Therapeutic options in coronary artery disease: Focusing on the guidelines

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There are three options for the treatment of patients with coronary artery disease: coronary artery bypass graft surgery (CABG), percutaneous coronary intervention (PCI) and optimal medical treatment alone. While there has been an active interface between CABG and PCI, medical treatment has not been as vociferously advocated. However, it performs well in randomized trials and is still a treatment arm in studies such as the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) trial. The present review compares these options in acute and chronic coronary syndromes, including the indications for each as summarized by recent American College of Cardiology and American Heart Association guidelines. While the landscape in Canada is changing for CABG and PCI, with an increase in the latter procedure for patients with multivessel disease, optimal medical treatment alone is very effective. There are few subsets, particularly in chronic syndromes, in which revascularization is indicated for prognosis alone.

Key Words: Angina; Coronary artery bypass; Guidelines; Myocardial infarction; Percutaneous coronary intervention

Options thérapeutiques dans la coronaropathie : Accent sur les lignes directrices

Trois options thérapeutiques s'offrent aux patients qui souffrent de coronaropathie : le pontage coronarien (PC), l'intervention coronarienne percutanée (ICP) et le traitement médical optimal seul. Bien qu'il y ait eu des interconnexions dynamiques entre le PC et l'ICP, on ne peut pas dire que le traitement médical ait fait l'objet d'une promotion tonitruante; or, il donne de bons résultats lorsqu'il est utilisé dans des essais cliniques randomisés et lorsqu'il forme la base de certains volets d'études, comme l'étude BARI 2D (pour *Bypass Angioplasty Revascularization Investigation 2 Diabetes*). La présente synthèse compare ces différentes options pour les syndromes coronariens aigus et chroniques, y compris leurs indications respectives telles qu'elles se trouvent résumées dans les récentes lignes directrices de l'*American College of Cardiology* et de l'*American Heart Association*. En ce qui a trait au pontage et à l'ICP, et compte tenu de l'augmentation des ICP chez les patients qui souffrent d'une maladie affectant plusieurs vaisseaux, le paysage canadien évolue, mais le traitement médical optimal seul demeure très efficace. Il existe plusieurs catégories d'indications, particulièrement dans les syndromes chroniques, pour lesquelles la revascularisation est indiquée à des fins pronostiques seulement.

In the 1970s, coronary surgeons were criticized for sometimes performing coronary artery bypass graft surgery (CABG) for unproven indications. This is not dissimilar from the criticism directed at interventional cardiologists today in their 'off-label' use of coronary stents and percutaneous coronary interventions (PCIs), as described in Bernard Goldman's paper, "The life and hard times of a coronary surgeon" (1). I, a coronary interventionist, do not disagree with much of what Dr Goldman says. In fact, the dangers of performing PCI today for questionable indications are greater than they were for CABG, then and now, for at least two reasons. First, PCI patients usually begin within the cardiologist's domain and do not require a consultation from another discipline; this is not the case for CABG, where the referral usually comes from a cardiologist. Second, PCI can and often is performed at the same time as the diagnostic angiogram, which is not possible with CABG. This practice is called ad hoc PCI and is referred to by Dr Goldman as one of the major sources of abuse. This, also, I do not dispute. The problem for cardiologists is that symptoms are often atypical and are rarely the classical angina symptoms that William Heberden read to the Royal College of Physicians in London in 1768 (2): "There is a disorder of the breast, marked with strong and peculiar symptoms...those who are afflicted with it are seized, while they are walking, and more particularly while walking after eating". For the large number of patients who do not have a classical chest pain presentation or who have symptoms such as dyspnea, which may be an angina equivalent, an angiogram is often performed, primarily for diagnostic reasons. Then, sometimes

unexpectedly, a significant, even critical, lesion is found, which is quite suitable for PCI. Then, the so-called oculostenotic reflex sets in and if one is in a situation in which ad hoc PCI can be performed, more often than not, it will be. If there were a truly reliable imaging technique with unquestionable diagnostic accuracy excluding, with near certainty, the possibility of missing critical disease, such as left main coronary artery disease, then a survey (3) of invasive cardiologists suggests that even they would prefer this and would forgo the diagnostic angiogram. Once it is performed, they admit that emotional and psychological factors, rather than evidence-based medicine, may dictate matters. The problem is that the most common imaging techniques – stress echocardiography and stress nuclear imaging – lack reliability when performed in the 'real world' (4). This often results in an invasive coronary angiogram being performed for purely diagnostic purposes in patients with no symptoms, atypical symptoms or typical symptoms that are either not disabling or without a proper trial of medical treatment. This is the background of potentially inappropriate ad hoc PCI.

It is within this milieu that cardiologists, particularly invasive cardiologists, must have a heightened awareness of the current indications for myocardial revascularization as set out by their associations and societies – the American College of Cardiology (ACC), the American Heart Association (AHA) and the Canadian Cardiovascular Society. Without this foundation, there are dangers of slipping into the unscientific waters of performing procedures for unproven indications on an unsuspecting and uninformed public. It does not mean that one

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Figure 1 Bernie Goldman (left) before the introduction of minimally invasive surgery, and Leonard Schwartz (right) when interventionists had only balloons, umbrellas and a halo. Circa 1985

should not individualize decision-making, but it should be done within a framework of guiding principles.

The purpose of the present viewpoint is to focus on the guidelines that are the most relevant to our daily practice in the management of patients with acute and chronic coronary syndromes. The interaction between CABG and PCI and their practitioners is historic, usually collegial, sometimes humorous (Figure 1) and often productive. There is, however, a third option for patients with coronary artery disease – optimal medical treatment alone. While the former two options have advocates who are often quite vocal, medical treatment may not have been so vociferously supported. However, it stands up very well against the other options in randomized trials. Another objective of the present review is to emphasize how well many patients do with optimal medical treatment alone in spite of the presence of quite significant coronary disease. This is not intended to diminish the impact that CABG and PCI have had on coronary patients, both from a prognostic and a functional standpoint. When I began my training in the 1960s, there was no effective method of revascularization, and practicing cardiology then was much less satisfying than it is today. However, medical treatment, particularly the assessment and management of risk factors, has made major progress in concert with the introduction and refinement of these revascularization procedures. Patients undergoing these procedures should have, and have had, the benefit of concomitant optimal medical treatment. Implicit to the recommendations for CABG and PCI is ongoing optimal medical treatment.

To a large degree, the treatment chosen depends on the interaction between anatomical disease and symptom severity. The interface between treatment modalities is a landscape that has and will change with new technology and information. Figure 2 illustrates the change in recommended treatment at one facility in Ontario (Catheterization Laboratory Statistics, Peterborough Regional Health Centre [Peterborough, Ontario]) between 2002 (Figure 2A) and 2006 (Figure 2B). Comparing these, one can appreciate an increase in the recommendation for PCI, particularly in patients with two-vessel disease, but also in those with three-vessel and left main coronary artery disease in the latter era compared with the former, with a corresponding decrease in CABG. The most important change between the two eras was the introduction of drug-eluting stents.

The recommendations, including class and level of evidence, are summarized in Table 1 and are discussed in the content of the present review.

ACUTE CORONARY SYNDROMES

ST elevation myocardial infarction

Overview: The two options here are essentially ever-improving medical treatment and PCI. The most recent ACC/AHA guidelines

Figure 2 **A** Treatment recommendations by disease severity in 2002 at a hospital in Ontario (Peterborough Regional Health Centre, Peterborough) before the introduction of drug-eluting stents. **B** Treatment recommendations by disease and symptom severity in 2006 at the same hospital after the introduction of drug-eluting stents. IVD One-vessel disease; 2VD Two-vessel disease; 3VD Three-vessel disease; CABG Coronary artery bypass graft surgery; CAD Coronary artery disease; LM Left main coronary artery disease; MED Medical treatment alone; PCI Percutaneous coronary intervention

for ST elevation myocardial infarction (STEMI) do not mention CABG as a treatment option (5). The most recent ACC/AHA guidelines for CABG include CABG for STEMI only for failed PCI or anatomy unsuitable for PCI with persistent pain or hemodynamic instability (6). In STEMI, medical treatment has a broad base and not only includes increasingly aggressive fibrinolytic, anticoagulant and antiplatelet regimens but also high-dose statins, beta-adrenergic blockers, and angiotensin-converting enzyme inhibitors and angiotensin-receptor blockers. PCI is the treatment of choice if it can be performed with a first medical contact to balloon time of less than 90 min, but if not, fibrinolysis is recommended (5). In spite of the well-established superiority of early PCI to the medical option of fibrinolytic therapy, the most common reperfusion therapy in Canada through 2007 is fibrinolysis (Paul Daly, Managing the acute coronary syndromes – a tracking project [MACSTRACK], personal communication). It is interesting that for both the fibrinolysis and primary PCI options, the guidelines permit a rather generous time to treatment that far exceeds the optimal window. For primary PCI, although the performance should be timely (within 90 min of presentation), it should still be performed within 12 h after symptom onset but should not routinely be performed more than 12 h after symptom onset if symptoms have resolved and there is no hemodynamic or electrical instability (7). Similarly, fibrinolytic therapy is recommended up to 12 h after symptom onset if there is persistent ST elevation (7).

Rescue PCI: Rescue PCI refers to PCI that is performed if there is clinical suspicion of failure of fibrinolysis. In the latest STEMI-focused

TABLE 1
Recommendations

Syndrome	Percutaneous coronary intervention (PCI)	CABG	Medical
ST elevation myocardial infarction (STEMI)	Within 90 min of symptom onset and do only STEMI vessel (I-A) (5)	Persistent pain when unsuitable for PCI or failed PCI (I-B) (6)	Fibrinolytic therapy >90 min and <6 h (I-B) (5)
Failed fibrinolytic therapy	Rescue (I-B if unstable; IIa-B for all others) (5)	—	—
Facilitated PCI	Not recommended (III-B)	—	—
Early post STEMI	If angina and do culprit (I), or if no angina and no total occlusion and do culprit (IIb-B) (5)	If unsuitable for PCI and persistent pain (I-B) (6)	Total occlusion and no angina – do not do PCI (III-B) (12)
UA/NSTEMI	PCI of all possible culprits within 24 h if possible (I-B) (14)	If unsuitable for PCI (I, IIa or IIb – depending on disease severity) (6)	Initial stabilization with anticoagulant, antiplatelet agents, beta-blockers
Chronic CAD and no or mild symptoms	≥1 significant lesion in 1 or 2 arteries subtending a large or moderate area of viability with high likelihood of success/low risk (IIa-B) (19)	Left main, left main equivalent or 3VD with EF<0.5; all assuming good graftability (I) (6)	For all others
Chronic CAD and disabling angina or equivalents	Single- or multivessel disease and ≥1 significant lesion in ≥1 vessel and high likelihood of success plus low risk (IIa-B for 1VD or 2VD, and IIb-C for 3VD) (19) but not left main or equivalent disease	The above and any other CAD anatomy unsuitable for PCI (eg, diffuse proximal/mid disease; multiple lesions in multiple main/branches) assuming good graftability/low risk (I-B) (6)	Optimal medical treatment has failed but should be continued following PCI or CABG

I, IIa, IIb, III refer to class of recommendation: Class I Procedure/treatment should be performed/administered (evidence or general agreement that a given procedure or treatment is beneficial, useful or effective); Class IIa It is reasonable to perform procedure/administer treatment (weight of evidence/opinion is in favour of usefulness/efficacy); Class IIb Procedure/treatment may be considered (usefulness/efficacy is less well established); Class III Procedure/treatment should not be performed/administered because it is not helpful and may be harmful (evidence and/or general agreement is that it is not useful and may be harmful). A, B and C refer to the level of evidence: A Data derived from multiple randomized clinical trials or meta-analysis; B Data from a single randomized trial or nonrandomized studies; C Only consensus opinion of experts, case studies or standard-of-care. 1VD One-vessel coronary disease; 2VD Two-vessel coronary disease; 3VD Three-vessel coronary disease; EF Left ventricular ejection fraction; CABG Coronary artery bypass graft surgery; CAD Coronary artery disease; UA/NSTEMI Unstable angina/non-ST elevation myocardial infarction

guidelines (5), the parameters of rescue PCI are better defined. It is now recognized that the presence or absence of chest pain is unreliable for identifying failed reperfusion and it is the failure of ST elevation resolution 90 min after the initiation of fibrinolysis by less than 50% in the lead showing the greatest elevation that is most reliable. A meta-analysis of rescue trials (8) has shown that rescue PCI decreases adverse clinical events compared with medical therapy. Nonetheless, this is a class I recommendation only for patients with failed fibrinolysis and hemodynamic instability, and a class IIa recommendation for those who are hemodynamically stable (5).

There are other important patient subsets in which the best management option is still in evolution.

Facilitated PCI: Facilitated PCI refers to a strategy of planned immediate PCI after administration of initial fibrinolytic therapy (which could be a full dose or reduced dose, with or without glycoprotein IIb/IIIa inhibitor). The largest randomized study (Assessment of the Safety and Efficacy of a New Treatment Strategy with Percutaneous Coronary Intervention [ASSENT-4 PCI]) showed a worse outcome for facilitated PCI (in this study, full-dose tenecteplase and PCI was used) compared with primary PCI alone (9). The mortality rate was particularly high when there was a short time to PCI and in PCI centres. Suboptimal antithrombotic cotherapy in the facilitated PCI arm may, in part, explain the worse outcome. It is possible that early mechanical reperfusion with recent fibrinolytic therapy still on board results in hemorrhagic extension of infarction. The use of this approach within 24 h of successful full-dose fibrinolysis is now considered potentially harmful and is categorized as class III in the most recent guidelines (5). However, this strategy was originally intended for initiation in non-PCI centres to limit infarct size during transfer, the so-called 'drip and ship'; therefore, this may still be its niche. The ASSENT investigators raise the possibility that a longer delay to PCI may have changed the outcome. In this context, if prehospital fibrinolysis becomes a reality, how will such patients be managed once they arrive at the hospital?

In-hospital intervention following STEMI: After successful fibrinolytic therapy or in those who receive no reperfusion therapy (which

was one in three patients, as recently as 2006 in one Canadian database, MACSTRACK), and if no overt ischemia evolves during the hospitalization, does medical treatment alone suffice, possibly with a predischARGE stress test to rule out silent ischemia, or should all patients have a routine angiogram? The 2007 STEMI guidelines (5) assigned a class IIb recommendation with level B evidence as follows: "PCI of a hemodynamically significant stenosis in a patent artery more than 24 h after STEMI may be considered to be part of an invasive strategy". There is no argument regarding the need for angiography and possible revascularization when there are symptoms of ischemia following STEMI, but the somewhat more controversial question is the management of patients following STEMI with no symptoms. Two studies randomly assigned patients early following STEMI and successful fibrinolysis with no or little angina or ischemia to revascularization or conservative management. In the Grupo de Analisis de la Cardiopatía Isquémica Aguda Group (GRACIA)-1 study (10), those in the invasive arm had a lower combined primary end point at 12 months (death, reinfarction or revascularization) but only a trend toward a lower mortality ($P=0.16$). However, the other study, the Arbeitsgemeinschaft Leitende Kardiologische Krankenhausärzte study (ALKK) (11), which randomly assigned post-STEMI, successful fibrinolysis patients with no symptoms or residual ischemia to PCI or conservative management one to six weeks following STEMI, found an improved long-term survival of 96% at 56 months in the PCI arm versus 89% in the conservative arm.

In general, it appears that for patients with a substantial completed STEMI with successful fibrinolysis (or in those who did not receive lytic therapy at all), routine angiography may be a reasonable approach pre-discharge with level B evidence. However, there is one subset of patients in whom PCI three to 28 days following STEMI may be harmful. This subset consists of patients in whom angiography documents a total occlusion of the STEMI artery but who are clinically quiescent and stable. The Occluded Artery Trial (OAT) (12) showed that these patients had a less favourable long-term outcome when treated by PCI than those who were treated with medical treatment alone.

STEMI conclusions: Regarding STEMI and the three options of CABG, PCI and optimal medical treatment, PCI is the preferred primary treatment (although, presently in Canada, not the most common, possibly because of access issues). It is effective as a rescue measure when fibrinolysis fails and it is beneficial in terms of reinfarction and mortality following STEMI, even without evidence of angina or ischemia. CABG is rarely used in STEMI, either in the acute phase or in the subacute phase. In GRACIA-1, where either option could have been used at 24 h, the ratio of PCI to CABG was 41:1 (10). Medical treatment alone is an option when revascularization is not possible or carries too high a risk.

Unstable angina/non-STEMI

Overview: For the other acute coronary syndrome, unstable angina/non-STEMI (UA/NSTEMI), a breakthrough occurred in the 1988 study by Theroux et al (13), which showed a sevenfold decrease in in-hospital myocardial infarction in patients admitted with unstable angina treated with acetylsalicylic acid and unfractionated heparin compared with placebo. The end point of this study was just 6 ± 3 days and it is now recognized that, in addition to acetylsalicylic acid and anticoagulation, more potent antiplatelet therapy in the form of thienopyridenes and glycoprotein IIb/IIIa receptor blockers may be beneficial and that ultimately, in most cases, a revascularization intervention should be considered. Seven randomized studies have compared a routine early invasive strategy versus a conservative approach and, individually, none showed benefit from an invasive strategy. However, a meta-analysis (14) of the studies showed a better long-term survival rate with a routine invasive strategy at two years (overall RR 0.76 [95% CI 0.63 to 0.90]). Presently, an early invasive PCI strategy is a class I recommendation for asymptomatic patients with a recent acute coronary syndrome who have no serious comorbidity, and with lesions amenable to PCI and an elevated risk of clinical events. There are 11 risk factors, any one of which identify the patient as high risk. Two of these risk factors are an elevated cardiac biomarker (troponin T or troponin I), and new or presumably new ST segment depression. Because the diagnosis of UA/NSTEMI requires at least one of these, the recommendations basically include all patients with this syndrome (14). One might speculate why such patients do better with PCI than with medical treatment alone. A likely explanation is that once heparin is discontinued and the patient is discharged from the hospital, antiplatelet agents alone are not sufficiently protective in preventing reocclusion at the site of plaque rupture, but stent deployment is, presumably by sealing it. Although CABG is also a class I recommendation with similar criteria, it appears likely that PCI is increasingly used as the revascularization option. The guidelines recommend CABG for any of left main coronary artery disease (CAD), three-vessel disease, two-vessel disease with proximal left anterior descending artery involvement, two-vessel disease with a large area of myocardium at risk (with or without proximal left anterior descending artery disease) and PCI for all others if there are amenable PCI lesions (14). Over the years and possibly with the introduction of drug-eluting stents (DES), PCI has been used with increasing frequency compared with CABG for UA/NSTEMI. Ten years ago, in the FRagmin and fast revascularization during InStability in Coronary artery disease (FRISC) II trial (15), the ratio of PCI to CABG was 5:4. In the recent Acute Catheterization and Urgent Intervention Trial strategy (ACUITY) trial (16), the ratio of PCI to CABG was 5:1.

The major remaining issues for UA/NSTEMI are the timing of angiography and the completeness of PCI revascularization.

Timing of angiography: The Intracoronary Stenting and Antithrombotic Regimen Cooling-off study (ISAR-COOL) (17) specifically examined the timing issue. All patients received intensive medical treatment (heparin, clopidogrel [600 mg loading], acetylsalicylic acid and tirofiban). One-half were randomly assigned to immediate angiography (median time 2.4 h) and one-half to delayed angiography (median time 86 h or approximately four days). The delayed angiography was associated with more deaths at 30 days (11.6% versus 5.9%, $P=0.04$) and most

events occurred before catheterization with a linear attrition between one and seven days. The Superior Yield of the New Strategy of Enoxaparin, Revascularization and Glycoprotein IIb/IIIa Inhibitors (SYNERGY) trial (18) examined this issue by breaking down the time to angiography into eight 6 h blocks and comparing the outcome of patients in the eight blocks. The adjusted estimates of 30-day death and myocardial infarction rates increased as time-to-angiography intervals became longer. In the SYNERGY trial, the lowest 30-day event rate occurred in the less than 6 h block and if angiography can be done in this time frame then it would be reasonable to proceed, but in the four blocks between 6 h and 30 h, the outcomes were virtually identical.

Completeness of revascularization: The only reference to this in the latest non-STEMI guidelines is "PCI of the culprit lesion can reduce subsequent hospitalizations and the need for antianginal drugs" (14). Implicit in this recommendation is that nonculprit lesions should not be treated. The most recent 2005 PCI guidelines for STEMI (19) are more explicit and state that elective PCI should not be performed in a noninfarct-related artery at the time of a primary PCI for STEMI. For STEMI, usually there is little question regarding which lesion and vessel is the culprit. For the vessel, one is guided by the electrocardiogram unless bundle branch block is present. For lesions, there are acute culprit angiographic lesion criteria that include intraluminal filling defect, ulcer with overhanging edges, extraluminal contrast, dissection or intraluminal flap, multiple irregularities, or acute occlusion. It may be more difficult to identify a target lesion in the UA/NSTEMI scenario. In the Veteran's Affairs Non-Q-Wave Infarction Strategies in-Hospital (VANQWISH) trial (20), a single culprit lesion was identified in only 49% of patients and the majority of patients had either no identifiable culprit (37%) or multiple apparent culprits (13%), and here the electrocardiogram may be less helpful. Angioscopy has shown that intraluminal thrombi, which are often quite small, are the hallmark of acute coronary non-STEMI syndromes and angiography is relatively insensitive in their detection (21). Intravascular ultrasound is unreliable in differentiating acute thrombi from echolucent plaques (22) but is better than angiography in detecting fresh plaque rupture. Relying strictly on the angiographic severity of a lesion to identify the culprit may direct one to a nonculprit (23). It may be necessary to perform PCI on several lesions and vessels when the culprit is not obvious or there are multiple possible candidates. If there are too many possible culprits, particularly if some are not very suitable for PCI, then it might be appropriate to consider either the CABG or medical treatment alone options.

CHRONIC CORONARY SYNDROMES

Disabling angina

There is general agreement that revascularization is indicated when angina is disabling and refractory to optimal medical treatment, and the risk of the intervention is low. For CABG, this is a class I recommendation with level B evidence (6) and for PCI, it is a class IIa recommendation as follows: "it is reasonable that PCI be performed in patients with Canadian Cardiovascular Society class III angina and single or multi vessel CAD who are undergoing medical therapy and who have 1 or more significant lesions in 1 or more coronary arteries suitable for PCI with a high likelihood of success and low risk of morbidity and mortality" (19). The CABG guidelines comment that if the angina is not typical, objective evidence of ischemia should be obtained. Otherwise, it appears that stress testing and imaging are not a requirement.

Revascularization for prognosis

Is there any justification in the chronic scenario for recommending revascularization strictly for prognosis, assuming that symptoms are under good control on medical treatment? In the 2005 guidelines, there is no class I recommendation for PCI (19). There is a class IIa recommendation that includes all patients (those with or without diabetes; the 2001 guidelines had different guidelines for patients with or without diabetes) and "the vessels to be dilated must subtend a

moderate to large area of viable myocardium or be associated with a moderate to severe degree of ischemia on noninvasive testing". The recommendation was changed from 2001 to 2005 to reflect the writing committee's consensus that not all patients in this category must have PCI performed. It is important to note that the PCI attempt must be associated with a high likelihood of success and a low risk of morbidity or mortality. It should also be noted that this does not include patients with three-vessel disease or left main stem coronary artery disease. PCI for left main stem disease is permitted only for patients who are not candidates for CABG. For three-vessel PCI, the recommendation is class IIb with efficacy less well established with level C evidence.

For CABG, there are three class I recommendations (6) for patients with no or mild angina: significant left main coronary artery disease; significant left main coronary artery equivalent (70% diameter stenosis or more of both the proximal left anterior descending and circumflex arteries); three-vessel disease and particularly with an ejection fraction less than 0.50 and/or large areas of demonstrable ischemia.

Completeness of revascularization

In chronic stable angina, as reflected in the guidelines, it is difficult to justify PCI strictly for the purpose of improving survival. In this context, PCI does not appear to fare well against either optimal medical treatment or CABG. The answer for this may be found in the contentious issue of the difference in completeness of revascularization between CABG and PCI. There are two points for which there should be little disagreement. First, there has never been any argument about the intention and usual achievement of completeness of surgical revascularization. Second, coronary angioplasty for patients with multivessel disease from the balloon era to the present DES era has never offered anything approaching complete revascularization (CR), even within trials. In the Bypass Angioplasty Revascularization Investigation (BARI) I trial (24), in which CR was encouraged but not mandated, it was intended in only 65% of patients in the PCI arm and of those, achieved in only 45%. In the Arterial Revascularization Therapies Study (ARTS) I trial (25), in which equivalent revascularization was mandated, CR was achieved in only 70.5% of those in the PCI arm compared with 84.1% in the CABG arm. The most recent publication regarding this issue came from the National Heart, Lung, and Blood Institute dynamic registry (26). CR was attained in only 21% of all patients with multivessel disease. Of the remaining patients with incomplete revascularization (IR), called targeted revascularization, CR was deemed achievable by the operator in 74% but was not performed. The major argument is whether completeness of revascularization has an impact on survival. IR is associated with more repeat PCI and more downstream CABG than CR, but this is of no great matter if there is no major intervening event and the patients survive to have the second procedure. For the question of survival, there are few randomized studies comparing PCI-CR and PCI-IR, and these have too small a sample size or too much crossover to answer this question. One must rely on randomized trials in which this was not the primary question, or post hoc analysis of registries. For the former, in the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial (27), the majority of the PCI patients almost certainly received IR, because more than two-thirds had multivessel disease but only 1576 lesions were attempted in 1149 patients, or 1.37 per patient. This could explain PCI's lack of impact on survival in this trial. From the New York state registry with a three-year follow-up period, PCI patients who were incompletely revascularized were significantly more likely to die at any time after adjustment of baseline differences (28). The enrollment for this registry was from 1997 to 2000 and did not include DES. A more recent publication from this registry found that overall, the PCI patients (for this analysis, only those with DES were included) with multivessel disease after propensity adjustment had a lower survival over a mean follow-up of approximately 1.5 years than the patients who had CABG (29). The reason for this, although not stated, may have been at least partially due to IR.

To further confuse matters in the dynamic PCI registry, patients with IR had one-year equivalent survival to those with CR after adjustment for clinical characteristics (26). Although this is still an undecided issue, the weight of evidence appears to favour CR.

This does not categorically exclude PCI of multivessel disease. If all lesions are ideal, localized and can be performed at low risk and with DES, then it still may be an acceptable option. In ARTS II, with 3.6 ± 1.5 sirolimus-eluting stents per patient and CR, patients at one year did as well as the CABG patients in ARTS I with risk adjustment (30).

CONCLUSIONS

I realize, as Bernie Goldman opines, that coronary surgeons have fallen on hard times, but the life of a coronary interventionist is not necessarily a happy one. We are accused of being more influenced by emotional factors than evidence-based medicine in our decision-making (3). It seems that hardly a week goes by without a disparaging news release – "Bypasses outshine stents in study; patients fared better by choosing surgery for multiple blockages" (31). If not from the surgical side, then we are ambushed by the medical treatment alone side in the very trials we designed, with the medical arm triumphing in OAT (12) or PCI offering nothing beyond medical treatment alone in COURAGE (27). In fact, optimal medical treatment alone is a tough competitor. In a United States study (32), 91% of people who self-reported coronary disease were on medical treatment alone and only 9% had had either PCI or CABG. In Canada, in 2000/2001, 1,019,808 people self-reported as having angina or a previous myocardial infarction (33). That year, 5.6% ($n=57,422$) had either PCI or CABG (34), indicating that the remaining 94.4% were likely on medical treatment alone. In Canada, where access to care is not always optimal, a viable medical option is fortunate. The majority of patients in Canada with an acute STEMI receive medical treatment in the form of fibrinolysis as their first treatment. The most important impact on survival for the UA/NSTEMI syndrome is medical treatment in the form of antiplatelet and anticoagulant agents, although PCI is a necessary follow-up. In the chronic syndromes, although CABG and PCI are both effective in relieving angina, there are only a few special patient subsets in which survival has been shown to be improved by revascularization. Optimal medical treatment is alive and well. Unfettered PCI, which occurred with CABG in the past, exposes its practitioners to criticism of misuse and overuse of the procedure. Focus on the guidelines!

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