

CCS Guidelines and Position Statements

Canadian Cardiovascular Society/Canadian Association of Interventional Cardiology/Canadian Society of Cardiac Surgery Position Statement on Revascularization—Multivessel Coronary Artery Disease

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ABSTRACT

This position statement addresses issues in revascularization for multivessel coronary artery disease (CAD) from the perspective of both cardiologists and cardiac surgeons. Recommendations are made based on evidence from clinical trials and observational studies, with an emphasis on the increasing number of individuals with significant comorbid disease burden and functional debilitation who are being referred for definitive management of their multivessel CAD in the context of routine clinical practice. These types of individuals have traditionally not been included in the many clinical trials that have been the basis for guidelines and recommendations, and the objective of the proposed medical intervention or revascularization (or both) would not necessarily be to improve prognosis but to improve quality of life. One purpose of this document is to propose practical multidisciplinary approaches to the management of these patients. Recommendations are made for revascularization in acute coronary syndromes and stable CAD, with specific considerations for individuals with left ventricular dysfunction and heart failure, chronic renal failure, and chronic obstructive pulmonary disease. We also consider the use of various risk scores, including the Society of Thoracic Surgeons score, the EuroSCORE, and the SYNTAX II score. The importance of a heart team approach is also emphasized. The complementary role of coronary bypass surgery and percutaneous coronary intervention is highlighted, along with the importance of optimal medical therapy.

Coronary artery disease (CAD) is a major cause of morbidity and mortality in Canada. In 2011, 29% of all deaths were caused by cardiovascular disease; 54% of these were a result of ischemic heart disease.¹ Technical and scientific advances in the field of coronary revascularization have created new areas of evidence and unique challenges with uncertainty, particularly with respect to the current optimal management of multivessel CAD. This position paper serves to provide summary guidance to cardiovascular clinicians in this important and complex area.

The overarching independent, but often complementary, goals of revascularization for multivessel CAD are to improve prognosis or enhance quality of life, or both. By definition, patients with multivessel CAD have advanced epicardial coronary atherosclerosis. Thus, a fundamental principle of multivessel coronary revascularization is that it be pursued in concert with long-term comprehensive secondary prevention therapies and durable supervised lifestyle interventions. Over the past 3 decades, randomized and observational data have provided a foundation for evidence-based revascularization in multivessel CAD. Both surgical and percutaneous revascularization techniques and technologies, however, continually evolve, with improvements that sometimes call into question the applicability of older trial and registry data. Moreover, patient-specific variables—such as coronary anatomy, left ventricular (LV) function, comorbidities, frailty, and personal circumstances—must be integrated into evidence-based decision-making strategies. Thus, the totality of historical and contemporary evidence guiding multivessel revascularization is best approached by following best available evidence and clinical reasoning rather than a prescriptive algorithm.

RÉSUMÉ

Cet énoncé de position traite des questions de revascularisation pour la coronaropathie plurivasculaire à la fois du point de vue des cardiologues et des chirurgiens cardiaques. Les recommandations sont basées sur les résultats d'essais cliniques et d'études observationnelles, en mettant l'accent sur le nombre croissant de personnes supportant une comorbidité importante et une infirmité fonctionnelle qui se voient référées pour la gestion définitive de leur coronaropathie plurivasculaire dans le contexte d'une pratique clinique de routine. Cette catégorie d'individus n'a traditionnellement pas été incluse dans les nombreux essais cliniques à la base des lignes directrices et des recommandations. L'objectif de l'intervention médicale ou de la revascularisation proposée ne viserait pas nécessairement à améliorer le pronostic, mais à améliorer la qualité de vie. Un des objectifs de ce document est de proposer des approches multidisciplinaires pratiques pour la prise en charge de ces patients. Nous faisons les recommandations pour la revascularisation dans le contexte des syndromes coronariens aigus et de coronaropathie stable, avec des considérations spécifiques pour les personnes ayant une dysfonction ventriculaire gauche et une insuffisance cardiaque, une insuffisance rénale chronique, et une maladie pulmonaire obstructive chronique. Nous considérons également l'emploi de divers scores de risque, y compris les scores de la Société des chirurgiens thoraciques, ceux d'EuroSCORE, et de SYNTAX II. L'importance d'une approche par une équipe multidisciplinaire pour des soins cardiaques est également soulignée. Le rôle complémentaire de la chirurgie de pontage coronarien et de l'angioplastie coronaire est mis en évidence, ainsi que l'importance du traitement médical optimal.

The purpose of this position statement is to make recommendations for the rational evidence-based use of revascularization in patients with multivessel CAD. To accomplish this, we (1) reviewed the current literature directly relevant to the management of patients with multivessel CAD and (2) identified common issues that are encountered when making decisions regarding a specific revascularization strategy. Technical issues about optimal revascularization of distal vessel quality (surgical targets), bifurcations, and chronic total occlusions are evolving and cannot be addressed in this document. This joint position statement was written and reviewed by cardiologists and cardiac surgeons representing the Canadian Cardiovascular Society, the Canadian Association of Interventional Cardiology, and the Canadian Society of Cardiac Surgeons.

Evidence for Revascularization in Multivessel CAD

Revascularization vs medical therapy in acute coronary syndromes

Randomized clinical trials have individually and on aggregate proved that routine early revascularization, in particular primary percutaneous coronary intervention (PCI), reduces death or nonfatal myocardial infarction (MI) in patients presenting with ST-segment elevation myocardial infarction (STEMI).² In acute coronary syndromes without STEMI, early angiography and appropriate revascularization have been found to reduce death or nonfatal MI.³ No studies specifically targeted patients with non-STEMI (NSTEMI) and multivessel CAD. Nevertheless, approximately 40% of

Changing pattern of revascularization in non-STE ACS since 1990

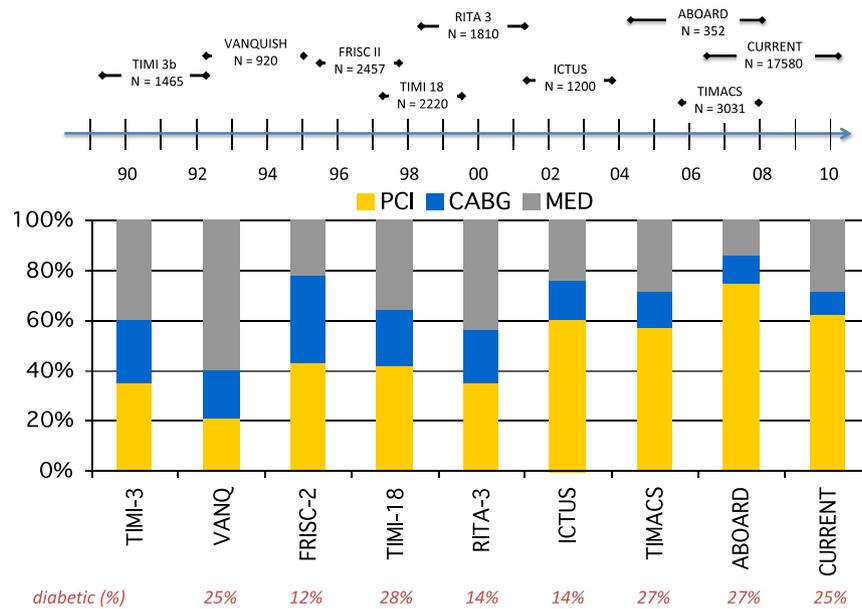


Figure 1. Changing pattern of revascularization 1990-2008, compiled with published data from various trials. ABOARD, Angioplasty to Blunt the Rise of Troponin in Acute Coronary Syndromes Randomized for an Immediate or Delayed Intervention trial; FRISC II, Fast Revascularization During Instability in Coronary Artery Disease trial; ICTUS, Invasive Versus Conservative Treatment in Unstable Coronary Syndromes trial; RITA-3, Randomized Intervention Trial of Unstable Angina 3 trial; TIMI-3, Thrombolysis in Myocardial Ischemia III trial; TIMI-18, Thrombolysis in Myocardial Ischemia 18 trial; TMACS, Timing of Intervention in Acute Coronary Syndromes trial; VANQUISH, Veterans Affairs Non-Q-Wave Myocardial Infarction Strategies in Hospital trial; CURRENT, Clopidogrel and Aspirin Optimal Dose Usage to Reduce Recurrent Events trial.

patients who enrolled before coronary anatomy was studied were found to have multivessel CAD at protocol angiography. The proportion of patients with NSTEMI treated with PCI has been rising, with more than 60% of patients receiving PCI in recently reported trials (Fig. 1). These observations suggest that both PCI and coronary artery bypass grafting (CABG) likely provide incremental benefits over medical therapy in

patients with NSTEMI and multivessel CAD. Less clear is the need for complete vs culprit-vessel-only revascularization. Identification of the culprit lesion in NSTEMI is sometimes challenging. In such cases, a strategy of complete revascularization is both reasonable and consistent with practices used in the relevant trials, but it is the subject of ongoing studies.

In the setting of emergent PCI for STEMI, current guidelines based on observational data alone restrict acute interventions to the infarct-related artery in hemodynamically stable patients with multivessel CAD. The Preventive Angioplasty in Acute Myocardial Infarction (PRAMI) trial (n = 465) recently tested the converse strategy, randomly assigning patients with STEMI and multivessel CAD to complete acute revascularization (infarcted and major noninfarcted arteries, a strategy of “preventive PCI”) vs conventional infarcted artery PCI alone.⁴ The trial was stopped early after a mean follow-up of 23 months when the primary outcome of cardiac death, MI, or refractory angina occurred significantly less frequently in the preventive PCI approach group (9.0% vs 22.9%). However, data from larger numbers of nonrandomized patients undergoing the procedure were less conclusive.^{5,6} It remains unclear whether this single small trial will influence a revision of practice guidelines. A larger clinical trial addressing the same questions is ongoing.

When a culprit lesion has been treated by PCI on a background of multivessel CAD, the extent and nature of the residual anatomic and ischemic burden spans a wide spectrum. Until ongoing trials provide specific guidance, present management should be individualized based on a patient’s clinical course as well as residual ischemia, residual anatomic complexity, vocational needs, recreational expectations, and

RECOMMENDATIONS FOR REVASCULARIZATION IN ACUTE CORONARY SYNDROMES

- We recommend early culprit-lesion revascularization with PCI, with minimal delay, in patients with STEMI. (Strong recommendation, high-quality evidence.)
- We recommend early culprit-lesion revascularization with PCI or early complete revascularization with CABG in most patients with acute coronary syndromes other than STEMI, depending on relative stability and anatomy. (Strong recommendation, moderate-quality evidence.)

Values and Preferences: When a culprit lesion has been treated by PCI on a background of multivessel CAD, and there is uncertainty about the residual multivessel disease, eg, residual ischemia and anatomic complexity, it is reasonable to treat the culprit lesion and delay decisions on nonculprit lesions in a staged PCI procedure until the acute threat has resolved.

global risk. In circumstances of uncertainty in patients with multivessel disease, it is reasonable to treat the culprit lesion and delay decisions on nonculprit lesions until the acute threat has resolved.

Revascularization vs medical therapy in stable CAD

The results of early clinical trials of CABG vs medical therapy demonstrated that patients with high-risk multivessel CAD and left main CAD, particularly those with impaired LV function, benefited from CABG when compared with medical therapy alone.⁷ These landmark results continue to influence modern decisions on referring patients for CABG. Importantly, however, these trials were undertaken before the routine use of modern secondary prevention medications, structured risk-reduction programs, and standard use of internal mammary artery grafts.

Studies comparing PCI with medical therapy have been less conclusive.⁸ Because it is routine practice for all patients with CAD to receive secondary prevention medication, the issue is the incremental benefit of PCI on the background of routine medical therapy in all participants. The **Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE)** trial randomized eligible patients to routine PCI plus comprehensive optimal medical therapy or optimal medical therapy alone as an initial strategy in a cohort with an equal mix of single-, double-, and triple-vessel CAD, which allowed about one third of patients randomized to optimal medical therapy to cross over to PCI. The long-term major clinical outcome of death and acute MI did not differ between the 2 groups.⁹ The **Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI-2D)** trial, using a similar design, randomized patients with diabetes and stable CAD to a strategy of optimal medical therapy with the option of subsequent revascularization (PCI or CABG). After average follow-up to 5.3 years, the primary outcome of all-cause death and main secondary outcomes (all-cause death and composite of death, MI, or stroke) did not differ between the 2 strategies.¹⁰

The addition of coronary pressure-derived fractional flow reserve appeared to enhance outcome during PCI in symptomatic patients in the **Fractional Flow Reserve vs Angiography for Multivessel Evaluation 2 (FAME 2)** trial, which was stopped prematurely when the PCI group had a significant benefit compared with the group on optimal medical therapy only. This was primarily based on the end point of urgent revascularization, leaving the question of whether a narrower end point composed of only hard events, similar to COURAGE and BARI-2D, would show benefit.

Many of the CABG vs medical therapy trials may no longer be applicable to contemporary practice. With the exception of the recent BARI-2D trial (surgical arm), which used optimal medical therapy, routine medical therapy administered in the other trials was not nearly as intensive or systematic as that provided in the more recent trials comparing PCI to medical therapy. The latter studies provided intensive state-of-the-art medical therapy to all patients regardless of treatment arm, a difference that has the potential to reduce any relative benefit that may be seen with revascularization over medical therapy.

CABG vs PCI

The evidence comparing the efficacy of CABG vs PCI has accumulated from a large number of randomized controlled clinical trials that suggest that mortality does not differ between CABG and PCI, but subgroups with diabetes and those aged 65 years or older appear to gain benefit from CABG, including freedom from angina.¹¹ Observation studies with long-term follow-up in large registries, in contrast, suggested improved long-term survival among patients who undergo CABG compared with PCI.¹² Interpretation of these non-randomized data is difficult because of the potential confounding effects of unmeasured variables and the role played by salvage PCI in those deemed too ill, unstable, or frail to undergo CABG.

Evidence-based incremental advances in stenting technologies and adjuvant therapies, as well as improvements in surgical techniques and perioperative care, have brought into question the validity of these earlier studies. No PCI vs CABG trials have used contemporary “second-generation” everolimus- or zotarolimus-eluting stents. Two trials that used first-generation drug-eluting stents have been reported.

The **Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery (SYNTAX)** randomized trial comparing PCI with the paclitaxel-eluting TAXUS stent (Boston Scientific, Natick, MA) vs CABG in 1800 patients with 3-vessel or left main CAD reported that the 12-month primary outcome of all-cause mortality, stroke, MI, or repeated revascularization was less frequent in the CABG group (12.4% vs 17.8%; $P = 0.002$), mainly because of less need for repeated revascularization,¹³ with a sustained reduction in major adverse cardiac and cerebrovascular events (MACCE) for CABG over PCI at 5-year follow-up.¹⁴ The SYNTAX trial also introduced a system for quantifying angiographic complexity of CAD (SYNTAX score) and studied the interaction of this score with mode of revascularization. In this subgroup analysis, as lesion complexity affecting optimal deployment of PCI devices increased (higher SYNTAX scores), completeness of revascularization by PCI declined, and an independent mortality benefit for surgery over TAXUS-based PCI emerged. In the high SYNTAX tertile (SYNTAX score ≥ 33), CABG was associated with a reduction in MACCE (26.8% vs 44.0%; $P < 0.0001$), all-cause mortality (11.4% vs 19.2%; $P = 0.005$), and cardiac mortality (4.9% vs 13.6%; $P = 0.0002$). It was concluded that for patients with complex multivessel CAD who were candidates for both revascularization techniques, CABG remains the standard of care. The subgroup findings in left main CAD are discussed further on in the section “Left Main CAD.”

The **Future Revascularization Evaluation in Patients With Diabetes Mellitus. Optimal Management of Multivessel Disease (FREEDOM)** trial, which randomized 1900 patients with diabetes and multivessel CAD to PCI with first-generation drug-eluting stents or CABG,¹⁵ reported similar findings, with lower composite outcome of all-cause mortality, MI, or stroke with CABG than with PCI. There was also excess stroke with CABG over PCI, both short and long term. These recent trials convincingly showed that CABG is superior to PCI in patients with diabetes and multivessel CAD who are candidates for both procedures.

Hybrid coronary revascularization

Hybrid coronary revascularization (HCR) combines surgical revascularization of the left anterior descending (LAD) coronary artery with PCI to remaining vessels/territories in patients with multivessel CAD.¹⁶ HCR, which is typically performed with minimally invasive incisions, has evolved to combine the advantage of the left internal mammary artery-to-LAD graft with the less invasive nature of PCI. Studies to date have demonstrated HCR to be safe and effective, but definitive data (eg, randomized trials) are lacking.¹⁶

Other considerations

Limitations of data. We have already alluded to limitations related to era, nonrandomized methods, sample size, and subgroup analyses. Randomized trials of PCI vs CABG enrolled only patients who were clinically and anatomically suitable for either procedure and had not undergone previous revascularization. Clinicians, however, are often faced with clinical scenarios poorly addressed by these data. Particularly relevant situations are addressed in the following sections.

Multiple comorbid conditions. Patients with CAD who are elderly (> 75 years) and frail were infrequently enrolled in strategic revascularization trials. Those with comorbidities such as advanced chronic obstructive pulmonary disease (COPD), severe renal insufficiency, previous stroke or advanced cerebrovascular disease, cognitive impairment or dementia, high bleeding risk, or cancer were also excluded from the randomized trials and may be over-represented in the PCI cohorts and could account for the findings from nonrandomized registries. By virtue of their noncardiac prognosis, the objectives for such patients may be limited to symptom relief and improved quality of life, obtained with the minimum of early hazard and with the shortest duration of functional recovery.

Social factors. Such factors may play an important role in decision making. For instance, caregivers and self-employed individuals may find the period of disability after CABG unmanageable. Conversely, some patients find the prospect of repeated revascularization procedures unacceptable. Some patients may predictably have difficulty with medication adherence; the consequences of nonadherence to dual-antiplatelet regimens after PCI can be a compelling reason to recommend CABG. Patients and physicians may weigh end-point components such as death, MI, and stroke differently. Consequently, physicians and surgeons should be prepared to provide reasonable options when providing counsel.

Repeated revascularization. Scant evidence exists for patients with multivessel CAD, previous revascularization (particularly previous CABG), and recurrent ischemia warranting additional revascularization. The solutions remain individualized and empirical, with a major focus on presence of objective ischemia and improvement of symptoms and quality of life.

RECOMMENDATIONS FOR REVASCULARIZATION FOR PATIENTS WITH NONACUTE CORONARY SYNDROME BEING CONSIDERED FOR REVASCULARIZATION

- We recommend either CABG or PCI in low- and moderate-complexity multivessel CAD with preserved LV function, particularly in patients without diabetes. (Strong recommendation, high-quality evidence.)
- We recommend CABG in patients who are acceptable surgical candidates and have multivessel CAD and diabetes, as well as in those with complex multivessel CAD. (Strong recommendation, high-quality evidence.)
- We suggest multivessel PCI or CABG for symptom relief in selected patients in whom survival benefit is uncertain. (Conditional recommendation, low-quality evidence.)

Values and preferences: The recommendation to perform revascularization either by CABG or PCI is with the understanding that the anatomy, and functional lesion assessment when applicable, is suited to effective revascularization by either technique.

Specific Clinical Considerations

LV dysfunction and congestive heart failure

The presence of mild to moderate LV dysfunction in historical trials of CABG vs medical therapy favoured CABG. These trials predated widespread use of β -blockers or renin-angiotensin modulating therapies (or both) for systolic heart failure. More recent trials of CABG vs PCI included many patients with similar degrees of LV dysfunction, and no interaction with treatment assignment was observed in the meta-analyses of these trials.¹¹ Thus mild to moderate LV dysfunction may favour revascularization over medical therapy in patients with evidence of ischemia, but favours neither CABG nor PCI over the other.

The Surgical Treatment for Ischemic Heart Failure (STICH) trial provides contemporary trial data¹⁷ to guide decisions on whether patients with CAD (> 90% multivessel) with CHF and advanced LV dysfunction (LV ejection fraction < 35%) could benefit from CABG. The primary outcome of all-cause mortality did not differ, but all-cause mortality or hospitalization occurred less frequently in the CABG group than in the medical therapy group. Although useful in helping decision making in patients with CHF, the less-than-conclusive findings and the high morbidity and mortality burden in these patients restrict its broad applicability. A small randomized trial of CABG and PCI (Angina With Extremely Serious Operative Mortality Evaluation [AWESOME] trial, N = 454) comparing CABG vs PCI in very high-risk surgical candidates (ejection fraction < 35%), reported that survival was not different between CABG and PCI groups.¹⁸

In patients being considered for revascularization in the setting of severe LV dysfunction, PCI is a valuable option when technically feasible, especially when comorbid conditions make CABG less desirable. In summarizing the overall data on surgical revascularization in patients with heart failure and reduced ejection fraction, Rouleau and Bonow concluded that (1) assessment of myocardial viability has limited value in determining which patients will benefit more from revascularization and (2) patients with 3-vessel CAD or 2-vessel CAD including proximal left anterior descending artery disease may have lower long-term mortality with CABG than with PCI.¹⁹

Assessment of myocardial viability as a guide to determine which patients would benefit from CABG has been recommended by 1 set of guidelines but not by others.²⁰⁻²² A recent further analysis by the STICH group pointed out that viability assessment should be considered, because subgroups of patients with viable myocardium seem to have better survival after CABG, compared with those without evidence of viable myocardium, but the difference was not significant after adjustment for other prognostic factors.²³ Thus the value of routine viability assessment has not been proved but could be considered in selected patients to assist decision making. Therefore a decision to proceed with CABG should take the general prognosis and comorbidities into consideration.

Left main CAD

For decades the standard of care for left main coronary stenosis has been CABG, supported by extrapolation of the early CABG vs medical therapy trials and large registries, although fewer than 200 patients with left main coronary stenosis had been enrolled in these historical trials. Contemporary evidence has offered a re-examination. One third of patients in the SYNTAX trial had left main coronary stenosis warranting revascularization, and this was a stratum for randomization. Cumulative 1- and 5-year event rate (all-cause death, stroke, or MI) did not differ between CABG and PCI.²⁴ Meta-analyses of SYNTAX and other smaller trials have supported these findings.^{25,26} Until the results of an ongoing dedicated CABG vs PCI trial (the Evaluation of XIENCE PRIME Everolimus Eluting Stent System [EECSS] or XIENCE V EECSS Versus Coronary Artery Bypass Surgery for Effectiveness of Left Main Revascularization [EXCEL] trial) in patients with left main coronary artery stenosis and low- or mid-tertile SYNTAX scores are known, an individualized approach is warranted that considers coronary disease complexity (SYNTAX score), technical feasibility for PCI vs CABG, comorbidity, local expertise, and patient preference. Patients should be made aware of the historical precedent favouring CABG in left main coronary stenosis, and also of the recent data and equipoise it has created. Ad hoc left main coronary artery intervention (at the time of diagnostic cardiac catheterization) is strongly discouraged in stable patients. Time should be provided for consultation with both an interventionist and surgeon, ideally in the context of a heart team, before finalizing a revascularization strategy in left main coronary artery stenosis.

Diabetes

Individuals with diabetes are at increased risk of cardiovascular disease and also have increased disease burden and

comorbidity.²⁷ The evidence indicates that for individuals with diabetes and multivessel CAD deemed suitable for revascularization, CABG is associated with better outcomes compared with PCI.^{15,28}

Chronic renal failure

Patients with CAD and chronic renal failure (CRF) are at increased risk of morbidity and mortality after coronary revascularization.²⁹ However, little evidence from randomized trials exists regarding the comparative effectiveness of revascularization with either CABG or PCI vs medical therapy alone in patients with CRF. An analysis from the Alberta Provincial Project for Outcome Assessment in Coronary Artery Heart Disease (APPROACH) registry reported that among patients with CRF who were not dependent on dialysis, CABG but not PCI was associated with improved survival when compared with medical therapy. In addition, revascularization (CABG or PCI) in patients dependent on dialysis improved survival compared with those who did not undergo revascularization.³⁰ However, another study comparing PCI with drug-eluting stents vs CABG in patients with CRF demonstrated no difference in the composite of death, MI, or cerebrovascular events.³¹ Similar inconclusive findings were reported in the Arterial Revascularization Therapies Study (ARTS) trial of 1205 participants, 290 with CRF, to CABG or PCI with multivessel bare-metal stenting.³²

Thus, in the absence of large randomized trials in patients with CRF that include both cardiac and clinically relevant renal end points, patients with CRF and multivessel CAD may be managed by either PCI or CABG and fare better compared with those receiving medical therapy alone. Conversely, because both CABG and PCI can produce renal injury and accelerate the development of end-stage kidney disease, thoughtful delay of revascularization is appropriate when the indication is weak or unclear.

Chronic obstructive pulmonary disease

The impact of COPD on outcomes has not been systematically examined in recent randomized clinical trials of revascularization in patients with stable CAD or those with acute coronary syndrome.^{9,14,15,33} patients with COPD present a higher risk profile because the condition is often found in conjunction with other predictors of adverse outcomes (old age, smoking). Although the evidence from clinical trial data on revascularization of multivessel CAD in patients with COPD is limited, COPD is included as a key component in all clinically relevant surgical risk scores (STS, EuroSCORE; see section on Risk Scores) and is widely recognized as an important risk factor for poorer outcome in patients with CAD undergoing CABG.²⁹ In the largest retrospective observational series (1117 with and 9877 without COPD), Selvaraj et al.³⁴ reported COPD to be an independent predictor of in-hospital mortality after PCI (odds ratio, 2.51; $P = 0.001$).³⁴ Patients with COPD should be considered at high risk for suboptimal results irrespective of revascularization therapy. In such patients being considered for revascularization, an assessment by a pulmonary specialist to assess disease severity and to individualize patient care is recommended.

Frailty

Frailty is a clinical state that raises an individual's susceptibility to increased dependency or mortality when exposed to a stressor, including revascularization.³⁵ Cardiovascular disease may accelerate the development of frailty, and frailty is present in 25%-50% of patients with cardiovascular disease.³⁶ Not surprisingly, frail patients with cardiovascular disease—especially those undergoing invasive procedures or those with CAD, MI, or heart failure—are more likely than nonfrail patients to have adverse outcomes.³⁶⁻³⁹

Among patients undergoing cardiac surgery, frailty is a risk for postoperative complications and independently predicts in-hospital mortality and reduced midterm survival.³⁸ Accordingly, routine frailty and comorbidity screening would be expected to improve risk assessment in patients undergoing cardiac surgery and to identify a subgroup that may benefit from innovative processes of care targeted at the early prevention and treatment of frailty.⁴⁰ In addition, such an approach, using the available frailty and disability scores,^{37,38} might also identify another subgroup, that of the excessively frail, for whom the risks of surgical intervention might be prohibitive, and thereby allow more informed decision making before surgery between clinicians and surgeons on the one hand and patients and their family members on the other.

RECOMMENDATIONS IN PATIENTS WITH COMORBIDITIES

LV Dysfunction and CHF

- We suggest that revascularization, typically with CABG, may be considered in patients with multivessel CAD, severe LV dysfunction, and CHF in whom there is evidence of ischemia or hibernating myocardium that may undergo revascularization. (Conditional recommendation, low/moderate-quality evidence.)
- We suggest that PCI may be considered in patients with severe angina despite optimal medical management who have LV dysfunction and CHF and are not candidates for surgery and who can undergo revascularization percutaneously. (Conditional recommendation, low-quality evidence.)

CRF

- We suggest PCI or CABG, after individualized assessments taking into consideration comorbid conditions and impact on renal viability, in patients with CRF and multivessel CAD. (Conditional recommendation, low-quality evidence.)

COPD

- We suggest that patients with COPD and multivessel CAD being evaluated for CABG undergo assessment for risk of surgical complications and have individualized management plans formulated. (Conditional recommendation, low-quality evidence.)

Approach to Patient Management

The foundation of treatment for all patients with CAD is effective risk reduction and the use of proven medical therapies to improve prognosis, relieve symptoms, and improve quality of life. For those in whom medical therapy alone is not adequate for symptom control and for those with acute coronary syndromes, assessment for revascularization is appropriate. In choosing between revascularization modalities, particularly in nonacute situations, many systemic, situational, and patient variables influence decision making. Only some of these have been subjected to evaluation in large well-conducted clinical trials, and thus high-quality data on these complex issues remain limited. When trial evidence exists, it should be used to guide treatment decisions.

Whether or not to proceed with revascularization and choosing between PCI and CABG is often difficult for both patients and clinicians. Acknowledging the increasing complexity of this decision making, the use of risk prediction scoring systems and the evolution of the multidisciplinary heart team model can be invaluable.⁴¹ In either case, clear communication between the interventional cardiologist and cardiac surgeon regarding the relevant clinical, technical, and social issues is the goal. Involvement of the referring clinical cardiologist, relevant specialists (nephrologists, respirologists, and so on), and primary care providers is encouraged, as is engagement of a competent spouse or close family member.

When considering revascularization, patients are better enabled to make informed and nuanced revascularization decisions when they are provided with the benefit of counsel from both cardiologists and cardiac surgeons. This decision may best be based on the shared decision-making model between the physician and the patient and often the patient's family. In addition to any appraisal of the evidence favoring 1 treatment modality over the other, attention should additionally be paid to matters such as the patient's preference, nuances of the anatomy and clinical circumstance, the extent and severity of noncardiovascular comorbidities, local expertise in both surgical and postoperative care, and resource availability.

Prediction risk scores

Recent trials have provided guidance about how coronary anatomy (SYNTAX; see section "LV Dysfunction and CHF") and diabetes (FREEDOM trial) may have an impact on which revascularization technique may be chosen, yet, they did not take into consideration other patient-related factors that could affect decision making. A number of risk scores have been developed and validated that could aid with decision making.^{27,29,42}

Society of Thoracic Surgeons score. The Society of Thoracic Surgeons risk calculator (<http://riskcalc.sts.org>) has been using risk models for > 2 decades to allow for prediction of risk-adjusted outcomes based on preoperative patient characteristics and disease severity, with the most recent update in 2009.²⁹ The STS score has high predictive power for mortality and morbidity and has been validated in numerous studies.⁴³

EuroSCORE. The EuroSCORE (<http://www.euroscore.org>) is a similar model, using development and validation cohorts for validation. The most recent version (EuroSCORE II), uses 18 patient- and procedure-related variables to predict mortality.⁴² Although previous versions of the EuroSCORE (additive and logistic) have commonly overestimated mortality, recent studies suggest that the EuroSCORE II is much more accurate.⁴⁴

SYNTAX II score. Although the original SYNTAX score (see section “LV Dysfunction and CHF”) has provided important information about coronary anatomy and has identified the appropriate revascularization strategy for individuals with multivessel CAD, it did not consider clinical variables. The SYNTAX II score combines baseline clinical and anatomic data—thus incorporating anatomic SYNTAX score plus age, creatinine clearance, LV ejection fraction, presence of unprotected left main CAD, peripheral vascular disease, female sex, and COPD—and has been validated in recent studies.²⁷

Summary. Clinical judgement remains the cornerstone of decision making for patients being referred for revascularization. When clinical judgement identifies high-risk or complex patients, application of well-validated risk scores helps to inform suitability for revascularization and whether PCI or CABG is appropriate.

Limitations. Because these scores rely on clinical characteristics that are routinely captured in cardiovascular data sets, they possess inherent limitations in that they fail to take into account commonly encountered noncardiac vulnerabilities, such as frailty and disability, that have been shown to be important independent predictors of adverse outcomes after cardiac surgery.^{38,40} The addition of these frailty variables, as discussed in the section “COPD,” to risk calculators may render such scores more comprehensive and better able to predict operative risk.⁴⁵ Use of more intricate scores for *all* patients being considered for revascularization may prove to be impractical; however, for complex patients, the information to be gained would be valuable and worth the additional effort required.

Multidisciplinary approach to decision making (the heart team)

Synthesizing all available information and making appropriate revascularization decisions has become increasingly challenging. The importance of a multidisciplinary approach (the heart team) in the management of complex patients requiring multivessel revascularization has been advocated. Although there is a paucity of definitive data supporting the efficacy of the heart team, many cardiology/cardiac surgery multidisciplinary groups have formally or informally discussed revascularization options for complex patients. A recent clinical update has outlined the rationale and structure of the heart team.⁴¹ The authors emphasized the importance of involving noninvasive cardiologists, interventional cardiologists, and cardiac surgeons in addition to the treating cardiologist or internist. The role of the team includes assessing diagnostic information, implementing comprehensive

prediction risk scores, considering local expertise, providing an objective decision-making process, and ultimately applying evidence/guideline-based therapy.⁴¹ Although having a formally constituted heart team may not be feasible or desired in every cardiac centre, the principles inherent in such a multidisciplinary approach would prove to be helpful.

Conclusions

For individuals with CAD, advances in medical management and coronary revascularization over the past few decades have resulted in significant improvements in overall survival as well as freedom from recurrent cardiac events, including acute coronary syndromes, heart failure, and life-threatening arrhythmias. In addition, significant improvements in symptom relief and quality of life have been observed.

The European Society of Cardiology recently published guidelines on myocardial revascularization that provide detailed information on the approach, assessment, and revascularization modalities based on trial and registry data. Recommendations were made with optimal timing and setting of procedures in mind.⁴⁶ Although the current document generally agrees with these conclusions and recommendations, it highlights the complementary roles of CABG and PCI while emphasizing the importance of appropriate optimal medical therapy for all patients encountered in the context of routine clinical practice in Canada. This document attempts to highlight the increasing number of individuals with significant comorbid disease burden and functional debilitation who are being referred for definitive management of their multivessel CAD. These types of individuals have traditionally not been included in the many clinical trials that have been the basis for guidelines and recommendations. In these individuals, the objective of the proposed medical intervention or revascularization, or both, would not necessarily be to improve prognosis but to improve quality of life. In such cases, when evidence to guide decision making is lacking, clinical judgement will be aided by the assessment of other variables, such as frailty, and formal or informal collaborative decision making focused on the patient using the principles or formal involvement of a multidisciplinary heart team.

The disclosure information of the authors and reviewers is available from the CCS on the following websites: www.ccs.ca and/or www.ccsguidelineprograms.ca.

This statement was developed following a thorough consideration of medical literature and the best available evidence and clinical experience. It represents the consensus of a Canadian panel comprised of multidisciplinary experts on this topic with a mandate to formulate disease-specific recommendations. These recommendations are aimed to provide a reasonable and practical approach to care for specialists and allied health professionals obliged with the duty of bestowing optimal care to patients and families, and can be subject to change as scientific knowledge and technology advance and as practice patterns evolve. The statement is not intended to be a substitute for physicians using their individual judgement in managing clinical care in consultation with the patient, with appropriate regard to all the individual circumstances of the patient, diagnostic and treatment options available and available resources. Adherence to these recommendations will not necessarily produce successful outcomes in every case.

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