late reintervention, and uncertainties associated with different treatment strategies should be discussed with patients and significant others before obtaining informed consent.[176] Patients should be clearly informed of the continuing need for medical therapy with or without revascularization, as well as lifestyle modification and other secondary prevention strategies (see section on cardiac rehabilitation).[24,158] In some situations when diagnostic catheterization reveals high-risk anatomy or when the superiority of PCI as compared with other treatments is uncertain, deferral of PCI until additional discussions ensue may be appropriate. The interventionalist is responsible for acting in the patient's best interest in these circumstances, considering all treatment options, consulting with additional specialists when appropriate, avoiding unnecessary interventional procedures, and allowing patients to consult with family members.[25,26]

Clinical Recommendation(s)
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3] 1. In patients undergoing revascularization, decisions should be patient centered–that is, considerate of the patient's preferences and goals, cultural beliefs, health literacy, and social determinants of health–and made in collaboration with the patient's support system.[178,179] (Class 1, Level of Evidence: C-LD) 2.. In patients undergoing coronary angiography or revascularization, adequate information about benefits, risks, therapeutic consequences, and potential alternatives in the performance of percutaneous and surgical myocardial revascularization should be given, when feasible, with sufficient time for informed decision-making to improve clinical outcomes.[173,180,181] (Class 1, Level of Evidence: C-LD)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; CAD, coronary artery disease; EHR, electronic health record; PCI, percutaneous coronary intervention; QM, quality measure; SCAI, Society for Cardiovascular Angiography and Interventions; and SDM, shared decision-making.

Appendix A.   Continued

Short Title: QM-2: Periprocedural Hydration in Cardiovascular Angiography

QM-2: Use of Periprocedural Hydration Therapy to Reduce the Risk of AKI After Cardiovascular Angiography or Intervention

Measure Description: Percentage of patients, age ≥18 y, who have an eGFR of ≤60 mL/min per 1.73 m2 and are administered periprocedural hydration therapy*	
*"Periprocedural" is used to acknowledge the importance of hydration before and after contrast administration. Although the term periprocedural is not used in the cited clinical practice guidelines, the writing committee felt this term better characterized the role of hydration therapy in altering the risk of contrast-induced AKI.	
Numerator	Patients undergoing cardiovascular angiography or intervention with an eGFR ≤60 mL/min per 1.73 m² in whom periprocedural hydration therapy* was administered within 12 h pre- and postprocedure
Denominator	Patients age ≥18 y undergoing cardiovascular angiography or intervention with an eGFR ≤60 mL/min per 1.73 m²
Denominator Exclusions	Refusal of periprocedural intravenous access, refusal to stay for the prescribed time period for postprocedure intravenous hydration therapy
Denominator Exceptions	Documentation of a medical reason(s) (eg, patients who are hypervolemic [eg, acute decompensated heart failure, euvolemic patients with HFpEF and elevated LVEDP], significant valvular heart disease, need for hemodialysis, patients with eGFR >60 mL/min/1.73 m²)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

AKI after cardiovascular angiography and interventions is associated with a markedly worse 1-y mortality rate, and mortality rates increase with lower eGFR (eGFR 30-60, 7% versus 19.9%; eGFR 15-30, 14.9% versus 44.1%; eGFR <15, 21.1% versus 62.5% 1-y mortality rate for patients without versus with postprocedure AKI).[182] The only strategies shown to reduce the risk of postprocedural AKI is contrast minimization and optimization of periprocedural hydration therapy, while radial artery access has been shown to be associated with lower risk of postprocedural AKI. A randomized trial of 1620 patients showed that use of isotonic (versus half-isotonic) hydration therapy reduced rate of postprocedure AKI from 2% to 0.7%.[183] In the POSEIDON trial (n=396), patients with CKD who were randomized to LVEDP-guided hydration therapy with mean volume 1727 mL normal saline solution (versus standard hydration with mean volume 812 mL normal saline solution) had a lower rate of postprocedure AKI from 16.3% to 6.7% and a lower rate of 6-mo all-cause mortality from 4% to 0.5%.[184] Similarly, the HYDRA study (n=303) randomized patients with low body fluid level to standard saline solution or double volume saline solution and showed a reduction in postprocedure AKI from 22.3% to 11.5% with double volume saline solution.[185]

Clinical Recommendation(s)

2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention[26]
1. Patients undergoing cardiac catheterization with contrast media should receive adequate preparatory hydration.[183,186–188] (Class 1, Level of Evidence: B)
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients with CKD undergoing contrast media injection for coronary angiography, measures should be taken to minimize the risk of contrast-induced acute kidney injury (AKI).[189–191] (Class 1, Level of Evidence: C-LD)

ACC indicates American College of Cardiology; ACCF, American College of Cardiology Foundation; AHA, American Heart Association; AKI, acute kidney injury; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; EHR, electronic health record; HFpEF, heart failure with preserved ejection fraction; HYDRA, Bioimpedance-Guided Hydration for the Prevention of Contrast-Induced Kidney Injury study; LVEDP, left ventricular end-diastolic pressure; POSEIDON, Prevention of Contrast Renal Injury with Different Hydration Strategies trial; QM, quality measure; and SCAI, Society for Cardiovascular Angiography and Interventions.

Appendix A.   Continued

Short Title: QM-3: Smoking Cessation After Revascularization

QM-3: Smoking Cessation in Patients After Revascularization

Measure Description: Percentage of patients, age ≥18 y, who are current smokers at the time of revascularization, who have medical or behavioral therapy aimed at smoking cessation initiated within 1 mo of the index revascularization procedure. This can be prescription of a smoking cessation medication or enrollment in a smoking cessation program.	
Numerator	Patients who report current smoking at the time of revascularization and who have medical or behavioral therapy aimed at smoking cessation initiated within 1 mo of the index revascularization procedure
Denominator	Patients age ≥18 y with current smoking at the time of revascularization
Denominator Exclusions	Patient refusal, patients who are unwilling to quit smoking or have already quit smoking after revascularization, lost to follow-up, patients who leave against medical advice, patients who are discharged to hospice or long-term acute care or skilled nursing facility or other acute care facility, patients who die within 1 mo of revascularization
Denominator Exceptions	None
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

Smoking is a major cardiovascular disease risk factor as well as a driver of excess morbidity and mortality.[192] Continued smoking after coronary revascularization is associated with worse clinical outcomes compared with abstention from smoking.[193] Recommendations for smoking cessation counseling and treatment as described in the "2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease"[168] can also apply to secondary prevention after coronary revascularization. Smoking cessation therapies as outlined in the US Public Health Service's "A Clinical Practice Guideline for Treating Tobacco Use and Dependence"[194] include behavioral interventions as well as pharmacological interventions, such as bupropion, varenicline, or nicotine replacement. When smokers receive counseling during an index hospitalization with supportive follow-up for ≥1 mo after discharge, smoking cessation rates increase significantly.[195]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients who use tobacco and have undergone coronary revascularization, a combination of behavioral interventions plus pharmacotherapy is recommended to maximize cessation and reduce adverse cardiac events.[196–198] (Class 1, Level of Evidence: A)
2. In patients who use tobacco and have undergone coronary revascularization, smoking cessation interventions are recommended during hospitalization and should include supportive follow-up for at least 1 month after discharge to facilitate tobacco cessation and reduce morbidity and mortality.[192,195,199] (Class 1, Level of Evidence: A)

ACC indicates American College of Cardiology; AHA, American Heart Association; EHR, electronic health record; QM, quality measure; and SCAI, Society for Cardiovascular Angiography and Interventions.

Appendix A.   Continued

Short Title: QM-4: Risk Assessment Before CABG

QM-4: Surgical Risk Assessment Before Myocardial Revascularization

Measure Description: Percentage of patients, age ≥18 y, being considered for CABG in whom calculation of the STS risk score is performed	
Numerator	Patients being considered for CABG with an STS risk assessment score calculated before revascularization* *Measuring the STS risk score is part of the process for determining the "best/preferred/optimal" revascularization choice for each individual patient. Determining the predicted surgical risk of death with CABG before deciding whether surgical or percutaneous revascularization is the best choice is an integral part of obtaining informed consent regarding the risks, benefits, and alternatives. This is closely integrated with the work of the Heart Team.
Denominator	Patients age ≥18 y who are being considered for CABG
Denominator Exclusions	Patients who refuse to undergo CABG
Denominator Exceptions	Documentation of a medical reason(s) (eg, need for emergency revascularization, cardiogenic shock, refractory arrhythmia, or other hemodynamic instability that precludes discussion of operative risk before revascularization)
Measurement Period	All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

CABG surgery should be performed for symptomatic benefit, prognostic benefit, or both. When revascularization options include surgery, the decision to perform CABG depends on the assessment of risks and benefits. This can be facilitated by a Heart Team approach, including the primary cardiologist, interventional cardiologist and cardiac surgeon, and the patient. When the patient has an indication for surgical myocardial revascularization, surgical risk as calculated by the STS Risk Calculator offers a validated and objective tool to estimate the risk of death and major morbidities for each individual patient undergoing CABG based on clinical factors.

The STS Risk Calculator estimates are one source of information in decision-making for patients being considered for myocardial revascularization. Excluding patients from surgery based on higher risk derived from a single characteristic is inappropriate. Numerous patient factors also are not incorporated into the STS Risk Calculator (eg, cirrhosis, frailty, and malnutrition).

The STS risk score has been validated in several studies and shows excellent predictive value for estimating risk of adverse events.[200–202] The STS risk score serves as a useful tool when a choice is being made among various treatment strategies because it allows the clinician, the patient, and the patient's family to have a reasonable estimate of operative risk. The STS risk score performs better than the EuroSCORE II for the patient population with CABG, particularly at higher (>5%) predicted mortality rates.[200,203] Commonly used cardiac surgery risk models, such as the STS and EuroSCORE II, are limited in assessing the influence of risk factors, including cirrhosis, frailty, and malnutrition, on outcome. Patients with liver cirrhosis, frailty, and malnutrition have increased risk of perioperative morbidity and mortality after cardiac surgery[204–215] and may be assessed by other tools.

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]
1. In patients who are being considered for CABG, calculation of the Society of Thoracic Surgeons (STS) risk score is recommended to help stratify patient risk.[200,203] (Class 1, Level of Evidence: B-NR)

ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; EHR, electronic health record; EuroSCORE, European System for Cardiac Operative Risk Evaluation II; QM, quality measure; SCAI, Society for Cardiovascular Angiography and Interventions; and STS, Society of Thoracic Surgeons.

Appendix A.   Continued

Short Title: QM-5: Reduction of AF After CABG

QM-5: Beta Blockers for the Reduction of AF After CABG

Measure Description: Percentage of patients, age ≥18 y, who were prescribed a beta blocker before or as soon as possible after CABG surgery to reduce the incidence or clinical sequelae of postoperative AF	
Numerator	Patients who receive beta-blocker therapy before or as soon as possible after CABG
Denominator	Patients age ≥18 y who undergo CABG
Denominator Exclusions	Patient refusal, patients who leave against medical advice, patients who die
Denominator Exceptions	Documentation of a medical reason(s) (eg, allergy, intolerance to therapy, contraindication to use of beta blockers [such as symptomatic sinus bradycardia or second-degree atrioventricular block], hypotension, or borderline low BP)
Measurement Period	Period of care: Index procedure or hospitalization Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient or outpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient
Rationale	
Postoperative AF occurs in about 18% of patients after CABG and is associated with a 4-fold increased risk of stroke and a 3-fold increase in all-cause mortality rate.[216,217] Postoperative AF after CABG can be challenging to prevent and treat. RCTs examining postoperative beta blockers did not show any impact on cardiovascular morbidity and mortality rates. A large meta-analysis with 7768 patients undergoing cardiac surgery found that beta blocker use may reduce the incidence of AF and ventricular arrhythmias and hospital stay but found no evidence of a difference in rates of early all-cause death, MI, cerebrovascular events, hypotension, or bradycardia.[218]	
Clinical Recommendation(s)	
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3] 1. In patients after CABG, beta blockers are recommended and should be started as soon as possible to reduce the incidence or clinical sequelae of postoperative atrial fibrillation.[25,219–224] (Class 1, Level of Evidence: B-R)	

   ACC indicates American College of Cardiology; AF, atrial fibrillation; AHA, American Heart Association; BP, blood pressure; CABG, coronary artery bypass graft; EHR, electronic health record; MI, myocardial infarction; QM, quality measure; RCT, randomized controlled trial; and SCAI, Society for Cardiovascular Angiography and Interventions.

Appendix A.   Continued

Structural Measures for Coronary Artery Revascularization

Short Title: SM-1: Preprocedural Assessment and the Heart Team

SM-1: Preprocedural Assessment by a Heart Team for Patients in Whom the Optimal Treatment Is Unclear

Measure Description: Percentage of patients, age ≥18 y, with significant CAD in whom the optimal treatment strategy is unclear who have a treatment recommended based on a Heart Team discussion (including, but not limited to, representatives from interventional cardiology, cardiac surgery, and clinical cardiology)	
Numerator	Patients with significant CAD for whom the optimal treatment strategy is unclear who undergo treatment based on a Heart Team discussion during the index hospitalization
Denominator	Patients age ≥18 y with significant CAD in whom the optimal treatment strategy is unclear
Denominator Exclusions	Patients who die before a meeting of the Heart Team
Denominator Exceptions	None
Measurement Period	Period of care: Index procedure, hospitalization, or pre-revascularization outpatient visit Period of observation: All cases accumulated over a 12-mo period
Sources of Data	EHR data Administrative data/claims (inpatient claims) Administrative data/claims expanded (multiple sources) Paper medical record
Attribution	Individual practitioner Facility
Care Setting	Inpatient Outpatient

Rationale

Observational studies using the Heart Team have included interventional cardiology, cardiac surgery, and noninvasive cardiologists.[225–229] Additional professionals who offer input may include the patient's primary physician, as well as palliative care, critical care, anesthesiology, and imaging specialists. Observational studies have shown favorable outcomes when the Heart Team was used in cases of unprotected left main disease, triple-vessel disease, double-vessel disease involving the proximal LAD artery, or single-vessel disease involving the proximal LAD artery in the context of diabetes, or in cases in which the referring physician requested such evaluation.[229–233] Heart Team decisions are generally reproducible[228] and associated with good outcomes.[226,229]

Clinical Recommendation(s)

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3]

1. In patients where the optimal treatment strategy is unclear, a Heart Team approach that includes representatives from interventional cardiology, cardiac surgery, and clinical cardiology is recommended to improve patient outcomes.[225–229,232,233] (Class 1, Level of Evidence: B-NR)

ACC indicates American College of Cardiology; AHA, American Heart Association; CAD, coronary artery disease; EHR, electronic health record; LAD, left anterior descending; SCAI, Society for Cardiovascular Angiography and Interventions; and SM, structural measure.

Appendix A.   Continued

Short Title: SM-2: Registry Participation

SM-2: Assessment of Outcomes in Patients After Revascularization

Measure Description: Indicates the participation in state, regional, and national clinical data registries and receipt of periodic reports of their risk-adjusted outcomes as a quality assessment and improvement strategy	
Numerator	Does the facility participate in a national or regional revascularization clinical data registry for PCI and CABG and receive periodic reports of their risk-adjusted outcomes? (yes/no) Examples of such registries include the STS Database, the NCDR, VA CART, and individual state databases
Denominator	Not applicable
Denominator Exclusions	None
Denominator Exceptions	None
Measurement Period	Period of observation: All cases accumulated over a 12-mo period
Sources of Data	Facility attestation
Attribution	Facility
Care Setting	Inpatient Outpatient

Rationale
Myocardial revascularization, whether by PCI or CABG, is an inherently significant clinical intervention with quality and quantity of life ramifications for patients with measurable outcomes. Because the goal of these procedures should be the optimal outcome for patients and because the procedures themselves continue to evolve and improve, monitoring risk-adjusted outcomes and process measures as offered by state, regional, and national registries is an integral component of a quality program. Participation in regional, state, or national registries that provide regular, risk-adjusted outcomes is beneficial in quality assessment and improvement. It allows participants to compare their performance to regional or national validated benchmarks, identify opportunities for improvement, and disseminate best practices.[234–241]

Clinical Recommendation(s)
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization[3] 1. With the goal of improving patient outcomes, it is recommended that cardiac surgery and PCI programs participate in state, regional, or national clinical data registries and receive periodic reports of their risk-adjusted outcomes as a quality assessment and improvement strategy.[234–241] (Class 1, Level of Evidence: B-NR)

   ACC indicates American College of Cardiology; AHA, American Heart Association; CABG, coronary artery bypass graft; NCDR, National Cardiovascular Disease Registry; PCI, percutaneous coronary intervention; SCAI, Society for Cardiovascular Angiography and Interventions; SM, structural measure; STS, Society of Thoracic Surgeons; and VA CART, Veterans Affairs Clinical Assessment Reporting and Tracking.

Appendix B. Author Relationships With Industry and Other Entities (Relevant)–2023 AHA/ACC Clinical Performance and Quality Measures for Coronary Artery Revascularization

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Gregory J. Dehmer, Chair	Carilion Clinic–Cardiology–Medical Director, Quality and Outcomes, Cardiovascular Institute	None	None	None	None	None	None
Cindy L. Grines, Vice Chair	Northside Cardiovascular Institute–Chief Scientific Officer	• Abiomed • Philips (Volcano)*	None	None	• Abiomed* • Boston Scientific*	None	None
Faisal G. Bakaeen, AATS Representative	Cleveland Clinic–Cardiac Surgeon, Department of Thoracic and Cardiovascular Surgery, Sydell and Arnold Miller Family Heart, Vascular & Thoracic Institute	None	None	None	None	None	None
Dorian L. Beasley	Community Health Network, Adult General and Interventional Cardiology	None	None	None	None	None	None
Theresa M. Beckie, ACC/AHA Revascularization Guideline Liaison	University of South Florida, College of Nursing–Professor and Director of PhD Program; College of Medicine–Professor, Division of Cardiovascular Sciences	None	None	None	None	None	None
Jack Boyd	Stanford University–Clinical Associate Professor, Cardiothoracic Surgery, Department of Cardiothoracic Surgery	None	None	None	None	None	None
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Sandeep R. Das, JCPM Liaison	UT Southwestern Medical Center–Professor of Medicine	None	None	None	None	None	None
Rebecca L. Diekempert	AHA/ACC Science and Health Advisor, Performance Measures	None	None	None	None	None	None
Jennifer Frampton	Yale School of Medicine–Assistant Professor of Medicine (Cardiovascular Medicine)	None	None	None	None	None	None
Connie N. Hess	University of Colorado Medicine–Associate Professor, Medicine–Cardiology	None	• Amgen‡	None	• Amgen‡ • Bayer‡ • Janssen‡	None	None
Nkechinyere Ijioma	Mayo Clinic College of Medicine and Science–Assistant Professor of Medicine, Senior Associate Consultant–Cardiology; Mayo Clinic Health System, La Crosse WI–Cardiologist; Massachusetts General Hospital, Boston MA–Fellow-in-Training	None	None	None	None	None	None
Jennifer S. Lawton, ACC/AHA Revascularization Guideline Liaison	Johns Hopkins Medicine–Chief, Division of Cardiac Surgery; Professor of Surgery	None	None	None	None	None	None
Binita Shah, SCAI Representative	NYU Grossman School of Medicine–Associate Professor, Department of Medicine; Director, Internal Medicine Residency Research; Associate Director of Research for the Cardiac Catheterization Laboratory	• Terumo	None	None	None	• Philips (Volcano)	None

Appendix B. Continued

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Nadia R. Sutton, JCCDS Liaison	Vanderbilt University–Interventional Cardiology Research; Assistant Professor, Division of Cardiovascular Medicine	• Abbott • Siemens • Zoll‡	None	None	None	• Cordis • Philips • Shockwave • Stallion* • Teleflex*	None

This table represents the relationships of committee members with industry and other entities that were determined to be relevant to this document. These relationships were reviewed and updated in conjunction with all meetings and/or conference calls of the writing committee during the document development process. The table does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of ≥5% of the voting stock or share of the business entity, or ownership of ≥$5000 of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. Relationships that exist with no financial benefit are also included for the purpose of transparency. Relationships in this table are modest unless otherwise noted.

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*No financial benefit.

†Rebecca Diekemper is an AHA/ACC joint staff member and acts as the Science and Health Advisor for the "2023 AHA/ACC Clinical Performance and Quality Measures for Coronary Artery Revascularization." No relevant relationships to report. Nonvoting author on measures and not included/counted in the RWI balance for this committee.

‡Significant relationship.

AATS indicates American Association for Thoracic Surgery; ACC, American College of Cardiology; AHA, American Heart Association; JCCDS, Joint Committee on Clinical Data Standards; JCPM, Joint Committee on Performance Measures; NYU, New York University; SCAI, Society for Cardiovascular Angiography and Interventions; and UT, University of Texas.

Appendix C.   Reviewer Relationships With Industry and Other Entities (Comprehensive)–2023 AHA/ACC Clinical Performance and Quality Measures for Coronary Artery Revascularization

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Dominick J. Angiolillo	AHA/ACC Content Reviewer	University of Florida College of Medicine	• Amgen* • AstraZeneca* • Bayer* • Biosensors • Boehringer Ingelheim* • Bristol Myers Squibb* • Chiesi* • Daiichi-Sankyo • Eli Lilly • Haemonetics • Janssen Pharmaceuticals* • Merck • Novartis* • Pfizer • Phasebio • PLx Pharma* • Sanofi* • Vectura*	None	None	• Amgen* • AstraZeneca* • Bayer* • Biosensors* • CSL Behring* • Idorsia* • Janssen Pharmaceuticals* • Scott R. MacKenzie Foundation*	• ABIM • *JACC*, Associate Editor* • NIH (DSMB)	None
James C. Blankenship	AHA/ACC Content Reviewer	University of New Mexico Health Sciences	None	None	None	• Therox, PI† • Zoll, PI†	• ABIM • ACC Representative† • CMS† • USDHHS	None
Jeffrey Bruckel	ACC/AHA JCPM Lead Reviewer	University of Rochester Medical Center	• Asahi Intecc • Avant-Garde Health	None	None	• NIH*	• NIH	None
Ravi Kiran Ghanta	AATS Official Reviewer	Baylor College of Medicine	None	None	None	• AHA • NIH	None	None
Hitinder S. Gurm	AHA/ACC Content Reviewer	University of Michigan Health	• Osprey Medical*	None	• Amplitude Vascular* • Jiaxing Bosch Medical Technology Partnership*	• Blue Cross Blue Shield of Michigan* • Contego Medical (DSMB)* • NIH*	None	None
Rani K. Hasan	AHA Official Reviewer	Johns Hopkins Medicine	None	None	None	• Abbott† • Medtronic†	• CTSN‡ • Edwards Lifesciences‡ • Medtronic‡ • V-Wave Medical‡	None
Paul A. Heidenreich	AHA/ACC Content Reviewer	Stanford VA Palo Alto Health Care System	None	None	None	• Gordon Betty Moore Foundation* • ICER • Palo Alto Veterans Institute for Research† • US Department of Veterans Affairs*	• US Department of Veterans Affairs*	None
David R. Holmes Jr	AHA/ACC Content Reviewer	Mayo Clinic	None	None	None	None	None	None
Dharam J. Kumbhani	SCAI Official Reviewer	UT Southwestern Medical Center	• ACC*	None	None	None	• *Circulation*, Associate Editor*	None
Shahar Lavi	ACC Official Reviewer	London Health Sciences Centre	• Abbott	None	None	None	None	None

(*Continued*)

Appendix C. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Kreton Mavromatis	ACC Official Reviewer	Emory Healthcare	None	None	None	None	• AstraZeneca‡ • CSL Behring‡	None
Frank J. Rybicki	AHA Official Reviewer	University of Cincinnati College of Medicine	None	None	• Imagia*	None	None	None
Craig R. Smith	AHA/ACC Content Reviewer	Columbia University	None	None	None	None	None	None
John A. Spertus	AHA/ACC Content Reviewer	St. Luke's Mid America Heart Institute	• AstraZeneca* • Bayer* • Bristol-Myers Squibb* • Eli Lilly • Janssen Pharmaceuticals* • Merck* • Novartis* • Pfizer† • Terumo • United Healthcare	None	• Copyright for SAQ, KCCQ, PAQ*	• ACC* • Myokardia*	• Abbott • ACC† • AHA† • Blue Cross Blue Shield*	None
Thoralf M. Sundt III	AHA/ACC Content Reviewer	Massachusetts General Hospital	None	None	None	None	• Unify Medical†	None

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*Significant relationship.

†No financial benefit.

‡This disclosure was entered under the Clinical Trial Enroller category in the ACC's disclosure system.

AATS indicates American Association for Thoracic Surgery; ABIM, American Board of Internal Medicine; ACC American College of Cardiology; AHA, American Heart Association; CMS, Centers for Medicare & Medicaid Services; CTSN, Cardiothoracic Surgical Trials Network; DSMB, Data and Safety and Monitoring Board; ICER, Institute for Clinical and Economic Review; *JACC, Journal of the American College of Cardiology*; JCPM, Joint Committee on Performance Measures; KCCQ, Kansas City Cardiomyopathy Questionnaire; NHLBI, National Heart, Blood, and Lung Institute; NIH, National Institutes of Health; PAQ, Peripheral Artery Questionnaire; PI, personal investigator; SAQ, Seattle Angina Questionnaire; SCAI, Society for Cardiovascular Angiography and Interventions; USDHHS, US Department of Health and Human Services; UT, University of Texas; and VA, Veterans Affairs.