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## Emergency Coronary Artery Bypass Surgery in the Contemporary Percutaneous Coronary Intervention Era

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**B**ackground; Since the advent of percutaneous coronary interventions (PCIs), technological advances, adjunctive pharmacotherapy, and increasing operator experience have contributed to lowering the occurrence of major complications. However, emergency coronary artery bypass surgery (CABG) for failed PCI is still associated with important morbidity and mortality, even in the era of coronary stenting. We sought to determine the prevalence, indications, predictors, and complications of emergency CABG after PCI in the past decade. **Methods and Results;** We reviewed 18 593 PCIs performed from 1992 through 2000. There was a need for emergency CABG in 113 (0.61%) cases. The major indications were extensive dissection (n=61, 54%), perforation/tamponade (n=23, 20%), and recurrent acute closure (n=23, 20%). Prevalence of emergency CABG decreased from 1.5% of PCIs in 1992 to 0.14% in 2000 ( $P<0.001$ ). Independent predictors of the need for emergency CABG included the worst ACC/AHA scoring of the intervened lesion ( $P<0.001$ ) and female sex ( $P= 0.028$ ), whereas history of prior bypass surgery and use of stents resulted in a decreased need for emergency CABG ( $P<0.001$  for both). In patients undergoing emergency CABG, there were 17 (15%) in-hospital deaths, 14 (12%) perioperative Q-wave myocardial infarctions, and 6 (5%) cerebrovascular accidents. **Conclusions;** The need for emergency CABG has considerably decreased over time. Risk factors include female sex and a higher ACC/AHA score of the intervened lesion. However, morbidity and mortality of emergency CABG remain high even in the new millennium.

## **Impact of intravenous thrombolysis prior to percutaneous coronary intervention in reperfusion therapy for acute myocardial infarction**

Uto K, Ota Y, Mizuno M, Nakamura A, Nakajima R, Endoh Y, Kasanuki H.

**OBJECTIVES:** To elucidate the effectiveness and safety of intravenous thrombolysis (IVT) with mutant tissue plasminogen activator prior to percutaneous coronary intervention (PCI) in patients with acute myocardial infarction. **METHODS:** Ninety consecutive patients were recruited with the following criteria: acute myocardial infarction with ST segment elevation or bundle branch block on electrocardiography, admission within 6 hr from onset, age of  $< \text{or} = 80$  years and without previous PCI or coronary bypass graft surgery. They were divided into two groups. Group IV consisted of 53 patients treated with IVT prior to PCI and Group D consisted of the other 37 patients with direct PCI. Mutant tissue plasminogen activator, monteplase, was administered with a dose of 27,500 U/kg in Group IV (maximum injection dose,  $160 \times 10^4$  U). The clinical features and in-hospital outcome were compared between the two groups. **RESULTS:** Patients in Group IV acquired earlier reperfusion estimated by electrocardiography recovery at 60 min after admission and higher Thrombolysis in Myocardial Infarction (TIMI) flow grade on the first coronary angiogram (TIMI 2 or 3 flow rate; Group IV vs Group D = 75% vs 35%,  $p < 0.0001$ ). The duration from onset to TIMI 3 flow grade was not significantly different between Group IV and Group D (230 vs 260 min,  $p = 0.15$ ). The incident of ST segment re-elevation with chest pain at recanalization was lower in Group IV than in Group D (23% vs 46%,  $p < 0.05$ ). The duration from TIMI 3 recognition to peak creatine kinase level was longer in Group IV (466 vs 359 min,  $p = 0.039$ ). Subacute thrombotic occlusion occurred in two patients in Group IV and three in Group D (NS). One patient in each group died from pump failure (NS). No severe bleeding complication was found in any patient. **CONCLUSIONS:** IVT prior to PCI was considered to be a safe, effective and useful therapy in patients with acute myocardial infarction. Different patterns of reperfusion might occur, because of the low frequency of ST re-elevation and elongation of duration from reperfusion to peak creatine kinase level in patients treated with IVT prior to PCI.

## **Enhanced external counterpulsation--a therapeutic option for patients with chronic cardiovascular problems.**

**Linnemeier G.**

**E**ECPC is a non-invasive outpatient treatment for cardiovascular disease refractory to medical and/or surgical therapy. It has been cleared by the Food and Drug Administration for the treatment of a variety of cardiac conditions including congestive heart failure and chronic stable angina. A course of therapy consists of 35 one-hour treatments given once or twice daily. Augmented diastolic pressure and retrograde flow improve myocardial perfusion, while systolic unloading reduces cardiac workload and oxygen requirements. As a result of this treatment, most patients experience increased time to onset of ischemia, increased exercise tolerance, a reduction in the number and severity of anginal episodes, and improved quality of life. Evidence has been presented that this effect lasts well beyond the immediate post-treatment period with some patients symptom-free for several years. Because patients principally seek medical care to live longer or feel better, heart programs need to offer their patients the latest medical advances which have the potential of improving patient survival and health status (symptoms, functioning, and quality of life). Heart programs face a challenging economic future. Increased competition makes it necessary to implement strategies for market differentiation. Those programs most attuned to what their patients define as critical to quality would be most likely to succeed. Over the past decade, there have been a growing number of patients with chronic angina who have exhausted the standard revascularization armamentarium. Because coronary artery bypass grafts occlude and restenosis occurs at angioplasty sites, many patients no longer have suitable coronary anatomy for additional procedures. Also, as the population ages, the proportion of patients with diffuse coronary disease, congestive heart failure, significant co-morbid illness, and poor functional status increases. The incapacitating effects of angina on patients' abilities to work, maintain regular social interactions, and participate in the usual activities of daily living are well described. In spite of the ongoing successes of catheter-based revascularization techniques, the population of patients with intractable angina continues to grow; and ironically, advancements in medical therapy have resulted in an increasing number of patients who are living with severe left ventricular dysfunction and congestive heart failure. Recent studies have estimated that approximately 5-15% of patients undergoing coronary angiography may be considered to have advanced coronary artery disease. Considering that 1,713,000 cardiac catheterizations were performed in 1996 in the United States, approximately 100,000-250,000 patients per year may be eligible for newer treatments for

coronary artery disease. More recent statistics in the AHA Heart and Stroke Update report that in 2001, nearly one million patients had coronary artery bypass graft surgery or percutaneous coronary intervention, (Figure 1). Of these, 125,650 patients experienced persistent angina.

**European Society of Cardiology and American College of Cardiology guidelines for redefinition of myocardial infarction: how to use existing assays clinically and for clinical trials.**

Apple FS, Wu AH, Jaffe AS.

**B**ACKGROUND: The European Society of Cardiology and American College of Cardiology guidelines for redefinition of myocardial infarction suggest that the cutoff value for diagnosis of acute myocardial infarction (AMI) be the 99th percentile of the reference population at a level measured with imprecision (coefficient of variation)  $>$  or  $=10\%$ . No current commercially available troponin assay meets this requirement. Accordingly, questions have been raised about how to implement cutoff values from the guidelines. The Clinical Outcomes Utilizing Revascularization and Aggressive druG Evaluation (COURAGE) trial asked for recommendations concerning the use of troponin assays for the trial. **METHODS:** Cutoff values for the various assays were obtained from package inserts or from direct communication with manufacturers. **RESULTS:** The cutoff value with  $>$  or  $=10\%$  imprecision was above the 99th percentile of the reference range for all assays. For the present, we suggest that this value be used for clinical and clinical trial purposes. It will account for analytic variability and individual biological changes. We provide recommendations for clinical practice and clinical trials concerning how to make the diagnosis of AMI in patients with ischemic symptoms and patients who undergo percutaneous coronary intervention and coronary artery bypass surgery. **CONCLUSIONS:** This is a first attempt to define cutoff values on the basis of the European Society of Cardiology and American College of Cardiology guidelines. These criteria will provide increased consistency until assays improve to allow full implementation of the guidelines.

## **Outcomes of repeat revascularization in diabetic patients with prior coronary surgery.**

**Cole JH, Jones EL, Craver JM, Guyton RA, Morris DC, Douglas JS, Ghazzal Z, Weintraub WS.**

**OBJECTIVES:** This study evaluated both short- and long-term outcomes of diabetic patients who underwent repeat coronary artery bypass graft surgery (CABG) or percutaneous coronary intervention (PCI) after initial CABG. **BACKGROUND:** Although diabetic patients who have multivessel coronary disease and require initial revascularization may benefit from CABG as compared with PCI, the uncertainty concerning the choice of revascularization may be greater for diabetic patients who have had previous CABG. **METHODS:** Data were obtained over 15 years for diabetic patients undergoing PCI procedures or repeat CABG after previous coronary surgery. Baseline characteristics were compared between groups, and in-hospital, 5-year, and 10-year mortality rates were calculated. Multivariate correlates of in-hospital and long-term mortality were determined. **RESULTS:** Both PCI (n = 1,123) and CABG (n = 598) patients were similar in age, gender, years of diabetes, and insulin dependence, but they varied in presence of hypertension, prior myocardial infarction, angina severity, heart failure, ejection fraction, and left main disease. In-hospital mortality was greater for CABG, but differences in long-term mortality were not significant (10 year mortality, 68% PCI vs. 74% CABG, p = 0.14). Multivariate correlates of long-term mortality were older age, hypertension, low ejection fraction, and an interaction between heart failure and choice of PCI. The PCI itself did not correlate with mortality. **CONCLUSIONS:** The increased initial risk of redo CABG in diabetic patients and the comparable high long-term mortality regardless of type of intervention suggest that, except for patients with severe heart failure, PCI be strongly considered in all patients for whom there is a percutaneous alternative.

**Percutaneous coronary intervention versus repeat bypass surgery for patients with medically refractory myocardial ischemia: AWESOME randomized trial and registry experience with post-CABG patients.**

Morrison DA, Sethi G, Sacks J, Henderson WG, Grover F, Sedlis S, Esposito R; Investigators of the Department of Veterans Affairs Cooperative Study #385, Angina With Extremely Serious Operative Mortality Evaluation.

**OBJECTIVES:** This report compares long-term percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG) survival among post-CABG patients included in the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME) randomized trial and prospective registry. **BACKGROUND:** Repeat CABG surgery is associated with a higher risk of mortality than first-time CABG. The AWESOME is the first randomized trial comparing CABG with PCI to include post-CABG patients. **METHODS:** Over a five-year period (1995 to 2000), patients at 16 hospitals were screened to identify a cohort of 2,431 individuals who had medically refractory myocardial ischemia and at least one of five high-risk factors. There were 454 patients in the randomized trial, of whom 142 had prior CABG. In the physician-directed registry of 1,650 patients, 719 had prior CABG. Of the 327 patient-choice registry patients, 119 had at least one prior CABG. The CABG and PCI survivals for the three groups were compared using Kaplan-Meier curves and log-rank tests. **RESULTS:** The CABG and PCI three-year survival rates were 73% and 76% respectively for the 142 randomized patients (75 and 67 patients) (log-rank = NS). In the physician-directed registry, 155 patients were assigned to reoperation and 357 to PCI (207 received medical therapy); 36-month survivals were 71% and 77% respectively (log-rank = NS). In the patient-choice registry, 32 patients chose reoperation and 74 chose PCI (13 received medical therapy); 36-month survivals were 65% and 86% respectively (log-rank test  $p = 0.01$ ). **CONCLUSIONS:** Percutaneous coronary intervention is preferable to CABG for many post-CABG patients.

**The hybrid approach to coronary artery revascularization: minimally invasive direct coronary artery bypass with percutaneous coronary intervention.**

**Amodeo VJ, Donias HW, Dancona G, Hoover EL, Karamanoukian HL.**

**I**n the past decade, new developments in cardiology and cardiac surgery have begun to offer patients a variety of new, less invasive options for the treatment of coronary artery disease. One such option is the hybrid approach to coronary artery revascularization. This combines minimally invasive direct coronary artery bypass surgery (MIDCAB) of the left anterior descending artery (LAD) with percutaneous coronary intervention (PCI) of the remaining diseased coronary arteries. This approach, as an alternative to conventional coronary artery bypass surgery, retains the benefit of internal mammary artery bypass to the LAD, accomplished with a minimally invasive technique, substitutes PCI for saphenous vein grafts as treatment for low-grade lesions of other coronary arteries, and may provide a maximally beneficial outcome for many patients. Preliminary outcomes of patients receiving the hybrid approach have been strikingly positive. This report highlights the rationale for the development of this procedure, patient selection, results, and future applications of this emerging method of treating coronary artery disease.

## **A comparison of the recovery of health status after percutaneous coronary intervention and coronary artery bypass.**

**Borkon AM, Muehlebach GF, House J, Marso SP, Spertus JA.**

**B**ACKGROUND: Selection of the optimum mode of coronary revascularization should not only be directed by technical outcomes, but should also consider patients' postprocedural health status, including symptoms, functionality, and quality of life. METHODS: Health status was analyzed and compared after percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) using the Seattle Angina Questionnaire (SAQ). The SAQ was administered to 475 patients (252 PCI and 223 CABG) preprocedure and then monthly for 6 months and again at 1 year. Differences in baseline characteristics were controlled by multivariable risk adjustment, and outcomes over time were compared using repeated-measures analysis of variance. RESULTS: In-hospital, 6- and 12-month clinical outcomes were not different; however, 25% of PCI patients required at least one reintervention during the study period, compared with only 1% of CABG patients ( $p < 0.001$ ). Although physical function decreased for CABG patients at 1 month ( $p < 0.001$ ), it improved and was better than the PCI group by 12 months ( $p = 0.008$ ). Relief of angina was greater for CABG than PCI when analyzed over time ( $p < 0.001$ ), principally due to the adverse effects of restenosis in the PCI group. Multivariable analysis confirmed that CABG independently conferred greater angina relief compared with PCI ( $p < 0.001$ ). At 12 months postprocedure, quality of life had improved to a greater extent for CABG than PCI ( $p = 0.004$ ). CONCLUSIONS: Over 12 months of follow-up, health status was improved to a greater extent for CABG patients than for PCI patients, primarily due to the adverse influence of restenosis after PCI.

## **Coronary bypass graft patency in patients with diabetes in the Bypass Angioplasty Revascularization Investigation (BARI).**

**Schwartz L, Kip KE, Frye RL, Alderman EL, Schaff HV, Detre KM; Bypass Angioplasty Revascularization Investigation.**

**B**ACKGROUND: Few studies have compared long-term status of bypass grafts between patients with and without diabetes, and uncertainty exists as to whether diabetes independently predicts poor clinical outcome after CABG. **METHODS AND RESULTS:** Among 1526 patients in BARI who underwent CABG as initial revascularization, 99 of 292 (34%) with treated diabetes mellitus (TDM) (those on insulin or oral hypoglycemic agents) and 469 of 1234 (38%) without TDM had follow-up angiography. Angiograms with the longest interval from initial surgery and before any percutaneous graft intervention (mean 3.9 years) were reviewed. An average of 3.0 grafts were placed at initial CABG for patients with TDM (n=297; internal mammary artery [IMA], 33%) and 2.9 grafts for patients without TDM (n=1347; IMA, 34%). Patients with TDM were more likely than those without to have small (<1.5 mm) grafted distal vessels (29% versus 22%) and vessels of poor quality (9% versus 6%). On follow-up angiography, 89% of IMA grafts were free of stenoses > or =50% among patients with TDM versus 85% among patients without TDM (P=0.23). For vein grafts, the corresponding percentages were 71% versus 75% (P=0.40). After statistical adjustment, TDM was unrelated to having a graft stenosis > or =50% (adjusted odds ratio, 0.87; 95% CI, 0.58 to 1.32). **CONCLUSIONS:** Despite diabetic patients' having smaller distal vessels and vessels judged to be of poorer quality, diabetes does not appear to adversely affect patency of IMA or vein grafts over an average of 4-year follow-up. Previously observed differences in survival between CABG-treated patients with and without diabetes may be largely a result of differential risk of mortality from noncardiac causes.

**Percutaneous coronary intervention versus coronary bypass graft surgery for diabetic patients with unstable angina and risk factors for adverse outcomes with bypass: outcome of diabetic patients in the AWESOME randomized trial and registry.**

Sedlis SP, Morrison DA, Lorin JD, Esposito R, Sethi G, Sacks J, Henderson W, Grover F, Ramanathan KB, Weiman D, Saucedo J, Antakli T, Paramesh V, Pett S, Vernon S, Birjiniuk V, Welt F, Krucoff M, Wolfe W, Lucke JC, Mediratta S, Booth D, Murphy E, Ward H, Miller L, Kiesz S, Barbieri C, Lewis D; Investigators of the Dept. of Veterans Affairs Cooperative Study #385, the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME).

**OBJECTIVES:** This study compared survival after percutaneous coronary intervention (PCI) with survival after coronary artery bypass graft surgery (CABG) among diabetics in the Veterans Affairs AWESOME (Angina With Extremely Serious Operative Mortality Evaluation) study randomized trial and registry of high-risk patients. **BACKGROUND:** Previous studies indicate that CABG may be superior to PCI for diabetics, but no comparisons have been made for diabetics at high risk for surgery. **METHODS:** Over five years (1995 to 2000), 2,431 patients with medically refractory myocardial ischemia and at least one of five risk factors (prior CABG, myocardial infarction within seven days, left ventricular ejection fraction <0.35, age >70 years, or an intra-aortic balloon being required to stabilize) were identified. A total of 781 were acceptable for CABG and PCI, and 454 consented to be randomized. The 1,650 patients not acceptable for both CABG and PCI constitute the physician-directed registry, and the 327 who were acceptable but refused to be randomized constitute the patient-choice registry. Diabetes prevalence was 32% (144) among randomized patients, 27% (89) in the patient-choice registry, and 32% (525) in the physician-directed registry. The CABG and PCI survival rates were compared using Kaplan-Meier curves and log-rank tests. **RESULTS:** The respective CABG and PCI 36-month survival rates for diabetic patients were 72% and 81% for randomized patients, 85% and 89% for patient-choice registry patients, and 73% and 71% for the physician-directed registry patients. None of the differences was statistically significant. **CONCLUSIONS:** We conclude that PCI is a relatively safe alternative to CABG for diabetic patients with medically refractory unstable angina who are at high risk for CABG.

## Comparative survival of dialysis patients in the United States after coronary angioplasty, coronary artery stenting, and coronary artery bypass surgery and impact of diabetes.

Herzog CA, Ma JZ, Collins AJ.

**B**ACKGROUND: The optimal method of coronary revascularization in dialysis patients is controversial. The purpose of this study was to compare the long-term survival of dialysis patients in the United States after PTCA, coronary stenting, or CABG. **METHODS AND RESULTS:** Dialysis patients hospitalized from 1995 to 1998 for first coronary revascularization procedures after renal replacement therapy initiation were identified from the US Renal Data System database. All-cause and cardiac survival was estimated by the life-table method and compared by the log-rank test. The impact of independent predictors on survival was examined in a Cox regression model. The in-hospital mortality was 8.6% for 6668 CABG patients, 6.4% for 4836 PTCA patients, and 4.1% for 4280 stent patients. The 2-year all-cause survival (meanSEM) was 56.41.4% for CABG patients, 48.21.5% for PTCA patients, and 48.42.0% for stent patients ( $P<0.0001$ ). After comorbidity adjustment, the relative risk (RR) for CABG (versus PTCA) patients was 0.80 (95% CI 0.76 to 0.84,  $P<0.0001$ ) for all-cause death and 0.72 (95% CI 0.67 to 0.77,  $P<0.0001$ ) for cardiac death. For stent (versus PTCA) patients, the RR was 0.94 (95% CI 0.88 to 0.99,  $P=0.03$ ) for all-cause death and 0.92 (95% CI 0.85 to 0.99,  $P=0.04$ ) for cardiac death. In diabetic (versus PTCA) patients, the RR for CABG surgery was 0.81 (95% CI 0.75 to 0.88,  $P<0.0001$ ) for all-cause death and 0.71 (95% CI 0.64 to 0.78,  $P<0.0001$ ) for cardiac death, and the RR for the stent procedure was 0.99 (95% CI 0.91 to 1.08,  $P=NS$ ) for all-cause death and 0.99 (95% CI 0.89 to 1.11,  $P=NS$ ) for cardiac death. **CONCLUSIONS:** In this retrospective study, dialysis patients in the United States had better long-term survival after CABG surgery than after percutaneous coronary intervention. Stent outcomes were relatively worse in diabetic patients. Our data support the need for large clinical registries and prospective trials of surgical and percutaneous coronary revascularization procedures in dialysis patients.

## **Coronary artery bypass surgery versus percutaneous coronary intervention with stent implantation in patients with multivessel coronary artery disease (the Stent or Surgery trial): a randomised controlled trial.**

**SoS Investigators.**

**B**ACKGROUND: Results of trials, comparing percutaneous transluminal coronary angioplasty (PTCA) with coronary artery bypass grafting (CABG), indicate that rates of death or myocardial infarction are similar with either treatment strategy. Management with PTCA is, however, associated with an increased requirement for subsequent, additional revascularisation. Coronary stents, used as an adjunct to PTCA, reduce restenosis and the need for repeat revascularisation. The aim of the Stent or Surgery (SoS) trial was to assess the effect of stent-assisted percutaneous coronary intervention (PCI) versus CABG in the management of patients with multivessel disease. **METHODS:** In 53 centres in Europe and Canada, symptomatic patients with multivessel coronary artery disease were randomised to CABG (n=500) or stent-assisted PCI (n=488). The primary outcome measure was a comparison of the rates of repeat revascularisation. Secondary outcomes included death or Q-wave myocardial infarction and all-cause mortality. Analysis was by intention to treat. **FINDINGS:** All patients were followed-up for a minimum of 1 year and the results are expressed for the median follow-up of 2 years. 21% (n=101) of patients in the PCI group required additional revascularisation procedures compared with 6% (n=30) in the CABG group (hazard ratio 3.85, 95% CI 2.56-5.79,  $p < 0.0001$ ). The incidence of death or Q-wave myocardial infarction was similar in both groups (PCI 9% [n=46], CABG 10% [n=49]; hazard ratio 0.95, 95% CI 0.63-1.42,  $p = 0.80$ ). There were fewer deaths in the CABG group than in the PCI group (PCI 5% [n=22], CABG 2% [n=8]; hazard ratio 2.91, 95% CI 1.29-6.53,  $p = 0.01$ ). **INTERPRETATION:** The use of coronary stents has reduced the need for repeat revascularisation when compared with previous studies that used balloon angioplasty, though the rate remains significantly higher than in patients managed with CABG. The apparent reduction in mortality with CABG requires further investigation.

## **Limitations in the cardiac risk reduction provided by coronary revascularization prior to elective vascular surgery.**

**Back MR, Stordahl N, Cuthbertson D, Johnson BL, Bandyk DF.**

**OBJECTIVE:** The objective of this study was to evaluate the proposed cardiac protective effect of previous coronary revascularization (coronary artery bypass grafting [CABG] or percutaneous transluminal coronary angioplasty [PTCA]) before elective major arterial surgery. **METHOD:** Preoperative cardiac risk stratification using American College of Cardiology/American Heart Association (ACC/AHA) guidelines was done on 425 consecutive patients undergoing 481 elective major vascular operations at an academic VA Medical Center. The algorithm assumed asymptomatic patients with prior coronary revascularization (CABG, <5 year; PTCA, <2 year) were low cardiac risk. Coronary angiography was done for recurrent symptoms with secondary intervention when appropriate. Outcomes (myocardial infarction, unstable angina, congestive heart failure, ventricular arrhythmia, cardiac death, and mortality) within 30 days of vascular surgery were compared between patients with and without previous CABG or PTCA by contingency table and logistic regression analyses. **RESULTS:** Coronary revascularization was classified as recent (CABG, <1 year; PTCA, <6 months) in 35 cases (7%), prior (1 year < or = CABG < 5 year, 6 months < or = PTCA < 2 year) in 45 cases (9%), and remote (CABG, > or = 5 year; PTCA, > or = 2 year) in 48 cases (10%). A larger fraction of patients with previous revascularization possessed pathologic cardiac risk variables and were stratified as high-risk preoperatively than their nonrevascularized counterparts. Outcomes in patients with previous PTCA were similar to those after CABG ( $P = .7$ ). Significant differences in adverse cardiac events ( $P = .01$ ) and mortality ( $P = .05$ ) were found between patients with CABG done within 5 years or PTCA within 2 years (6.3%, 1.3%, respectively), individuals with remote revascularization (10.4%, 6.3%), and nonrevascularized patients stratified at high risk (13.3%, 3.3%) or intermediate/low (2.8%, 0.9%) risk. De novo or recurrent 3-vessel coronary disease by angiography, but not the presence or timing of previous revascularization, was an independent predictor of cardiac events after vascular operations, whereas remote revascularization was associated with fatal outcomes by multivariate analysis. **CONCLUSIONS:** Previous coronary revascularization (CABG, <5 years; PTCA, <2 years) may provide only modest protection against adverse cardiac events and mortality following major arterial reconstruction.

## **Comparative outcomes of percutaneous coronary interventions in diabetics vs non-diabetics with prior coronary artery bypass grafting.**

**Mathew V, Wilson SH, Barsness GW, Frye RL, Lennon R, Holmes DR.**

**A**IMS: To determine the influence of diabetes on outcome after percutaneous coronary intervention in patients with prior coronary artery bypass grafting. **METHODS AND RESULTS:** Patients with prior coronary artery bypass grafting undergoing percutaneous coronary intervention from 1 January 1996, to 31 August 2000, were divided into two groups based on whether or not they had diabetes, excluding patients with acute infarction or shock. Cox proportional hazards models were utilized to estimate the association between diabetes and adverse events. One thousand one hundred and fifty-three post-coronary artery bypass grafting percutaneous coronary intervention patients were identified (326 diabetics and 827 non-diabetics). Diabetics were younger, more likely to have hypertension, heart failure, and lower ejection fraction. Procedural characteristics and angiographic and procedural success rates were similar. Diabetes was associated with increased mortality (hazard ratio 1.58, 95% confidence intervals 1.10-2.27). Diabetes did not have a significant effect on mortality in patients treated for single-territory coronary disease (hazard ratio 1.44, 95% confidence intervals 0.69-3.02), but did in patients with multi-territory disease (hazard ratio 1.79, 95% confidence intervals 1.16-2.76). However, in diabetics with multi-territory disease who were completely revascularized with percutaneous coronary intervention, mortality was comparable to non-diabetics (hazard ratio 1.32, 95% confidence intervals 0.57-3.03). **CONCLUSION:** Among percutaneous coronary intervention patients with prior coronary artery bypass grafting, diabetes portends an adverse prognosis.

## Comparison of stenting with minimally invasive bypass surgery for stenosis of the left anterior descending coronary artery.

Diegeler A, Thiele H, Falk V, Hambrecht R, Spyranis N, Sick P, Diederich KW, Mohr FW, Schuler G.

**B**ACKGROUND: Minimally invasive bypass surgery and coronary-artery stenting are both accepted treatments for isolated stenosis of the proximal left anterior descending coronary artery. We compared the clinical outcomes after these two procedures. **METHODS:** A total of 220 symptomatic patients with high-grade lesions in the proximal left anterior descending coronary artery were randomly assigned to treatment--110 to surgery and 110 to stenting. The combined clinical end point was freedom from major adverse cardiac events, such as death from cardiac causes, myocardial infarction, and the need for repeated revascularization of the target lesion within six months. **RESULTS:** A major adverse cardiac event occurred in 31 percent of patients after stenting, as compared with 15 percent in the surgery group ( $P=0.02$ ). The difference was predominantly due to a higher rate of repeated revascularization of the target vessel for restenosis after stenting (29 percent vs. 8 percent,  $P=0.003$ ). The combined rates of death and myocardial infarction did not differ significantly between groups (3 percent in the stenting group and 6 percent in the surgery group,  $P=0.50$ ). Adverse events occurred more frequently after surgery. The percentage of patients free from angina after six months was 79 percent in the surgery group, as compared with 62 percent in the stenting group ( $P=0.03$ ). **CONCLUSIONS:** In patients with isolated high-grade lesions of the proximal left anterior descending artery, both minimally invasive bypass surgery and stenting are effective. Stenting yields excellent short-term results with fewer periprocedural adverse events, but surgery is superior with regard to the need for repeated intervention in the target vessel and freedom from angina at six months of follow-up.

## **Integrated minimally invasive direct coronary artery bypass grafting and angioplasty for coronary artery revascularization.**

**Cisowski M, Morawski W, Drzewiecki J, Kruczak W, Toczek K, Bis J, Bochenek A.**

**O**BJECTIVE: Minimally invasive direct coronary artery bypass (MIDCAB) through the anterolateral minithoracotomy has become a promising therapeutic option in patients with lesion in left anterior descending artery (LAD), especially in multimorbid, elderly and reoperated patients with type C or B lesions. To expand the benefits of MIDCAB concept to patients with multivessel disease, a hybrid myocardial revascularization procedure (HMR) combining surgery of the LAD with interventional procedures for additional coronary lesions has recently been introduced. **METHODS:** Between January 1999 and September 2001, 50 patients (37 male, 13 female, mean age 54.8±20.1 years) underwent an HMR procedure. MIDCAB with endoscopic left internal thoracic artery (LITA) harvesting, followed by percutaneous coronary intervention (PCI) for additional coronary lesions and percutaneous transluminal coronary angioplasty (PTCA), was performed in 11 patients (22%) and stenting in 39 patients (78%). Angiographic assessment of graft patency was performed in all patients during the PCI procedure. The clinical follow-up period was 3–32 months. **RESULTS:** There were no early and late deaths. Baseline Canadian Cardiology Society (CCS) class was 2.8±0.7 versus 1.1±0.9 ( $P<0.001$ ) 30 days after HMR procedure. There were no major acute in-hospital cardiac events. Angiographic studies showed patent LIMA–LAD graft in 50 patients (100%). We showed good quality of anastomosis in 49 patients (98%). There was a moderate graft stenosis in one patient (2%). At long term follow-up, the rate of major cardiac events was 12%. Five patients (10%) developed restenosis after PCI, and one patient (2%) developed significant stenosis in site of LITA–LAD anastomosis; redo PCI was performed successfully. **CONCLUSIONS:** The hybrid procedure is a safe and effective method for complete revascularization in selected patients with double-vessel coronary artery disease (patients with type B or C lesions in the proximal LAD). This method allows performance of complete revascularization with minimization of surgical trauma. So far, long-term results of HMR are limited by the results of PCI.

**Rescue percutaneous coronary intervention following coronary artery bypass graft—a descriptive analysis of the changing interface between interventional cardiologist and cardiac surgeon.**

Adams MR, Orford JL, Blake GJ, Wainstein MV, Byrne JG, Selwyn AP.

**B**ACKGROUND: Despite decreasing rates of acute and subacute complications of percutaneous coronary intervention (PCI), these procedures are generally only performed in centers where it is possible for failed PCI to be treated by rescue coronary artery bypass graft (CABG). Case reports and case series have documented successful PCI following failed CABG. We sought to confirm this decrease in the need for rescue CABG following failed PCI and to examine trends in the utilization of rescue PCI following failed CABG. **HYPOTHESIS:** The interface between interventional cardiologist and cardiac surgeon is characterized by changing practice patterns and resource utilization. **METHODS:** We examined the medical records of all patients admitted to the Brigham and Women's Hospital over a 7-year period and identified 169 patients who required both PCI and CABG during the same hospital admission. We describe and compare three predetermined groups of patients defined by the sequence of, and indication for, the relevant myocardial revascularization procedures. **RESULTS:** In all, 100 patients required CABG for failed PCI, 46 patients had planned hybrid procedures involving both CABG and PCI, and 23 patients required PCI following failed CABG. There was a decrease in the need for rescue CABG following failed PCI, both in total numbers and as a percentage of total cases (2.5% in 1994 and 0.22% in 1999). There was a simultaneous increase in the utilization of rescue PCI following failed CABG (0% in 1994 and 1.6% in 2000). Hybrid procedures were identified as a source of innovative solutions to a variety of challenging clinical problems. **CONCLUSIONS:** Changing patterns of resource utilization should be considered when planning hospital facilities and patient triage, and these patients undergoing percutaneous or surgical revascularization may benefit from close cooperation between the cardiac surgeon and the interventional cardiologist.

## **Coronary artery bypass graft surgery and percutaneous transluminal coronary angioplasty. Twenty-year clinical outcome.**

**van Domburg RT, Foley DP, Breeman A, van Herwerden LA, Serruys PW.**

**A**IMS: The purpose of this study is to compare the long-term outcome (up to 20 years) of coronary artery bypass surgery (CABG) with percutaneous transluminal coronary angioplasty (PTCA) in a consecutive patient series at a single centre. Survival is similar after CABG and PTCA up to 8 years follow-up in patients with multivessel disease, with a reduced need for repeat revascularization after CABG. As coronary artery disease is a lifetime disease, longer-term follow-up of these revascularization therapies is necessary to help clinical decision-making. **METHODS AND RESULTS:** The CABG study population consisted of the first 1041 consecutive patients who underwent a first elective coronary bypass surgery between 1970 and 1980. The PTCA study population consisted of 702 consecutive patients who underwent a first elective coronary angioplasty procedure between 1980 and 1985. Mortality and subsequent revascularization up to 20 years were captured. Survival rates were adjusted using proportional hazards methods to account for baseline differences. **RESULTS:** The unadjusted survival rates were 92%, 77%, 57% and 49% after CABG at respectively, 5-, 10-, 15- and 17 years and 91%, 80%, 64% and 59% after PTCA. In the multivessel disease subgroup, survival was similar with a benefit apparent after CABG in the first 8 years of follow-up. The therapy chosen, CABG or PTCA, was a univariate predictor of mortality in favour of PTCA (RR: 1.28; 95% CI: 1.10-1.49), but after correction for baseline characteristics, the relative risk of mortality for CABG vs PTCA was comparable (RR: 1.03; 95% CI: 0.87-1.24). The adjusted survival curves in the subgroup of diabetic elderly patients with multivessel disease were similar after the tenth year with only a slightly better survival in the CABG population in the first 10 years. Repeat intervention was more frequently required after PTCA during the first 8 years, but after this time more frequently in the CABG group. **CONCLUSION:** When comparing CABG and PTCA it can be concluded that both strategies are equally effective in terms of 20-year survival. In particular, after more than 10 years all differences tend to disappear. While repeat intervention was significantly higher in the first year after PTCA, after 7-8 years, reintervention was greater in patients who had initial CABG. Copyright 2001 The European Society of Cardiology.

## **The role of PCI and CABG in the management of coronary artery disease in patients with diabetes.**

**Frye RL, Bell MR, Schaff HV, Holubkov R, Detre KM.**

**T**he role of percutaneous coronary intervention (PCI) and coronary artery bypass surgery (CABG) in patients with diabetes mellitus (DM) is evolving. Data from clinical trials and observational studies are reviewed as well as current clinical practice guidelines. The importance of aggressive medical therapy to achieve recommended glycemic control targets, and management of usual risk factors in patients with coronary artery disease (CAD) cannot be overemphasized regardless of the revascularization therapy selected. Patients with type 2 diabetes are at increased risk for CAD, which is the cause of death in the majority of patients. Outcomes following PCI and CABG are worse in patients with DM compared to those without DM. This calls for randomized trials and other studies focused on patients with DM.

## PTCA and CABG

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Frye RL, Bell MR, Schaff HV, Holubkov R, Detre KM.

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**N Engl J Med , 2001;344(15):1117-24**

**Comparison of coronary-artery bypass surgery and stenting for the treatment of multivessel disease.**

Serruys PW, Unger F, Sousa JE, Jatene A, Bonnier HJ, Schonberger JP, Buller N, Bonser R, van den Brand MJ, van Herwerden LA, Morel MA, van Hout BA; Arterial Revascularization Therapies Study Group.

**BACKGROUND:** The recent recognition that coronary-artery stenting has improved the short- and long-term outcomes of patients treated with angioplasty has made it necessary to reevaluate the relative benefits of bypass surgery and percutaneous interventions in patients with multivessel disease. **METHODS:** A total of 1205 patients were randomly assigned to undergo stent implantation or bypass surgery when a cardiac surgeon and an interventional cardiologist agreed that the same extent of revascularization could be achieved by either technique. The primary clinical end point was freedom from major adverse cardiac and cerebrovascular events at one year. The costs of hospital resources used were also determined. **RESULTS:** At one year, there was no significant difference between the two groups in terms of the rates of death, stroke, or myocardial infarction. Among patients who survived without a stroke or a myocardial infarction, 16.8 percent of those in the stenting group underwent a second revascularization, as compared with 3.5 percent of those in the surgery group. The rate of event-free survival at one year was 73.8 percent among the patients who received stents and 87.8 percent among those who underwent bypass surgery ( $P < 0.001$  by the log-rank test). The costs for the initial procedure were \$4,212 less for patients assigned to stenting than for those assigned to bypass surgery, but this difference was reduced during follow-up because of the increased need for repeated revascularization; after one year, the net difference in favor of stenting was estimated to be \$2,973 per patient. **CONCLUSION:** As measured one year after the procedure, coronary stenting for multivessel disease is less expensive than bypass surgery and

offers the same degree of protection against death, stroke, and myocardial infarction. However, stenting is associated with a greater need for repeated revascularization.

J Am Coll Cardiol ,2001;37(7):1877-82

Percutaneous and surgical interventions for in-stent restenosis: long-term outcomes and effect of diabetes mellitus.

Moustapha A, Assali AR, Sdringola S, Vaughn WK, Fish RD, Rosales O, Schroth G, Krajcer Z, Smalling RW.

**OBJECTIVE:** We examined long-term outcomes of patients with in-stent restenosis (ISR) who underwent different percutaneous interventions at the discretion of individual operators: balloon angioplasty (BA), repeat stent or rotational atherectomy (RA). We also examined long-term outcomes of patients with ISR who underwent coronary artery bypass surgery (CABG). **BACKGROUND:** In-stent restenosis remains a challenging problem, and its optimal management is still unknown. **METHODS:** Symptomatic patients (n = 510) with ISR were identified using cardiac catheterization laboratory data. Management for ISR included BA (169 patients), repeat stenting (117 patients), RA (107 patients) or CABG (117 patients). Clinical outcome events of interest included death, myocardial infarction, target vessel revascularization (TVR) and a combined end point of these major adverse cardiovascular events (MACE). Mean follow-up was 19+/-12 months (range = 6 to 61 months). **RESULTS:** Patients with ISR treated with repeat stent had significantly larger average post-procedure minimal lumen diameter compared with BA or RA (3.3+/-0.4 mm vs. 3.0+/-0.4 vs. 2.9+/-0.5, respectively, p < 0.05). Incidence of TVR and MACE were similar in the BA, stent and RA groups (39%, 40%, 33% for TVR and 43%, 40%, 33% for MACE, p = NS). Patients with diabetes who underwent RA had similar outcomes as patients without diabetes, while patients with diabetes who underwent BA or stent had worse outcomes than patients without diabetes. Patients who underwent CABG for ISR, mainly because of the presence of multivessel disease, had significantly better outcomes than any percutaneous treatment (8% for TVR and 23% for MACE). **CONCLUSIONS:** In this large cohort of patients with ISR and in the subset of patients without diabetes, long-term outcomes were similar in the BA, repeat stent and RA groups. Tissue debulking with RA yielded better results only in diabetic patients. Bypass surgery for patients with multivessel disease and ISR provided the best outcomes.

Heart , 2001;85(6):662-6

Outcomes following coronary artery bypass grafting and percutaneous transluminal coronary angioplasty in the stent era: a prospective study of all 9890 consecutive patients operated on in Scotland over a two year period.

Pell JP, Walsh D, Norrie J, Berg G, Colquhoun AD, Davidson K, Eteiba H, Faichney A, Flapan A, Hogg KJ, Jeffrey RR, Jennings K, McArthur J, Mankad P, Oldroyd K, Pell AC, Starkey IR.

**OBJECTIVE:** To determine current outcomes of percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass grafting (CABG). **DESIGN:** The Scottish coronary revascularisation register provided prospectively collected data on case mix and in-hospital complications for all revascularisation procedures between April 1997 and March 1999 (4775 PTCA; 5115 CABG). Linkage to routine hospital discharge and death data provided follow up information on survival and repeat revascularisation. **RESULTS:** Stents were used in 51% of PTCA procedures. CABG patients were older, had more severe coronary disease, and had greater comorbidity. PTCA was more likely to be undertaken as an urgent or emergency procedure. Perioperative death and urgent surgery followed 0.3% and 0.6% of PTCA procedures, respectively. Case fatality rates were higher following CABG, with 6.7% dead within two years compared with 3.4% following PTCA. PTCA was more often followed by readmission for ischaemic heart disease, repeat angiography, or revascularisation: 22.8% of patients had repeat revascularisation within two years, compared with 1.8% following CABG. **CONCLUSIONS:** The severity of coronary heart disease was greater than in previously published registry studies and randomised trials. Despite this, overall survival figures were comparable and repeat revascularisation rates lower, particularly following PTCA. Perioperative death and urgent surgery following PTCA were also lower. These favourable outcomes may be attributable, in part, to increased use of bail out and elective stenting.

J Am Coll Cardiol, 2001;38(1):41-8

Is early invasive treatment of unstable coronary artery disease equally effective for both women and men?  
FRISC II Study Group Investigators.

Lagerqvist B, Safstrom K, Stahle E, Wallentin L, Swahn E; FRISC II Study Group Investigators.

**BACKGROUND:** The Fragmin and fast Revascularization during InStability in Coronary artery disease (FRISC II) trial compared the effectiveness of an early invasive versus a noninvasive strategy in terms of the incidence of death and myocardial infarction (MI) in patients with unstable coronary artery disease (CAD). **OBJECTIVES:** In this subanalysis, we sought to evaluate gender differences in the effect of these different strategies. **METHODS:** The patients (749 women and 1,708 men) were randomized to early invasive or noninvasive strategies. Coronary angiography was performed within the first 7 days in 96% and 10% of the invasive and noninvasive groups, respectively, and revascularization was performed within the first 10 days in 71% and 9% of the invasive and noninvasive groups, respectively. **RESULTS:** Women presenting with unstable CAD were older, but fewer had previous infarctions, left ventricular dysfunction and elevated troponin T levels. Women had fewer angiographic changes. There was no difference in MI or death at 12 months among women in the invasive and noninvasive groups (12.4% vs. 10.5%, respectively), in contrast to the favorable effect in the invasively treated group of men (9.6% vs. 15.8%,  $p < 0.001$ ). In an interaction analysis, there was a different effect of the early invasive strategy for the two genders ( $p = 0.008$ ). **CONCLUSIONS:** Women with symptoms and/or signs of unstable CAD are older, but still have less severe CAD and a better prognosis compared with men. In contrast to its beneficial effect in men, an early invasive strategy did not reduce the risk of future events among women. Further research is warranted to identify the most appropriate treatment strategy in women with unstable CAD.

J Am Coll Cardiol 2001;38(1):143-9

Percutaneous coronary intervention versus coronary artery bypass graft surgery for patients with medically refractory myocardial ischemia and risk factors for adverse outcomes with bypass: a multicenter, randomized trial. Investigators of the Department of Veterans Affairs Cooperative Study #385, the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME).

Morrison DA, Sethi G, Sacks J, Henderson W, Grover F, Sedlis S, Esposito R, Ramanathan K, Weiman D, Saucedo J, Antakli T, Paramesh V, Pett S, Vernon S, Birjiniuk V, Welt F, Krucoff M, Wolfe W, Lucke JC, Mediratta S, Booth D, Barbieri C, Lewis D; Angina With Extremely Serious Operative Mortality Evaluation (AWESOME).

**BACKGROUND:** Percutaneous coronary intervention (PCI) and coronary artery bypass graft surgery (CABG) are being applied to high-risk populations, but previous randomized trials comparing revascularization

methods have excluded a number of important high-risk groups. OBJECTIVES: This five-year, multicenter, randomized clinical trial was designed to compare long-term survival among patients with medically refractory myocardial ischemia and a high risk of adverse outcomes assigned to either a CABG or a PCI strategy, which could include stents. METHODS: Patients from 16 Veterans Affairs Medical Centers were screened to identify myocardial ischemia refractory to medical management and the presence of one or more risk factors for adverse outcome with CABG, including prior open-heart surgery, age >70 years, left ventricular ejection fraction <0.35, myocardial infarction within seven days or intraaortic balloon pump required. Clinically eligible patients (n = 2,431) underwent coronary angiography; 781 were angiographically acceptable; 454 (58% of eligible) patients consented to random assignment between CABG and PCI. RESULTS: A total of 232 patients was randomized to CABG and 222 to PCI. The 30-day survivals for CABG and PCI were 95% and 97%, respectively. Survival rates for CABG and PCI were 90% versus 94% at six months and 79% versus 80% at 36 months (log-rank test, p = 0.46). CONCLUSIONS: Percutaneous coronary intervention is an alternative to CABG for patients with medically refractory myocardial ischemia and a high risk of adverse outcomes with CABG.

Am Heart J ,2001;142(1):190-6

Urgent coronary bypass surgery for failed percutaneous coronary intervention in the stent era: Is backup still necessary?

Shubrooks SJ Jr, Nesto RW, Leeman D, Waxman S, Lewis SM, Fitzpatrick P, Dib N.

BACKGROUND: Current practice guidelines for performance of percutaneous coronary intervention (PCI) in the United States mandate availability of on-site surgical backup. With the decreasing frequency of urgent coronary bypass surgery (UCABG) with newer technologies, it is unclear whether such backup continues to be necessary. METHODS: A database of 5655 consecutive patients undergoing PCI at a single center between August 1, 1992, and December 31, 1997, was analyzed. Outcomes were determined as well as clinical, lesion, and procedural characteristics of patients during 4 time periods preceding and during use of coronary stenting. RESULTS: Frequency of UCABG for failed PCI decreased from 2.2% to 0.6% in the most recent time period (P <.01) with no change in incidence of in-hospital death or myocardial infarction. Incidence of stenting progressively increased to 72% in the latest period. Patients requiring UCABG had a higher prevalence of acute coronary syndromes (95%) and type B lesions (79%), but these characteristics were also common in patients

who did not undergo UCABG. Although coronary stents were available during the last 3 periods studied, only 30% of UCABG patients had lesions or complications amenable to stenting, and stenting attempts in these patients were all unsuccessful. Despite stenting and use of perfusion balloons and intra-aortic balloon pumps, only 40% of patients having UCABG were stable and pain free on transfer to the operating room. CONCLUSIONS: Although use of UCABG for a failed PCI is currently very low, there are no satisfactory predictors, patients requiring UCABG are frequently clinically unstable, and availability of stenting does not reliably eliminate the need for UCABG or result in a decrease in mortality. This small group of patients continues to require readily available surgical standby.

Am Heart J ,2001;142(4):563-70

Combination of minimally invasive coronary bypass and percutaneous transluminal coronary angioplasty in the treatment of double-vessel coronary disease: Two-year follow-up of a new hybrid procedure compared with ?n-pump?double bypass grafting.

de Canniere D, Jansens JL, Goldschmidt-Clermont P, Barvais L, Decroly P, Stoupe E.

OBJECTIVE: Percutaneous transluminal coronary angioplasty (PTCA) or surgery can be chosen as first-line therapies in multiple-vessel coronary disease. A mammary-to-left anterior descending (LAD) graft is the most important statistical determinant of a favorable outcome after coronary artery bypass grafting (CABG) and can be performed with lower morbidity off pump through a minithoracotomy. PTCA and stenting of the ?on-LAD?vessels compete with CABG in terms of patency rates. Our purpose was to compare a combination of minimally invasive direct coronary artery bypass (MIDCAB) and PTCA with double CABG as a treatment for double-vessel coronary artery disease involving the proximal LAD. METHODS: Two matched groups of 20 patients with double-vessel coronary disease undergoing either sequential MIDCAB and PTCA (group 1) or double CABG on cardiopulmonary bypass (group 2) were compared. Angiographic control, complications, hospital costs, quality of life, and 2-year follow-up of ischemia are reported. RESULTS: All bypasses were patent at early control. Three adverse events were noted in group 1 and 17 in group 2. The hybrid-procedure group exhibited a shorter intensive care unit stay, fewer blood products transfused, less pain, better early quality of life, faster return to work, and similar cost. Three patients required a second PTCA in group 1, one of which for restenosis. At 2 years all the patients are asymptomatic with no residual ischemia. CONCLUSIONS: We conclude from this pilot study that the hybrid procedure is feasible and appears to be a safe therapy for

double-vessel coronary artery disease and that it appears to generate less perioperative morbidity than classic double CABG does. Therefore we believe that there is room to undertake prospective randomized studies on a larger-scale basis.

J Am Coll Cardiol ,2001;38(3):659-65

Long-term clinical outcome and predictors of major adverse cardiac events after percutaneous interventions on saphenous vein grafts.

Keeley EC, Velez CA, O'eill WW, Safian RD.

**OBJECTIVES:** The purpose of this study was to examine the long-term clinical outcome after percutaneous intervention of saphenous vein grafts (SVG) and to identify the predictors of major adverse cardiac events (MACE). **BACKGROUND:** Percutaneous interventions of SVGs have been associated with more procedural complications and higher restenosis rates compared with interventions on native vessels. **METHODS:** From 1993 to 1997, 1,062 patients underwent percutaneous intervention on 1,142 SVG lesions. Procedural, in-hospital and long-term clinical outcomes were recorded in a database and analyzed. **RESULTS:** In-hospital MACE occurred in 137 patients (13%) including death (8%), Q-wave myocardial infarction (MI) (2%) and coronary artery bypass surgery (3%). Late MACE occurred in 565 patients (54%) including death (9%), Q-wave MI (9%) and target vessel revascularization (36%). Any MACE occurred in 457 (43%) patients. Follow-up was available in 1,056 (99%) patients at 3 +/- 1 year. Univariate predictors were restenotic lesion (odds ratio [OR]: 2.47, confidence interval [CI]: 1.13 to 3.85, p = 0.0003), unstable angina (OR: 1.99, CI: 1.27 to 2.91, p = 0.04) and congestive heart failure (CHF) (OR: 1.97, CI: 1.14 to 3.24, p = 0.02) for in-hospital MACE, and peripheral vascular disease (PVD) (OR: 2.18, CI: 1.34 to 3.44, p = 0.002), intra-aortic balloon pump placement (OR: 2.08, CI: 1.13 to 3.85, p = 0.02) and previous MI (OR: 1.97, CI: 1.14 to 3.25, p = 0.007) for late MACE. Independent multivariate predictors for late MACE were restenotic lesion (relative risk [RR] 1.33, p = 0.02), PVD (RR: 1.31, p = 0.01), CHF (RR: 1.42, p = 0.01) and multiple stents (RR: 1.47, p = 0.004). Angiographic follow-up was available for 422 patients. Angiographic restenosis occurred in 122 (29%) of stented SVGs and 181 (43%) of nonstented SVGs (p = 0.04). Stent implantation did not confer a survival benefit. **CONCLUSIONS:** Despite the use of new interventional devices, SVG interventions are associated with significant morbidity and mortality; SVG stenting is not associated with better three-year event-free survival. This may be due to progressive disease at nonstented sites.

J Am Coll Cardiol ,2001;38(5):1440-9

Survival following coronary angioplasty versus coronary artery bypass surgery in anatomic subsets in which coronary artery bypass surgery improves survival compared with medical therapy. Results from the Bypass Angioplasty Revascularization Investigation (BARI).

Berger PB, Velianou JL, Aslanidou Vlachos H, Feit F, Jacobs AK, Faxon DP, Attubato M, Keller N, Stadius ML, Weiner BH, Williams DO, Detre KM; The BARI Investigators.

**OBJECTIVES:** We sought to compare survival after coronary artery bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA) in high-risk anatomic subsets. **BACKGROUND:** Compared with medical therapy, CABG decreases mortality in patients with three-vessel disease and two-vessel disease involving the proximal left anterior descending artery (LAD), particularly if left ventricular (LV) dysfunction is present. How survival after PTCA and CABG compares in these high-risk anatomic subsets is unknown. **METHODS:** In the Bypass Angioplasty Revascularization Investigation (BARI), 1,829 patients with multivessel disease were randomized to an initial strategy of PTCA or CABG between 1988 and 1991. Stents and IIB/IIIa inhibitors were not utilized. Since patients in BARI with diabetes mellitus had greater survival with CABG, separate analyses of patients without diabetes were performed. **RESULTS:** Seven-year survival among patients with three-vessel disease undergoing PTCA and CABG (n = 754) was 79% versus 84% (p = 0.06), respectively, and 85% versus 87% (p = 0.36) when only non-diabetics (n = 592) were analyzed. In patients with three-vessel disease and reduced LV function (ejection fraction <50%), seven-year survival was 70% versus 74% (p = 0.6) in all PTCA and CABG patients (n = 176), and 82% versus 73% (p = 0.29) among non-diabetic patients (n = 124). Seven-year survival was 87% versus 84% (p = 0.9) in all PTCA and CABG patients (including diabetics) with two-vessel disease involving the proximal LAD (n = 352), and 78% versus 71% (p = 0.7) in patients with two-vessel disease involving the proximal LAD with reduced LV function (n = 72). **CONCLUSION:** In high-risk anatomic subsets in which survival is prolonged by CABG versus medical therapy, revascularization by PTCA and CABG yielded equivalent survival over seven years.

J Am Coll Cardiol ,2002 ;39(2):266-73

Percutaneous coronary intervention versus coronary bypass graft surgery for patients with medically refractory

myocardial ischemia and risk factors for adverse outcomes with bypass: The VA AWESOME multicenter registry: comparison with the randomized clinical trial.

Morrison DA, Sethi G, Sacks J, Henderson W, Grover F, Sedlis S, Esposito R, Ramanathan KB, Weiman D, Talley JD, Saucedo J, Antakli T, Paramesh V, Pett S, Vernon S, Birjiniuk V, Welt F, Krucoff M, Wolfe W, Lucke JC, Mediratta S, Booth D, Barbieri C, Lewis D; The VA AWESOME (Angina With Extremely Serious Operative Mortality Evaluation) Multicenter Registry.

**OBJECTIVES:** This study was designed to compare the three-year survival after percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG) in physician-directed and patient-choice registries with the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME) randomized trial results. **BACKGROUND:** The AWESOME multicenter randomized trial and registry compared the long-term survival after PCI and CABG for the treatment of patients with medically refractory myocardial ischemia and at least one additional risk factor for adverse outcome with CABG. The randomized trial demonstrated comparable three-year survival. **METHODS:** Over a five-year period (1995 to 2000), 2,431 patients with medically refractory myocardial ischemia and at least one of five risk factors (prior heart surgery, myocardial infarction within seven days, left ventricular ejection fraction <0.35, age >70 years, intra-aortic balloon required to stabilize) were identified. By physician consensus, 1,650 patients formed a physician-directed registry assigned to CABG (692), PCI (651) or further medical therapy (307), and 781 were angiographically eligible for random allocation; 454 of these patients constitute the randomized trial, and the remaining 327 constitute a patient choice registry. Survival for CABG and PCI was compared using Kaplan-Meier curves and log-rank tests. **RESULTS:** The CABG and PCI 36-month survival rates for randomized patients were 79% and 80%, respectively. The CABG and PCI 36-month survival rates were both 76% for the physician-directed subgroup; comparable survival rates for the patient-choice subgroup were 80% and 89%, respectively. None of the global log-rank tests for survival demonstrated significant differences. **CONCLUSIONS:** Both registries support the randomized trial conclusion: PCI is an alternative to CABG for some medically refractory high-risk patients.

Am J Cardiol ,2002;89(3):251-6

Comparison of event and procedure rates following percutaneous transluminal coronary angioplasty in patients with and without previous coronary artery bypass graft surgery [the ROSETTA (Routine versus Selective Exercise Treadmill Testing after Angioplasty) Registry].

Garzon P, Sheppard R, Eisenberg MJ, Schechter D, Lefkovits J, Goudreau E, Mak KH, Brown DL; The ROSETTA Investigators.

To compare 6-month post-percutaneous transluminal coronary angioplasty (PTCA) outcomes and cardiac procedure use among patients with and without prior coronary artery bypass graft (CABG) surgery, we examined 791 patients who were enrolled in the Routine versus Selective Exercise Treadmill Testing after Angioplasty (ROSETTA) Registry. The ROSETTA Registry is a prospective, multicenter registry that examines the use of functional testing after successful PTCA. Most patients were men (76%, mean age 61 +/- 11 years) who underwent single-vessel PTCA (85%) with stent implantation (58%). Baseline and procedural characteristics differed between patients with a prior CABG (n = 131) and patients with no prior CABG (n = 660), including Canadian Cardiovascular Society angina class III to IV (60% vs 49%, respectively, p = 0.03) and stenosis involving the proximal left anterior descending coronary artery (10% vs 22%, p = 0.004). Event rates among patients with prior CABG were higher than among patients with no prior CABG, including unstable angina (19% vs 11%, p = 0.02), myocardial infarction (2% vs 1%, p = 0.2), death (4% vs 2%, p = 0.08), and composite clinical events (22% vs 12%, p = 0.003). Furthermore, patients with prior CABG had higher rates of follow-up cardiac procedures, including angiography (24% vs 14%, p = 0.008) and PTCA (13% vs 7%, p = 0.04), but not repeat CABG (2% vs 3%, p = 0.8). A multivariate analysis that included baseline clinical and procedural characteristics demonstrated that prior CABG was a significant independent predictor of clinical events and cardiac procedure use (odds ratio 2.3, 95% confidence interval 1.5 to 3.5, p = 0.0001). Within the prior CABG group, patients with a PTCA of a bypass graft had a higher composite clinical event rate than patients with a PTCA of a native vessel (32% vs 17%, p = 0.05). In contrast, patients with a PTCA of a native vessel had event rates similar to those of patients with no prior CABG (17% vs 12%, p = 0.2). Thus, post-CABG patients have an increased risk of developing a cardiac event or needing a follow-up cardiac procedure during the 6 months after PTCA.

Outcome of Coronary Bypass Surgery Versus Coronary Angioplasty in Diabetic Patients With Multivessel Coronary Artery Disease

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**Objectives.** This study sought to compare the outcome of percutaneous transluminal coronary angioplasty (PTCA) (n = 834) and coronary artery bypass graft surgery (CABG) (n = 1805) in diabetic patients with multivessel coronary disease from an observational database.

**Background.** There is concern about selection of revascularization in diabetic patients with multivessel coronary artery disease.

**Methods.** Data were collected prospectively and entered into a computerized database. Follow-up was by letter or telephone or additional events resulting in readmission.

**Results.** After CABG there were more in-hospital deaths (0.36% vs. 4.99%,  $p < 0.0001$ ) and a trend toward more Q wave myocardial infarctions than after PTCA. Five- and 10-year survival rates were 78% and 45% after PTCA and 76% and 48% after CABG, respectively ( $p = 0.47$ ). At 5 and 10 years, insulin-requiring patients had lower survival rates of 72% and 31% after PTCA and 70% and 48% after CABG, respectively ( $p = 0.54$ ). Multivariate correlates of long-term mortality were older age, low left ventricular ejection fraction, heart failure and hypertension. In the total group, insulin requirement was a correlate of long-term mortality. For the total group, choice of therapy had a multivariate hazard ratio close to 1. In the insulin-requiring subgroup, the multivariate hazard ratio was 1.35 (95% confidence interval 1.01 to 1.79) for PTCA versus CABG. Corrected for baseline differences, 5- and 10-year survival rates were 68% and 36% after PTCA and 75% and 47% after CABG, respectively, in the insulin-requiring subgroup. Nonfatal events were more common after PTCA, especially additional revascularization.

**Conclusions.** This study reveals a high incidence of events in diabetic patients and raises further questions about angioplasty in insulin-requiring diabetic patients with multivessel disease.

### Summary

1. In hospital death - CABG: 0.36%, PTCA: 4.99% ( $p < 0.0001$ )
2. Five- and 10-year survival rates - CABG 76% and 48%, PTCA: 78% and 45% ( $p = 0.47$ ).
3. Five and 10-year survival rates in insulin-requiring patients - CABG: 70% and 48% PTCA: 72% and 31% ( $p = 0.54$ ).
4. Factors affecting long-term mortality: older age, low left ventricular ejection fraction, heart failure and hypertension. ( In the total group, insulin requirement was a correlate of long-term mortality.)

## A Randomized Study of Coronary Angioplasty Compared with Bypass Surgery in Patients with Symptomatic Multivessel Coronary Disease

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**Background.** The standard treatment for patients with symptomatic multivessel coronary artery disease is coronary-artery bypass grafting (CABG). Percutaneous transluminal coronary angioplasty (PTCA) is widely used as an alternative approach to revascularization, but a systematic comparison of the two procedures is needed. We compared the outcomes in patients one year after complete revascularization with CABG or PTCA. **Methods.** A total of 8981 patients with multivessel coronary disease were screened at eight clinical sites, and 359 patients were randomly assigned to undergo CABG (177 patients) or PTCA (182 patients). Enrollment required that complete revascularization of at least two major vessels supplying different myocardial regions be deemed clinically necessary and technically feasible.

**Results.** Among the patients in the CABG group, an average ( $\pm$ SD) of  $2.2\pm 0.6$  vessels were grafted, and among those in the PTCA group,  $1.9\pm 0.5$  vessels were dilated. After CABG, hospitalization was longer (median, 19 days, as compared with 5 for PTCA), and Q-wave myocardial infarction in relation to the procedure was more frequent (8.1 percent, as compared with 2.3 percent after PTCA;  $P = 0.022$ ), whereas in-hospital mortality did not differ significantly between the two groups (2.5 percent in the CABG group and 1.1 percent in the PTCA group). At discharge 93 percent of the patients in the CABG group were free of angina, as compared with 82 percent of those in the PTCA group ( $P = 0.005$ ). During the first year of follow-up, further interventions were necessary in 44 percent of the patients in the PTCA group (repeated PTCA in 23 percent, CABG in 18 percent, and both in 3 percent) but in only 6 percent of the patients in the CABG group (repeated CABG in 1 percent and PTCA in 5 percent;  $P < 0.001$ ). Seventy-four percent of the patients in the CABG group and 71 percent of those in the PTCA group were free of angina one year after treatment. Exercise capacity improved similarly in both groups. However, 22 percent of the CABG group, as compared with only 12 percent of the PTCA group, did not require antianginal medication ( $P = 0.041$ ).

**Conclusions.** In selected patients with multivessel coronary disease, PTCA and CABG as initial treatments resulted in equivalent improvement in angina after one year. However, in order to achieve similar clinical outcomes, the patients treated with PTCA were more likely to require further interventions and antianginal drugs, whereas the patients treated with CABG were more likely to sustain an acute myocardial infarction at the time of the procedure.

## Summary

Journal of the American College of Cardiology, 30:3:657-663

### Transluminal Extraction Catheter Atherectomy Followed by Immediate Stenting in Treatment of Saphenous Vein Grafts

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**Objectives.** The purpose of this study was to evaluate the effectiveness of transluminal extraction catheter (TEC) atherectomy followed by immediate Palmaz-Schatz coronary stenting of coronary bypass vein grafts.

**Background.** Degeneration of saphenous vein coronary bypass grafts has become a common problem. Repeat bypass surgery is associated with greater risk and a poorer outcome than the initial operation. Moreover, percutaneous interventional procedures in vein grafts have been associated with high procedural complication rates, including distal embolization, and high restenosis rates. TEC atherectomy may reduce distal embolization, and stenting may reduce restenosis rates.

**Methods.** We evaluated the procedural, hospital and clinical outcomes of TEC atherectomy followed by immediate Palmaz-Schatz coronary stenting of 53 vein grafts in 49 consecutive patients. The strategy was to limit instrumentation to extraction debulking and to stabilizing the site with stent deployment before using balloon dilation for optimal gain in lumen diameter.

**Results.** Results are shown as mean value (95% confidence interval [CI]). The mean graft age was 9.2 years (95% CI 7.9 to 10.5), and 1.0 (95% CI 1 to 1) TEC cutter (2.2 mm [95% CI 2.1 to 2.3]) and 1.7 (95% CI 1.4 to 2.0) Palmaz-Schatz coronary stents/vein graft were used. The procedural success rate was 98%, with a minimal lumen diameter at baseline of 1.3 mm (95% CI 1.1 to 1.5), increasing to 3.9 mm (95% CI 3.6 to 4.2) ( $p < 0.05$ ) after the TEC-stent procedure. Procedural complications occurred infrequently: graft perforation in 1 (2%) of 53 patients and distal embolization in 1 (2%) of 53 (same patient). In-hospital complications included non-Q wave myocardial infarction in two patients and death after a successful procedure in three (6%) ( $n = 1$  each: massive bleeding from the catheter site; sepsis; and acute myocardial infarction with asystole in the distribution of the stented vessel). The event-free survival rate to hospital discharge was 90%. Clinical follow-up (13 months [95% CI 11 to 15]) was available for all patients. There were five (11%) revascularization procedures (three bypass grafts and two percutaneous transluminal coronary interventions), four (9%) nonfatal myocardial infarctions

and five (11%) deaths, for a cumulative rate of 28% for any adverse outcome occurring in 13 of 46 patients.

**Conclusions.** TEC atherectomy followed by immediate Palmaz-Schatz coronary stenting of stenoses in old (>9 years) saphenous vein grafts can be successfully performed, with a low incidence of procedural and hospital complications. Clinical restenosis rates are low and less than those previously reported; however, late morbid cardiac events are still frequent in this high risk group of patients. These observational findings suggest that this technique may improve percutaneous management of vein graft disease, but optimal long-term management strategies remain to be determined.

N Engl J Med , 1997;337:1124-30

## A Comparison of Continuous Infusion of Alteplase with Double-Bolus Administration for Acute Myocardial Infarction

The Continuous Infusion versus Double-Bolus Administration of Alteplase (COBALT) Investigators

**Background.** Accelerated infusion of alteplase (tissue plasminogen activator) over a period of 90 minutes induces more rapid lysis of coronary-artery thrombi than a 3-hour infusion. With two bolus doses of alteplase, further shortening the duration of administration, complete reperfusion was achieved in more than 85 percent of the patients in initial angiographic studies. We tested the hypothesis that double-bolus alteplase is at least as effective as accelerated infusion.

**Methods.** In 398 hospitals, 7169 patients with acute myocardial infarction were randomly assigned to weight-adjusted, accelerated infusion of 100 mg of alteplase or to a bolus of 50 mg of alteplase over a period of 1 to 3 minutes followed 30 minutes later by a second bolus of 50 mg (or 40 mg for patients who weighed less than 60 kg). The primary end point was death from any cause at 30 days. The trial was stopped prematurely because of concern about the safety of the double-bolus injection.

**Results.** Thirty-day mortality was higher in the double-bolus group than in the accelerated-infusion group: 7.98 percent as compared with 7.53 percent. The absolute difference was 0.44 percent, with a one-sided 95 percent upper boundary of 1.49 percent, which exceeded the prespecified upper limit of 0.40 percent to indicate equivalence in 30-day mortality between the two regimens. The respective rates of any stroke and of hemorrhagic stroke were 1.92 and 1.12 percent after double-bolus alteplase, as compared with 1.53 and 0.81 percent after an accelerated infusion of alteplase ( $P = 0.24$  and  $P = 0.23$ , respectively).

**Conclusions.** Double-bolus alteplase was not shown to be equivalent, according to the prespecified criteria, to accelerated infusion with regard to 30-day mortality. There was also a slightly higher rate of intracranial

hemorrhage with the double-bolus method. Therefore, accelerated infusion of alteplase over a period of 90 minutes remains the preferred regimen.

Circulation , 1997 96: 1761-1769

Influence of Diabetes on 5-Year Mortality and Morbidity in a Randomized Trial Comparing CABG and PTCA in Patients With Multivessel Disease : The Bypass Angioplasty Revascularization Investigation (BARI)  
The BARI Investigators

**Background** Patients with diabetes mellitus have increased morbidity and mortality after coronary revascularization. The Bypass Angioplasty Revascularization Investigation (BARI), a trial of percutaneous transluminal coronary angioplasty (PTCA) versus coronary artery bypass graft surgery (CABG) in patients with multivessel disease, reported a 5-year survival advantage of CABG over PTCA in patients with treated diabetes mellitus (TDM). This report examines these findings in more detail.

**Methods and Results** Eighteen clinical centers randomly assigned 1829 patients with multivessel coronary disease to undergo initial CABG or PTCA. Patients were followed an average of 5.4 years. TDM was defined as a history of diabetes with use of oral hypoglycemic agents or insulin at study entry. Nineteen percent of the randomized population (353 patients) met these criteria. TDM patients had more unfavorable baseline characteristics than other patients, but among TDM patients, these characteristics were similar between the CABG and PTCA groups. Better average 5.4-year survival with CABG was due to reduced cardiac mortality (5.8% versus 20.6%,  $P=.0003$ ), which was confined to those receiving at least one internal mammary artery graft.

**Conclusions** Patients with TDM assigned to an initial strategy of CABG have a striking reduction in cardiac mortality compared with PTCA. Long-term internal mammary artery graft patency may contribute to this improved outcome by reducing the fatality of follow-up myocardial infarction.

Am J Cardiol , 1998;82:272-276

Impact of Postangioplasty Restenosis on Comparisons of Outcome Between Angioplasty and Bypass Grafting

Arvinder S. Kurbaan, Timothy J. Bowker, Charles D.J. Ilesley, Anthony F. Rickards, on behalf of the Coronary

## Angioplasty versus Bypass Revascularization Investigation (CABRI) Investigators

Restenosis is a major limitation of percutaneous transluminal coronary angioplasty (PTCA). In this study, we assessed the impact of restenosis on PTCA with reference to coronary angioplasty bypass grafting (CABG). In the Coronary Angioplasty versus Bypass Revascularization investigation (CABRI) PTCA population, those who had restenosis were defined as those needing a second revascularization at a site revascularized at the initial procedure. The 1-year clinical outcome of nonrestenosis group (n=437) was compared with those who underwent CABG (n=453). There was no difference in deaths. In the nonrestenotic PTCA group, the incidence of more infarctions was insignificant (relative risk [RR] 1.9, 95% confidence intervals [CI] 0.96 to 3.75, p=0.064), there was a much greater need for repeat revascularization (RR 8.6, CI 5.14 to 14.41, p<0.0005), and patients had a poorer angina status (RR 1.46, CI 1.01 to 2.13, p=0.046). Using 2 measures of coronary disease, the degree of pre- and postrevascularization disease was compared between groups. There were no differences in prerevascularization disease. However, using either measure, residual postrevascularization disease was more frequent in the nonrestenotic PTCA group. Restenosis only partially accounts for the greater morbidity seen after PTCA, compared with CABG, in multivessel disease. The greater likelihood of residual disease post-PTCA may contribute to this greater morbidity.

Table. Comparison of 1-year outcome between CABG and nonrestenotic PTCA

Lancet, 1998; 352: 1419-25

Long-term results of RITA-1 trial: clinical and cost comparisons of coronary angioplasty and coronary-artery bypass grafting

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Background Percutaneous transluminal coronary angioplasty (PTCA) and coronary-artery bypass grafting (CABG) are both effective intervention strategies for patients with coronary heart disease. We report comparative long-term clinical and health-service cost findings for these interventions in the first Randomised Intervention Treatment of Angina (RITA-1) trial.

**Methods** 1011 patients with coronary heart disease (45% single-vessel, 55% multivessel) were randomly assigned initial treatment strategies of PTCA or CABG. Information on clinical events, subsequent intervention, symptomatic status, exercise testing, and use of health-care resources is available for a median 6.5 years of follow-up. Analyses were by intention to treat.

**Findings** The predefined primary endpoint of death or non-fatal myocardial infarction occurred in 87 (17%) PTCA-group patients and 80 (16%) CABG-group patients ( $p=0.64$ ). Similarly, there was no significant treatment difference in deaths alone (39 PTCA, 45 CABG), of which 46% were cardiac related. In both groups, the risk of cardiac death or myocardial infarction was more than five times higher in the first year than in subsequent years of follow-up. 26% of patients assigned PTCA subsequently also had CABG, and a further 19% required additional non-randomised PTCA. Most of these reinterventions occurred within a year of randomisation, and from 3 years onwards the reintervention rate averaged 4% per year. In the CABG group the reintervention rate averaged 2% per year. The prevalence of angina was consistently higher in the PTCA group, with an absolute average 10% excess compared with the CABG group ( $p<0.001$ ). Total health-service costs over 5 years showed no significant difference between initial strategies of PTCA and CABG (mean difference £ 426 [95% CI - £ 383 to £ 1235];  $p=0.30$ ). The clinical and cost comparisons showed similar patterns for patients with single-vessel and multivessel disease.

**Interpretation** Initial strategies of PTCA and CABG led to similar long-term results in terms of survival and avoidance of myocardial infarction and to similar long-term health-care costs. Choice of approach, therefore, rests on weighing the more invasive nature of CABG against the greater risk of recurrent angina and reintervention over many years after PTCA.

Circulation , 1998 97: 2402-2405

### Low Recurrence of Angina Pectoris After Coronary Artery Bypass Graft Surgery With Bilateral Internal Thoracic and Right Gastroepiploic Arteries

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**Background**-In the past 10 years, there has been a trend to use more arterial grafts instead of vein grafts for coronary artery bypass graft surgery. Although there are many reports on the short- and mid-term follow-up of patients who underwent arterial revascularization with 1 or 2 arteries, little has been reported on the follow-up of patients with 3-vessel disease who received 3 arteries.

**Methods and Results**-We reviewed a group of 256 patients with 3-vessel disease who received the right gastroepiploic artery together with both internal thoracic arteries (ITAs). Vein grafts were not used in these patients. The patients were monitored for up to 7 years (mean,  $51\pm 15$  months). Seven-year actuarial survival

was 91.1%. The cumulative probability of event-free survival for myocardial infarction, reintervention, and angina pectoris at 7 years was 97.3%, 95.4%, and 85.4%, respectively.

**Conclusions**-We conclude that concomitant use of the gastroepiploic artery with both ITAs results in low mortality and a low incidence of myocardial infarction and reintervention at follow-up. Most interestingly, we found 85.4% freedom from angina pectoris after 7 years, which is considerably lower than the results of studies in which vein grafts, single ITA grafts, or double ITA grafts are used. These results strongly support the use of both ITAs and the right gastroepiploic artery for bypass grafting in patients with 3-vessel disease.

JAMA., 1999;281:1298-1303

### Health-Related Quality of Life as a Predictor of Mortality Following Coronary Artery Bypass Graft Surgery

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**Context** Health-related quality of life has not been evaluated as a predictor of mortality following coronary artery bypass graft (CABG) surgery. Evaluation of health status as a mortality predictor may be useful for preoperative risk stratification.

**Objective** To determine whether the Physical and Mental Component Summary scores from the preoperative Short-Form 36 (SF-36) health status survey predict mortality following CABG surgery after adjustment for known clinical risk variables.

**Design** Prospective cohort study conducted between September 1992 and December 1996.

**Setting** Fourteen Veterans Affairs hospitals.

**Patients** Of the 3956 patients undergoing CABG surgery only and who were enrolled in the Processes, Structures, and Outcomes of Care in Cardiac Surgery study, the 2480 who completed a preoperative SF-36.

**Main Outcome Measure** All-cause mortality within 180 days after surgery.

**Results** A total of 117 deaths (4.7%) occurred within 180 days of CABG surgery. The Physical Component Summary of the preoperative SF-36 was a statistically significant risk factor for 6-month mortality after adjustment for known clinical risk factors for mortality following CABG surgery. In multivariate analysis, a 10-point lower SF-36 Physical Component Summary score had an odds ratio (OR) of 1.39 (95% confidence interval

[CI], 1.11-1.77; P=.006) for predicting mortality. The SF-36 Mental Component Summary score was not associated with 6-month mortality in multivariate analyses (OR, 1.09; 95% CI, 0.92-1.29; P=.31).

**Conclusions** The Physical Component Summary score from the preoperative SF-36 is an independent risk factor for mortality following CABG surgery. The baseline Mental Component Summary score does not appear to be predictive of mortality. Preoperative patient self-report of the physical component of health status may be helpful for risk stratification and clinical decision making for patients undergoing CABG surgery.

Circulation , 1999 ;99: 3255-3259

#### Five-Year Outcome in Patients With Isolated Proximal Left Anterior Descending Coronary Artery Stenosis Treated by Angioplasty or Left Internal Mammary Artery Grafting : A Prospective Trial

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**Background**-Percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass surgery (CABG) improve the clinical status of patients with isolated proximal left anterior descending coronary artery stenosis. At 2 years, only additional revascularization was more frequently required after PTCA.

**Methods and Results**-We monitored 134 patients randomized to PTCA (n=68) or CABG (n=66) for 5 years. End points were death, myocardial infarction, need for additional revascularization, clinical status, and medical treatment. At 5 years, 6 patients (9%) had died in the PTCA group versus 2 (3%) in the CABG group (P=0.12). One patient in each group died of a cardiac cause. Myocardial infarction was more frequent after PTCA (15% versus 4%; P=0.0001), but Q-wave infarction was not (6% in the PTCA group versus 3% in the CABG group; P=0.8). Additional revascularization was required in 38% of patients in the PTCA group versus 9% in the CABG group (P=0.0001). Functional status was comparable, with 6% of patients after PTCA and 3% after CABG in functional class III or IV. Finally, after PTCA or CABG, 62% and 91% of patients, respectively, were free of events (P=0.0001).

**Conclusions**-The 5-year prognosis of patients with isolated proximal left anterior descending coronary artery stenosis is good. Both PTCA and CABG improve clinical status, but revascularization was needed more frequently after PTCA. There is an excess incidence of non-Q-wave myocardial infarction in the PTCA group that does not affect the vital or symptomatic outcome.

Circulation, 1999 ;99: 633-640

Coronary Revascularization in Diabetic Patients : A Comparison of the Randomized and Observational Components of the Bypass Angioplasty Revascularization Investigation (BARI)

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**Background-**Patients with treated diabetes in the randomized-trial segment of the Bypass Angioplasty Revascularization Investigation (BARI) who were randomized to initial revascularization with PTCA had significantly worse 5-year survival than patients assigned to CABG. This treatment difference was not seen among diabetic patients eligible for BARI who opted to select their mode of revascularization. We hypothesized that differences in patient characteristics, assessed and unmeasured, together with the treatment selection in the registry, at least partially account for this discrepancy.

**Methods and Results-**Among diabetics taking insulin or oral hypoglycemic drugs at entry, angiographic and clinical presentations were comparable between randomized and registry patients. However, more registry patients were white, and registry diabetics tended to be more educated and more physically active and to report better quality of life. Procedural characteristics and in-hospital complications were comparable. The 5-year all-cause mortality rate was 34.5% in randomized diabetic patients assigned to PTCA versus 19.4% in CABG patients ( $P=0.0024$ ; relative risk [RR]=1.87); corresponding cardiac mortality rates were 23.4% and 8.2%, respectively ( $P=0.0002$ ; RR=3.10). The CABG benefit was more apparent among patients requiring insulin. In the registry, all-cause mortality was 14.4% for PTCA versus 14.9% for CABG ( $P=0.86$ , RR=1.10), with corresponding cardiac mortality rates of 7.5% and 6.0%, respectively ( $P=0.73$ ; RR=1.07). These RRs in the registry increased to 1.29 and 1.41, respectively, after adjustment for all known differences between treatment groups.

**Conclusions-**BARI registry results are not inconsistent with the finding in the randomized trial that initial CABG is associated with better long-term survival than PTCA in treated diabetic patients with multivessel coronary disease suitable for either surgical or catheter-based revascularization.

Journal of the American College of Cardiology, 1999;34:2:532-538

Effects of coronary artery bypass grafting using internal mammary arteries for diabetic patients

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**OBJECTIVES** In our institute, internal mammary arteries (IMAs) have been preferred for coronary artery bypass grafting (CABG) in diabetic patients. The purpose of this study was to evaluate the influence of diabetes and IMA grafting on survival after CABG.

**BACKGROUND** The influence of diabetes on the results of CABG is not well documented, and there is controversy about whether the use of IMAs conveys greater survival benefits to diabetic patients.

**METHODS** A total of 420 consecutive patients who underwent CABG from April 1990 to July 1998 were reviewed; 211 of these patients had diabetes mellitus at the time of surgery. Internal mammary artery grafts have been used with increasing frequency, and bilateral IMAs have been used when possible since 1993. Internal mammary artery grafts were used in 164 nondiabetic patients (78%) and in 155 diabetic patients (73%). Seventy-eight nondiabetic patients and 74 diabetic patients received bilateral IMA grafts.

**RESULTS** The postoperative mortality was 2.4% in the nondiabetic and 2.8% in the diabetic group. With regard to postoperative complications, diabetic patients had a significantly higher rate of chest wound infection ( $p < 0.05$ ), irrespective of whether IMAs were used or not. The use of bilateral IMAs did not increase the risk of chest wound infection in nondiabetic or diabetic patients. Overall survival curve, cardiac death-free curve and cardiac event-free curve were not affected adversely by diabetes, and in diabetic patients, CABG with saphenous veins alone conveyed significantly ( $p < 0.01$ ) less long-term benefit than did CABG with at least one IMA graft.

**CONCLUSIONS** It was suggested that IMA grafts should be preferred in diabetic patients.

Journal of the American College of Cardiology, 1999;33:2:488-498

CASS registry : Long term surgical survival

William O. Myers, Eugene H. Blackstone, Kathryn Davis, Eric D. Foster, George C. Kaiser

## Objectives

To show the effect of clinical, angio and demographic traits on late survival of Coronary Artery Surgery Study (CASS) patients following coronary artery bypass grafting (CABG) and introduce Hazard Function analysis to CASS survival data.

## Methods

Patients were reached by mail survey with 94% response. By National Death Index, vital status was obtained in 99.7% (n = 8221) with a mean follow up of 15 years. Cox proportional hazard and Blackstone Hazard Function regressions were used to assess effects of preoperative traits.

## Results

Ninety percent of patients were alive at 5, 74% at 10 and 56% at 15 years. Of those age 65 and age 75 at operation, 74% and 59% were living at 10 years and 54% and 33% at 15 years (now age 90), survival exceeding the matched U.S. population. Hazard Function falls rapidly after CABG to 9 to 12 months, then rises, doubling by 15 years. Young patients, below age 35, had lower late survival. The time-segmented Cox model (divided at time suggested by the Hazard Function) identified traits showing predictive power early, throughout and late. Female sex, small body surface, ischemic symptoms and emergency status affected survival early. Heavier weight, infarct(s), diuretics, diabetes, smoking, left main and LAD stenosis and use of vein grafts only increased hazard late only.

## Conclusions

There are still lessons from the CASS database. CABG in the elderly is supported by the survival pattern of our patients age 75 at operation. Time-segmented Cox analysis and Hazard Function analysis separate baseline variables into those that predict early mortality and those that predict long survival.

JACC , 1999;33:63-72

A comparison of three-year survival after coronary artery bypass graft surgery and percutaneous transluminal coronary angioplasty

Edward L. Hannan, Michael J. Racz, Ben D. McCallister, Thomas J. Ryan, Djavad T. Arani, O. Wayne Isom and Robert H. Jones

Objectives.

The purpose of this study was to compare 3-year risk-adjusted survival in patients undergoing coronary artery bypass graft (CABG) surgery and percutaneous transluminal coronary angioplasty.

#### Background.

Coronary artery bypass graft surgery and angioplasty are two common treatments for coronary artery disease. For referral purposes, it is important to know the relative pattern of survival after hospital discharge for these procedures and to identify patient characteristics that are related to survival.

#### Methods.

New York's CABG surgery and angioplasty registries were used to identify New York patients undergoing CABG surgery and angioplasty from January 1, 1993 to December 31, 1995. Mortality within 3 years of undergoing the procedure (adjusted for patient severity of illness) and subsequent revascularization within 3 years were captured. Three-year mortality rates were adjusted using proportional hazards methods to account for baseline differences in patients' severity of illness.

#### Results.

Patients with one-vessel disease with the one vessel not involving the left anterior descending artery (LAD) or with less than 70% LAD stenosis had a statistically significantly longer adjusted 3-year survival with angioplasty (95.3%) than with CABG surgery (92.4%). Patients with proximal LAD stenosis of at least 70% had a statistically significantly longer adjusted 3-year survival with CABG surgery than with angioplasty regardless of the number of coronary vessels diseased. Also, patients with three-vessel disease had a statistically significantly longer adjusted 3-year survival with CABG surgery regardless of proximal LAD disease. Patients with other one-vessel or two-vessel disease had no treatment-related differences in survival.

#### Conclusions.

Treatment-related survival benefit at 3-years in patients with ischemic heart disease is predicted by the anatomic extent and specific site of the disease, as well as by the treatment chosen.

Am J Cardiol , 1999 ;84(12):1381-4

In-hospital and long-term results of stent deployment compared with balloon angioplasty for treatment of narrowing at the saphenous vein graft distal anastomosis site.

Gruberg L, Hong MK, Mehran R, Mintz GS, Kornowski R, Lansky AJ, Kent KM, Pichard AD, Satler LF, Dangas G, Wu H, Stone GW, Leon MB

Disease at the distal anastomosis site of saphenous vein grafts (SVGs) has been successfully treated with balloon angioplasty, with a lower restenosis rate than at sites of the aortoostial or proximal portion of the SVG. The role of stents for these lesions has not been well defined. To compare the in-hospital and long-term outcome of patients who underwent treatment at this site by either balloon angioplasty or tubular stent implantation, we studied 182 consecutive patients who underwent balloon angioplasty and 77 patients who underwent stenting between January 1994 and August 1997. Baseline clinical characteristics for both groups were similar. Angiographically, SVG stenoses treated with stents were older, longer in lesion length, and more restenotic. The in-hospital outcome was similar for both groups, with 98% procedural success rates and 1% major ischemic complications. Long-term follow-up was obtained for 93% of the patients, for an average of 17 +/- 14 months. The mortality rates were similar for patients who underwent balloon angioplasty and stenting (11.6% vs 13%, p = NS). The Q-wave myocardial infarction rates were also similar (1% vs 0%, p = NS). There was a trend toward a higher rate of target lesion revascularization in the balloon angioplasty group (25% vs 14%, p = 0.058). We conclude that percutaneous revascularization of the SVG distal anastomosis site by either balloon angioplasty or stenting can be performed with a high rate of procedural success and favorable in-hospital and long-term outcomes. Stent deployment may further improve the long-term outcome of these patients by reducing the need for repeat revascularization.

None of the above comparisons was significant.

## Summary

Circulation, 1999;100(24):2400-5

Creatine kinase-MB enzyme elevation following successful saphenous vein graft intervention is associated with late mortality.

Hong MK, Mehran R, Dangas G, Mintz GS, Lansky AJ, Pichard AD, Kent KM, Satler LF, Stone GW, Leon MB

**BACKGROUND:** Although the risk for development of creatine kinase (CK-MB) elevation after saphenous vein graft (SVG) intervention is high, its prognostic significance remains unknown. This study evaluated the impact of periprocedural CK-MB elevation on late clinical events following successful SVG angioplasty. **METHODS AND RESULTS:** We studied 1056 consecutive patients with successful (defined by angiographic success and absence of major complications) intervention of 1693 SVG lesions. These patients were grouped as normal CK-

MB (n=556), minor CK-MB rise (CK-MB 1 to 5 times normal, n=339), and major CK-MB rise (CK-MB >5 times normal, n=161). There were no differences in major clinical events at 30-day follow-up among the 3 groups. However, 1-year mortality was 4.8%, 6.5%, and 11.7%, respectively,  $P < 0.05$  (ANOVA). Even within a population without any intraprocedure or in-hospital complications (n=727, 69% of the overall cohort), 1-year mortality remained significantly higher with CK-MB elevation: 2.4%, 5.5%, and 10.7%, respectively,  $P < 0.05$  (ANOVA). Multivariate analysis revealed major CK-MB elevation as the strongest independent predictor of late mortality (odds ratio 3.3, with 95% CI 1.7 to 6.2), followed by diabetes mellitus (odds ratio 2.6, with 95% CI 1.5 to 4.5). CONCLUSIONS: Major CK-MB elevation occurs after 15% of otherwise successful SVG interventions and is associated with increased late mortality.

### Summary

1. No differences in major clinical events at 30-day follow-up
2. 1-year mortality- Normal: 4.8%, Minor elevation: 6.5%, Major elevation: 11.7% ( $P < 0.05$ )
3. Multivariate analysis: Major CK-MB elevation - the strongest independent predictor of late mortality (odds ratio 3.3, with 95% CI 1.7 to 6.2)

Catheter Cardiovasc Interv, 1999 ;47(4):441-8

Emergency coronary artery bypass surgery following coronary angioplasty and stenting: results of a French multicenter registry.

Loubeyre C, Morice MC, Berzin B, Virot P, Commeau P, Drobinski G, Ethevenot G, Moquet B, Marco J, Labrunie P, Cattan S, Coste P, Aubry P, Ferrier A

This study investigates the influence of coronary stenting on the risk of emergency bypass surgery performed within 24 hr of percutaneous transluminal coronary angioplasty (PTCA) with particular concern for incidence and indication. Since 1995, coronary stenting has been increasingly performed in France during angioplasty procedures, altering significantly the role of emergency bypass surgery. The outcome of elective stenting and widespread use of coronary stenting and its influence on emergency surgery have not been evaluated so far. Through a retrospective (1995) and prospective (1996) registry, we analyzed the incidence, indication and results of emergency bypass surgery performed within 24 hr of PTCA in 68 and 57 centers, respectively, accounting for nearly half of all angioplasty procedures in France. Data were collected through questionnaires

consisting of separate forms for every case report that were sent to every center. Over the two years, 26,885 and 27,497 procedures were investigated with a stenting rate of 46% and 64%, respectively. The observed need for emergency surgery was constantly low throughout this period (0.38% and 0.32%, respectively). Indications for surgery included complications directly due to stent in 37% of cases in the 2-year period. Outcome remained poor, with in-hospital mortality in 10% and 17% and myocardial infarction in 27% and 25% of cases, respectively. A comparison of the results in centers with and without surgical facilities showed no differences in outcome, despite a longer time to surgery (359 min +/- 406 min vs. 170 min +/- 205 min, P = 0.0001) and a lower incidence of emergency surgery (0.25% vs. 0.44%, P = 0.0001) in centers without on-site surgery backup. The French multicenter registry reveals an increase in the use of stents together with a dramatic decrease in the incidence of emergency bypass surgery (below 0.5%) following PTCA. There has been a significant evolution in the indication, and stent implantation now accounts for a third of the indications for emergency bypass surgery.

#### Summary

1. The need for emergency surgery: 0.38% and 0.32%
2. Surgery directly due to stent: 37%
3. Outcome - in-hospital mortality: 10% and 17%, myocardial infarction: 27% and 25%

Am Heart J , 1999 ;138(2 Pt 1):376-83

Clinical correlates of the initial and long-term cost of coronary bypass surgery and coronary angioplasty.

Hlatky MA, Boothroyd DB, Brooks MM, Winston C, Rosen A, Rogers WJ, Reeder GS, Smith HC, Ryan TJ, Pitt B, Whitlow PL, Wiens RD, Mark DB

**BACKGROUND:** Medical costs vary substantially among patients. Understanding the baseline factors that predict subsequent cost may allow better selection of therapy for individual patients. Understanding the postprocedure events that increase cost should help to improve efficiency and effectiveness of coronary revascularization. **METHODS:** Data on 4-year costs were collected from patients randomly assigned to coronary angioplasty or bypass surgery as part of the BARI (Bypass Angioplasty Revascularization Investigation) trial. Regression models first examined factors known at the time of randomization that prospectively predicted initial procedure cost and long-term cost. Subsequent models tested the value of postrandomization events as explanatory variables for cost. **RESULTS:** The independent baseline predictors of

higher initial percutaneous transluminal coronary angioplasty cost included 3-vessel disease (+12%) and acute presentations (+22%), whereas the independent predictors of higher initial coronary artery bypass grafting cost included the number of comorbid conditions (+5% per condition) and female sex (+7%). The independent baseline predictors of 4-year cost included heart failure (+26%), diabetes (+22%), comorbidity (+10%), and angioplasty assignment in patients with 2-vessel disease (-15%). Postrandomization models showed higher initial and long-term costs were strongly correlated with the number of repeat revascularization procedures (+30% to +128%) and the occurrence of clinical complications (+8% to +131%). CONCLUSIONS: Two-vessel disease identifies patients likely to have lower costs after angioplasty, whereas heart failure, comorbid conditions, and diabetes identify patients likely to accrue higher costs after either angioplasty or bypass surgery. Long-term costs can be potentially reduced by interventions that decrease procedural complications or reduce the need for repeat revascularization.

#### Summary

1. Baseline predictors of higher initial PTCA cost: 3-VD(+12%), acute presentations (+22%)
2. Baseline predictors of higher CABG cost: the number of comorbid conditions (+5% per condition), female sex (+7%).
3. Independent baseline predictors of 4-year cost: heart failure (+26%), diabetes (+22%), comorbidity (+10%), angioplasty assignment of 2VD patients (-15%).
4. Higher initial and long-term costs - strongly correlated with the number of repeat revascularization procedures (+30% to +128%) and the occurrence of clinical complications (+8% to +131%).

Ann Thorac Surg, 68:1644-7 1999

Favorable impact of stents after emergent coronary artery bypass for failed angioplasty.

Lazar HL ; Bao Y ; Lancaster D ; Shapira OM ; Aldea GS ; Shemin RJ

**BACKGROUND:** This study was undertaken to determine the impact of the use and availability of coronary stents on outcomes in patients requiring emergent coronary artery bypass graft (CABG) surgery following a failed percutaneous transluminal coronary angioplasty (PTCA). **METHODS:** Patients were divided into two groups based on the year of their CABG for a failed PTCA and the availability of stents: group 1, 1992 to 1994, stents not available (n = 34); and group 2, 1995 to 1997, stents available (n = 26). **RESULTS:** CABG patients in the

group where stents were not available were more likely to have had an abrupt coronary occlusion (26 of 34 versus 3 of 26;  $p < 0.0001$ ) and less likely to have had a dissection (8 of 34 versus 23 of 26;  $p < 0.0001$ ) as their indication for emergent CABG. Patients in the stent era had a lower incidence of perioperative myocardial infarction (5 of 26 versus 17 of 34;  $p < 0.01$ ) and a decreased mortality rate (0 of 26 versus 6 of 34;  $p < 0.03$ ). In the 9 patients where stents were employed, patency of the lumen was restored in 8 patients and there was only 1 myocardial infarction. CONCLUSIONS: Stents have had a favorable impact on patients requiring an emergent CABG following a failed PTCA.

Eur J Cardiothorac Surg, 16 Suppl 1(-HD-):S79-82, 1999

Indication and patient selection in minimally invasive and 'off-pump' coronary artery bypass grafting.

Diegeler A ; Matin M ; Falk V ; Binner C ; Walther T ; Autschbach R ; Mohr FW

**BACKGROUND:** The selection criteria to perform 'off-pump' coronary bypass (OPCAB) grafting are not well defined. The aim of this presentation is to outline the indications and the patient selection on the basis of 2 years experience with 572 OPCAB procedures. **MATERIALS AND METHODS:** From November 1996 minimally invasive coronary bypass grafting was performed in 406 patients using a limited minithoracotomy for single left anterior descending artery (LAD) revascularization (group A). In 166 patients full sternotomy and OPCAB grafting for single or multiple vessel revascularization was performed (group B). **RESULTS:** In group A the procedure could be performed 'off-pump' together with a limited thoracotomy in 406 out of 457 patients (88.8%) who were scheduled for single graft revascularization to LAD. Exposure and quality of the LAD was good in 308/406 (76.0%) of the patients. The decision for sternotomy was made for different preoperative characteristics of these patients: Obese female patients 16/457 (3.5%), angiographic evidence of an intramyocardial running LAD 6/457 (1.4%), diffusely diseased and small LAD 11/457 (2.4%) severe COPD 3/457 (0.7%), unstable angina 11/457 (2.4%), emergency revascularization after failed PTCA 4/457 (0.8%). In 315/406 (77.8%) of the minimally invasive direct coronary artery bypass (MIDCAB)-patients exposure and quality of the LAD was good, in 97/406 (22.2%) moderate or even bad. In the latter subgroup stenosis free anastomosis was reduced (86.5%) compared to the subgroup of good exposure and quality with 98.3%. In group B selection for sternotomy and 'off-pump' procedure was made in 117/166 (70.4%) patients with a normal preoperative status (stable angina, ejection fraction  $> 35\%$ ) and with coronary lesions amenable for

beating heart surgery (proximal RCA lesion > 80%, not calcified and well defined POD and marginal branches). In 49/166 (29.5%) decision for 'off-pump' procedure was made on the basis of a potential risk for cardiopulmonary bypass (CPB) such as acute myocardial infarction in 10/166 (6.0%), reduced ventricular function with EF < 35 in 28/166 (16.9%), calcified ascending aorta 4/166 (2.4%) or concomitant diseases 7/166 (2.5). CONCLUSION: To maintain excellent results after single LAD revascularization using the MIDCAB-approach, appropriate patient selection is crucial. Indication for sternotomy and 'off-pump' single LAD revascularization should made in those patients excluded for MIDCAB and in patients scheduled for multiple vessel-CABG who are at high risk for CPB (concomitant pulmonary, renal, neurological diseases or severely impaired left ventricular dysfunction) and have suitable target coronary arteries in term of location and quality.

Jpn Circ J, 63(12):981-7, 1999

Long-term outcome of percutaneous transluminal coronary angioplasty and coronary artery bypass grafting in patients with end-stage renal disease.

Ohmoto Y ; Ayabe M ; Hara K ; Sugimoto T ; Tagawa H ; Fukuda S ; Suma H ; Wanibuchi Y ; Tamura T

This study was conducted to investigate therapeutic methods for end-stage renal disease (ESRD) by retrospectively analyzing in-hospital outcome and long-term outcome in patients who underwent either percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG). Ninety-two patients underwent PTCA and 47 underwent CABG, and the initial success rates were 87% and 85%, respectively. As major in-hospital complications, in the PTCA group 1 died (1%), 2 required emergency CABG (2%), and 2 had Q-wave myocardial infarction (2%); in the CABG group, 7 died (15%) and 3 had Q-wave myocardial infarction (6%). As for the long-term outcome, although there were no differences in the incidence of death or the incidence of cardiac death between the 2 groups, the cumulative proportion of patients free of death, myocardial infarction, CABG and repeat PTCA was lower in the PTCA group, which was mainly due to a higher incidence of repeat PTCA in that group. The incidence of cardiac death was low for both groups among the patients attaining complete revascularization. Twenty-three percent of the patients required cross-over implementation of PTCA and CABG. In conclusion, it is necessary to aim for complete revascularization using both treatments for a better prognosis in patients with ESRD.

Heart Lung, 28(6):409-17 1999 Nov-Dec

Quality of life comparisons after coronary angioplasty and coronary artery bypass graft surgery.

Skaggs BG ; Yates BC

**OBJECTIVE:** To examine the differences in realization of expected benefits, complications, and quality of life (QOL) 3 months after percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft (CABG) surgery. **DESIGN:** Nonexperimental, prospective, and comparative. Before discharge, participants listed benefits expected from the procedure, as well as comorbid health problems (Charlson Comorbidity Index) and complications. At 3 months, they quantified their realization of expected benefits, reported postdischarge complications, and completed Ferrans and Powers' Quality of Life Index-Cardiac Version III. **SAMPLE:** 36 patients who had PTCA; 38 patients who had CABG. **RESULTS:** There were no differences between groups in realization of expected benefits or QOL. Patients who had CABG reported a greater number of complications after discharge, and a greater proportion of patients who had PTCA reported angina. Patients who had PTCA and then recurrent angina had significantly lower health QOL and psychologic and spiritual QOL. **CONCLUSIONS:** Patients who undergo CABG need guidance regarding what complications to expect, and patients who undergo PTCA need to know that recurrent angina is possible and how to manage it.

Eur J Cardiothorac Surg, 16 Suppl 2(-HD-):S117-8 1999

Interventional cardiology versus minimally invasive cardiac surgery.

Park JW

Comparing interventional cardiology with minimally invasive cardiac surgery 1998 goes back to the early 80s when cardiologists treated coronary artery disease patients with balloon angioplasty under a permanent observation of cardiac surgeons who could offer to the patient the well established Conventional CABG, which already had proven to be safe, effective, durable, reproducible, and complete. At that time some critics

predicted PTCA would remain the hobby of some cardiologists. During the last two decades, however, an explosive proliferation in the number of PTCA procedures has occurred, which soon exceeded the number of CABG procedures. As technology has advanced and operator experience has increased, the application of PTCA has expanded from dilatation of simple, concentric single-vessel stenotic lesions to progressively more complex lesions in multivessel disease. Within the last 5 years the minimally invasive cardiac surgery has progressed, which allows the performance of even complex cardiac surgery through small incisions with (port-access technique) or without (MIDCAB technique) cardiopulmonary bypass. The rationale of enthusiastic users of these new techniques leads to improved cosmetic results, less surgical trauma, decreased length of hospital stay, reduced cost, and comparable long-term results with respect to conventional CABG. Similar to the prediction about PTCA two decades ago, some critics say that minimally invasive cardiac surgery would remain the hobby of some cardiac surgeons.

Journal of the American College of Cardiology, 2000;36:4:1166-1172

Diabetes and outcomes of coronary artery bypass graft surgery in patients with severe left ventricular dysfunction: results from The CABG Patch Trial database

William Whang, J. Thomas Bigger, Jr. The CABG Patch Trial Investigators and Coordinators

#### OBJECTIVES

We examined the relationship between diabetes mellitus and outcomes after coronary artery bypass graft (CABG) surgery in patients with severe left ventricular (LV) dysfunction.

#### BACKGROUND

Although diabetes is associated with poor outcomes after CABG surgery among unselected patients, the relationship between diabetes and mortality after CABG surgery among patients with LV dysfunction is less certain.

#### METHODS

Using data from The CABG Patch Trial, a study of implantable cardiac defibrillator therapy, we analyzed 900 patients with ejection fraction  $<0.36$  who underwent CABG surgery from 1990 to 1996.

#### RESULTS

Diabetics comprised 38% of the patients, and 48% of diabetics were prescribed insulin. Diabetes was associated

with hypertension, peripheral vascular disease, history of stroke, clinical heart failure and rales on physical exam. Diabetics were at higher risk for postoperative superficial sternal wound infection and renal failure. With an average follow-up time of  $32 \pm 16$  months, actuarial all-cause mortality 48 months after CABG surgery was 26% in diabetics and 24% in nondiabetics ( $p = 0.66$ , log-rank test). Diabetes was not associated with long-term mortality in Cox multiple regression analyses. Actuarial re-hospitalization rates 48 months after CABG surgery were 85% in diabetics and 69% in nondiabetics ( $p = 0.0001$ , log-rank test). Diabetics had a 44% higher risk of re-hospitalization for any cause ( $p = 0.0001$ ) and a 24% higher risk of re-admission for cardiac causes ( $p < 0.05$ ). Unexpectedly, fewer arrhythmic events were found in diabetics.

#### CONCLUSIONS

Diabetes was not a predictor of mortality after CABG surgery among patients with LV dysfunction despite associated comorbidities. However, diabetes was associated with increased postoperative complications and re-hospitalization.

Circulation , 2000 ;101: 2682-2689

#### Predictors of Mortality and Mortality From Cardiac Causes in the Bypass Angioplasty Revascularization Investigation (BARI) Randomized Trial and Registry

Maria Mori Brooks, Robert H. Jones, Richard G. Bach, Bernard R. Chaitman, Morton J. Kern, Thomas A. Orszulak, Dean Follmann, George Sopko, Eugene H. Blackstone, and Robert M. Califf

**Background-**The impact of percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass grafting (CABG) on long-term mortality rates in the presence of various demographic, clinical, and angiographic factors is uncertain in the population of patients suitable for both procedures.

**Methods and Results-**In the Bypass Angioplasty Revascularization Investigation (BARI) randomized trial and registry, 3610 patients who were eligible to receive PTCA and CABG were revascularized between 1989 and 1992. Multivariate Cox models were used to identify factors associated with 5-year mortality and cardiac mortality, with particular attention to factors that interact with treatment. Diabetic patients receiving insulin had higher mortality and cardiac mortality rates with PTCA compared with CABG (relative risk [RR] 1.78 and 2.63, respectively,  $P < 0.001$ ), and patients with ST elevation had higher cardiac mortality rates with CABG than with PTCA (RR 4.08,  $P < 0.001$ ). Factors most strongly associated with high overall mortality rates were insulin-treated diabetes, congestive heart failure, kidney failure, and older age. Black race was also associated with

higher mortality rates (RR 1.49, P=0.019).

Conclusions-A set of variables was identified that could be used to help select a revascularization procedure and to evaluate risk of long-term mortality in the population of patients considering revascularization.

Journal of the American College of Cardiology, 35:5:1122-1129

Seven-year outcome in the Bypass Angioplasty Revascularization Investigation (BARI) by treatment and diabetic status

The BARI Investigators

#### OBJECTIVES

To compare seven-year survival in the Bypass Angioplasty Revascularization Investigation (BARI) patients randomly assigned to percutaneous transluminal coronary angioplasty (PTCA) versus coronary artery bypass grafting (CABG).

#### BACKGROUND

The primary results of BARI reported no significant difference in five-year survival between CABG and PTCA groups. However, among patients with treated diabetes mellitus, a subgroup not specified a priori, a striking difference was seen in favor of CABG.

#### METHODS

Symptomatic patients with multivessel disease (n = 1,829) were randomly assigned to initial treatment strategy of CABG or PTCA and followed for an average of 7.8 years. The intention-to-treat principle was used to extend the initial five-year BARI treatment comparisons.

#### RESULTS

Kaplan-Meier estimates of seven-year survival for the total population were 84.4% for CABG and 80.9% for PTCA (p = 0.043). This difference could be explained by the 353 patients with treated diabetes mellitus for whom estimates of seven year survival were 76.4% CABG and 55.7% PTCA (p = 0.0011). Among the remaining 1,476 patients without treated diabetes, survival was virtually identical by assigned treatment (86.4% CABG, 86.8% PTCA, p = 0.72). The PTCA group had substantially higher subsequent revascularization rates than the CABG group (59.7% vs. 13.1%, p < 0.001); however, the changes between the five- and seven-year rates were similar for the two groups.

#### CONCLUSIONS

At seven years, there was a statistically significant survival advantage for patients randomized to CABG

compared with PTCA. Among patients with treated diabetes mellitus, the benefit of CABG over PTCA seen at five years was more pronounced at seven years; among nondiabetic patients, there was essentially no treatment difference.

Journal of the American College of Cardiology, 2000;35:5:1116-1121

Eight-year mortality in the Emory Angioplasty versus Surgery Trial (EAST)

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#### OBJECTIVES

To evaluate the long-term outcome of patients randomized to coronary bypass surgery or coronary angioplasty.

#### BACKGROUND

The Emory Angioplasty versus Surgery Trial (EAST) is a single center randomized comparison of a strategy of initial coronary angioplasty (n = 198) or coronary bypass surgery (n = 194) for patients with multivessel coronary artery disease. The primary end point (death, myocardial infarction or a large ischemic defect at 3 years) was not different, and repeat revascularization was significantly greater in the angioplasty group. Subsequently, the National Heart, Lung and Blood Institute supported a five-year extension of the trial.

#### METHODS

After the three year anniversary visit, annual questionnaires, telephone contact and examination of medical records were accomplished until death or the eight year anniversary in 100% of the patients surviving at 3 years.

#### RESULTS

Survival at 8 years is 79.3% in the angioplasty group and 82.7% in the surgical group (p = 0.40). Patients with proximal left anterior descending stenosis and those with diabetes tended to have better late survival with surgical intervention although not reaching statistical significance. After the first 3 years, repeat interventions remained relatively equal for both treatment groups.

#### CONCLUSIONS

Long-term survival is not significantly different between angioplasty and surgery, and late (three to eight year) revascularization procedures were infrequent. Patients without treated diabetes had similar survival in both groups.

J Am Coll Cardiol, 35(3):605-11, 2000

Clinical and angiographic outcomes in patients with previous coronary artery bypass graft surgery treated with primary balloon angioplasty for acute myocardial infarction. Second Primary Angioplasty in Myocardial Infarction Trial (PAMI-2) Investigators.

Stone GW ; Brodie BR ; Griffin JJ ; Grines L ; Boura J ; O'Neill WW ; Grines CL

**OBJECTIVES:** We sought to characterize the presenting characteristics of patients with previous coronary artery bypass graft surgery (CABG) and acute myocardial infarction (AMI) and to determine the angiographic success rate and clinical outcomes of a primary percutaneous transluminal coronary angioplasty (PTCA) strategy. **BACKGROUND:** Patients who have had previous CABG and AMI comprise a high risk group with decreased reperfusion success and increased mortality after thrombolytic therapy. Little is known about the efficacy of primary PTCA in AMI. **METHODS:** Early cardiac catheterization was performed in 1,100 patients within 12 h of onset of AMI at 34 centers in the prospective, controlled Second Primary Angioplasty in Myocardial Infarction trial (PAMI-2), followed by primary PTCA when appropriate. Data were collected by independent study monitors, end points were adjudicated and films were read at an independent core laboratory. **RESULTS:** Of 1,100 patients with AMI, 58 (5.3%) had undergone previous CABG. The infarct-related vessel in these patients was a bypass graft in 32 patients (55%) and a native coronary artery in 26 patients. Compared with patients without previous CABG, patients with previous CABG were older and more frequently had a previous myocardial infarction and triple-vessel disease. Coronary angioplasty was less likely to be performed when the infarct-related vessel was a bypass graft rather than a native coronary artery (71.9% vs. 89.8%,  $p = 0.001$ ); Thrombolysis in Myocardial Infarction trial (TIMI) flow grade 3 was less frequently achieved (70.2% vs. 94.3%,  $p < 0.0001$ ); and in-hospital mortality was increased (9.4% vs. 2.6%,  $p = 0.02$ ). As a result, mortality at six months was 14.3% versus 4.1% in patients with versus without previous CABG ( $p = 0.001$ ). By multivariate analysis, independent determinants of late mortality in the entire study group were advanced age, triple-vessel disease, Killip class and post-PTCA TIMI flow grade  $<3$ . **CONCLUSIONS:** Reperfusion success of a primary PTCA strategy in patients with previous CABG, although favorable with respect to historic control studies, is reduced as compared with that in patients without previous CABG. New approaches are required to treat patients with previous CABG and AMI, especially when the infarct-related vessel is a diseased saphenous vein graft.

Figure 1. Survival curves (Kaplan-Meier estimates) for 1,100 patients with AMI treated with primary PTCA, stratified by whether or not the patient had undergone CABG before the index hospital admission. Event rates are cumulative (including in-hospital and postdischarge outcomes). Bold lines represent patients with previous CABG; standard lines represent patients without previous CABG. reMI = repeat myocardial infarction.

Figure 2. Survival curves, stratified by whether or not the infarct-related vessel was a bypass graft conduit or native coronary artery. Event rates are cumulative (including in-hospital and postdischarge outcomes). Bold lines represent bypass graft infarct vessels; standard lines represent native coronary artery infarct vessels. reMI = repeat myocardial infarction.

J Intern Med , 2001;249(1):47-57

Quality of life of chronic stable angina patients 4 years after coronary angioplasty or coronary artery bypass surgery.

Brorsson B, Bernstein SJ, Brook RH, Werko L

**OBJECTIVE:** To evaluate the quality of life experienced by chronic stable angina patients with one- or two-vessel coronary artery disease treated with percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft (CABG). **DESIGN:** Prospective survey and review of medical records. **PATIENTS:** Consecutive series of 601 Swedish chronic stable angina patients with one- or two-vessel disease who underwent CABG (n = 252) or PTCA (n = 349) between May 1994 and January 1995. **MAIN OUTCOME MEASURES:** We assessed five components of the Swedish Quality of Life Survey, anginal frequency, sublingual nitroglycerin use, and survival at 6, 21 and 48 months following coronary revascularization. **RESULTS:** Anginal frequency and sublingual nitroglycerin use decreased for all patients by 6 months, but more amongst surgery patients than amongst angioplasty patients (P < 0.05). At 48 months, more bypass patients reported that they

had not used sublingual nitroglycerin during the preceding 4 weeks (73.1 vs. 63.4%,  $P < 0.05$ ). At 6 months, bypass patients had greater levels of improvement in physical functioning (15.3 vs. 10.5,  $P < 0.05$ ) and general health perception (16.5 vs. 10.2,  $P < 0.05$ ) than angioplasty patients. Bypass patients also had better relief from pain (19.4 vs. 14.6,  $P < 0.05$ ), quality of sleep (17.6 vs. 4.6,  $P < 0.05$ ) and general health perception (17.3 vs. 12.1,  $P < 0.05$ ) at 21 months. By 48 months follow-up, there was no longer any difference in these measures between groups. **CONCLUSIONS:** Both bypass surgery and angioplasty lead to improved quality of life for patients with chronic stable angina and one- or two-vessel coronary artery disease. Bypass surgery is associated with better quality of life at 6 months, but by 48 months quality of life is similar for patients initially treated by either procedure.

Ann Thorac Surg 2000 ;70(6):1997-2003

Emergency coronary artery bypass grafting after failed coronary angioplasty: what has changed in a decade?

Reinecke H, Fetsch T, Roeder N, Schmid C, Winter A, Ribbing M, Berendes E, Block M, Scheld HH, Breithardt G, Kerber S

**BACKGROUND:** We assessed the impact of patient and procedural characteristics on the outcome after emergency coronary artery bypass grafting (CABG) for failed percutaneous transluminal coronary angioplasty (PTCA) and temporal changes in these factors. **METHODS:** Patients who underwent PTCA and subsequent emergency CABG were identified from the databases of the Departments of Cardiology and Cardiothoracic Surgery. **RESULTS:** Two periods of clinical practice were compared. In 1989 to 1993, 2,880 PTCA were performed, 64 patients underwent emergency CABG (2.3%), and 7 patients died (10.9%). During 1994 to 1998, 46 patients of 3,801 PTCA underwent emergency CABG (1.2%,  $p < 0.01$ ), and 7 patients died (15.2%, NS). The average rate of stenting increased from 0.8% to 24% in 1994 to 1998 as well as the frequency of arterial bypass grafts (0% vs 39%). In the latter period, patients were older, were more often females, had more cardiovascular risk factors, a higher Cleveland score (each  $p < 0.05$ ), and suffered more often from periprocedural myocardial infarctions ( $p < 0.001$ ) and nonfatal periprocedural complications ( $p < 0.01$ ). **CONCLUSIONS:** Although the frequency of emergency CABG after failed PTCA declined, perioperative mortality tended to increase according to an unfavorable shift in patient risk factors and morbidity.

Curr Opin Cardiol 2000;15(4):287-92

Clinical trials of revascularization therapy in diabetics.

Brooks RC, Detre KM

Diabetic patients are a high-risk group for cardiovascular morbidity and mortality, with poorer long-term outcomes, with or without revascularization, than non-diabetic patients. Results from the Bypass Angioplasty Revascularization Investigation (BARI) trial, the largest randomized study of coronary revascularization strategies, showed that diabetic patients with multivessel coronary disease who were undergoing an initial revascularization procedure had a significant long-term survival advantage with coronary artery bypass graft surgery (CABG) compared with percutaneous transluminal coronary angioplasty (PTCA). The 8-year follow-up data from the Emory Angioplasty Versus Surgery Trial (EAST) study, the other major US trial of CABG versus PTCA, and results of other clinical trials that enrolled similar patients are consistent with an advantage for CABG in diabetic patients but not for nondiabetic patients. This benefit is entirely a result of improved cardiac mortality. It is limited to patients receiving an internal mammary artery (IMA) graft and is apparent earlier in insulin-treated patients. The benefit of CABG in diabetic patients may be significantly related to a protective effect on mortality after myocardial infarction, because CABG greatly reduced the risk of death after spontaneous Q-wave myocardial infarction in BARI-eligible diabetic patients (relative risk 0.09,  $P < 0.001$ ), an effect not seen in non-diabetic patients.

J Thromb Thrombolysis, 2000;10(3):255-264

Activation of Blood Platelets after Percutaneous Transluminal Coronary Angioplasty and Coronary Artery Bypass Graft Surgery.

Kralisz U, Mussur M, Jegier B, Pawlicki L, Majewska E, Iwaszkiewicz A, Ligocka A, Kowalski J, Zaslonka J, Cierniewski C

We have evaluated the activation of platelets in blood samples taken from patients with stable angina undergoing balloon angioplasty (percutaneous transluminal coronary angioplasty [PTCA]) (n=11) or coronary

artery bypass grafting (CABG) under hypothermic (n=11) or normothermic conditions (n=11). We have found that surface expression of P-selectin on platelets in whole blood from PTCA patients upon thrombin treatment was significantly reduced, as compared with control platelets from healthy subjects. This effect was partially reversed when platelets washed from the same blood sample were used, but even then P-selectin expression was significantly lower in PTCA patients than it was in control subjects. There was a significant increase in basal expression of P-selectin in blood platelets taken from patients who underwent CABG under normothermic conditions (warm blood cardioplegia) as opposed to hypothermic patients (cold crystalloid cardioplegia). These platelets retain the ability to respond to agonists, although to a much lower extent than do those from healthy control donors. The surface exposure of P-selectin on resting and thrombin-treated platelets isolated from CABG surgery patients was not different from that of the control platelets. The adhesion to fibrinogen of resting and thrombin-treated platelets from patients who underwent balloon angioplasty as well as CABG surgery under normothermic and hypothermic conditions was significantly reduced when compared with the fibrinogen of the control platelets. These results suggest that the function of platelet fibrinogen receptor is impaired in patients with stable angina pectoris and that PTCA and CABG surgery activates platelets.

Am J Cardiol , 2000 ;85(3):321-6

Ten-year outcome after coronary angioplasty in patients with single-vessel coronary artery disease and comparison with the results of the Coronary Artery Surgery Study (CASS)

Espinola-Klein C, Rupprecht HJ, Erbel R, Nafe B, Brennecke R, Meyer J

The 10-year results of randomized trials comparing percutaneous transluminal coronary angioplasty (PTCA) in patients with single-vessel coronary artery disease (CAD) with coronary artery bypass grafting (CABG) and medical treatment are not available yet. The aim of this evaluation was to compare our 10-year follow-up results after PTCA in patients with single-vessel CAD with the 10-year follow-up results after CABG and medical treatment in the Coronary Artery Surgery Study (CASS) trial. We evaluated the clinical outcome of 509 patients with single-vessel CAD 10 years after coronary angioplasty. The data were compared with the results of 214 patients with single-vessel CAD after CABG or medical treatment from the CASS trial. End points were defined as death and myocardial infarction. Statistical evaluation was performed by life-table analysis and 2-sided Fisher's exact test. The rate of survival was 86% 10 years after PTCA compared with 85% after CABG and

82% after medical treatment in patients from the CASS trial ( $p = \text{NS}$ ). Survival free from myocardial infarction was 77% after coronary angioplasty, 70% after CABG, and 72% after medical treatment ( $p = \text{NS}$ ). Thus, in patients with single-vessel CAD, infarct-free survival 10 years after coronary angioplasty compared favorably with the results after bypass surgery or medical treatment from the CASS trial.

Figure 2. Life-table analysis.

Table IV. Randomized Trials Comparing Percutaneous Transluminal Coronary Angioplasty (PTCA) With Coronary Artery Bypass Grafting (CABG) and/or Medical Treatment

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A prospective randomized trial comparing stenting to internal mammary artery grafting for proximal, isolated de novo left anterior coronary artery stenosis: the SIMA trial. Stenting vs Internal Mammary Artery

Goy JJ, Kaufmann U, Goy-Eggenberger D, Garachemani A, Hurni M, Carrel T, Gaspardone A, Burnand B, Meier B, Versaci F, Tomai F, Bertel O, Pieper M, de Benedictis M, Eeckhout E

**OBJECTIVE:** To compare coronary artery bypass grafting (CABG) with percutaneous transluminal coronary angioplasty (PTCA) in patients with proximal, isolated de novo left anterior descending coronary artery disease and left ventricular ejection fraction of 45%. **PATIENTS AND METHODS:** In the multicenter Stenting vs Internal Mammary Artery (SIMA) study, patients were randomly assigned to PTCA and stent implantation or to CABG (using the internal mammary artery). The primary clinical composite end point was event-free survival, including death, myocardial infarction, and the need for additional revascularization. Secondary end points were functional class, antianginal treatment, and quality of life. Analyses were by intention to treat. **RESULTS:** Of 123 patients who accepted randomization, 59 underwent CABG, and 62 were treated with stent implantation (2 patients were excluded because of protocol violation). At a mean  $\pm$  SD follow-up of  $2.4 \pm 0.9$  years, a primary end point had occurred in 19 patients (31%) in the stent group and in 4 (7%) in the CABG group ( $P < .001$ ). This significant difference in clinical outcome is due to a higher incidence of additional revascularization in the stent group, the incidence of death and myocardial infarction being similar (7% vs 7%, respectively;  $P = .90$ ). The functional class, need for antianginal drug, and quality-of-life assessment showed no significant differences. **CONCLUSIONS:** Both stent implantation and CABG are safe and highly effective treatments to relieve symptoms in patients with isolated, proximal left anterior descending coronary artery stenosis. Both are associated with a low and comparable incidence of death and myocardial infarction.

However, similar to PTCA alone, a percutaneous approach using elective stent placement remains hampered by a higher need for repeated intervention because of restenosis.

Eur J Cardiothorac Surg, 2000 ;18(4):380-7

European criteria for the appropriateness and necessity of coronary revascularization procedures

Fitch K, Lazaro P, Aguilar MD, Kahan JP, van het Loo M, Bernstein SJ

**Objectives:** Large variations in the use of coronary revascularization procedures have led many countries to apply the RAND appropriateness method to develop specific criteria describing patients who should be offered these procedures. The method is based on the work of a multidisciplinary expert panel that reviews a synthesis of the scientific evidence and rates the appropriateness of a comprehensive list of indications for the procedure being studied. Previous studies, however, have all involved single-country panels. We tested the feasibility of carrying out a multinational panel to rate the appropriateness and necessity of coronary revascularization, thereby producing recommendations for common European criteria. **Methods:** Using the RAND methodology, a multispecialty (interventional cardiologists, non-interventional cardiologists and cardiovascular surgeons), multinational (The Netherlands, Spain, Sweden, Switzerland and the United Kingdom) panel rated the appropriateness and necessity of indications for percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft surgery (CABG). A synthesis of the evidence and list of indications for PTCA and CABG were sent to 15 panelists, three from each country, who performed their ratings in three rounds. **Results:** For PTCA, 24% of the indications were appropriate and necessary, 16% were appropriate, 43% were uncertain and 17% were inappropriate. The corresponding values for CABG were 33% appropriate and necessary, 7% appropriate, 40% uncertain and 20% inappropriate. The proportion of indications rated with disagreement was 4% for PTCA and 7% for CABG. **Conclusion:** Multinational panels appear to be a feasible method of addressing issues concerning the appropriateness and necessity of medical procedures in western European countries. The criteria produced provide a common tool that can be used to measure the overuse and underuse of medical procedures and to guide decision-making.

Am Heart J ,2000 ;140(4):556-64

Projected long-term costs of coronary stenting in multivessel coronary disease based on the experience of the bypass angioplasty revascularization investigation (BARI)

Yock CA, Boothroyd DB, Owens DK, Winston C, Hlatky MA

**BACKGROUND:** Stents are now used in the majority of percutaneous coronary revascularization procedures. It is not clear whether the higher initial cost of stenting is later repaid by reducing costly complications and repeat revascularization procedures, especially for patients with multivessel disease. **METHODS:** To project the long-term costs of using coronary stents, angioplasty, or bypass surgery to treat patients with multivessel coronary artery disease, we developed a decision model based on the outcomes documented in the Bypass Angioplasty Revascularization Investigation (BARI) randomized trial of coronary artery bypass grafting (CABG) and percutaneous transluminal coronary angioplasty (PTCA). We studied 2 clinical strategies: provisional stenting of suboptimal PTCA results and primary stenting of all angiographically eligible lesions. The cost of CABG was also updated to reflect contemporary practice. **RESULTS:** Provisional stenting had lower projected costs over a 4-year period than either traditional PTCA (-\$1742, or -3.4%) or contemporary CABG (-\$832, or -1.7%), mostly because of reductions in emergency CABG after PTCA. In contrast, primary stenting had higher projected costs over a 4-year period than either PTCA (+\$333, or +0.7%) or contemporary CABG (+\$1243, or +2.5%), mainly because of the higher initial procedure costs. These results were not substantially altered when we systematically varied the key parameters of the models in 1-way and 2-way sensitivity analyses. **CONCLUSIONS:** A primary stenting strategy in patients with multivessel disease has higher projected long-term costs than CABG. In contrast, a provisional stenting strategy in multivessel disease has lower projected costs than either PTCA or CABG.

Clin Cardiol ,2000 ;23(8):580-6

Clinical and nonclinical correlates of racial and ethnic differences in recommendation patterns for coronary revascularization

Barnhart JM, Wassertheil-Smoller S, Monrad ES

**BACKGROUND:** We sought to determine whether gender or racial differences exist in recommendations for coronary revascularization in a multiracial patient population undergoing their first coronary angiography at an academic institution from 1990-1993 for the evaluation of coronary artery disease (CAD). **HYPOTHESIS:** For patients with clinically significant CAD, no racial differences exist in the recommendation to revascularization following coronary angiography. **METHODS:** The main outcome measure was a recommendation for coronary revascularization such as percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft (CABG) for patients with clinically significant CAD (n = 590). The primary multiple logistic regression analysis focused on only those patients with angiographically severe disease, defined as triple-vessel or left main CAD (n = 180). Race was trichotomized into Hispanic, black, and white to ascertain whether any differential effects of race/ethnicity existed while controlling for age, gender, ejection fraction, angina, diabetes, hypertension, and peripheral vascular disease. A medical record review for all patients with severe CAD, who were given a recommendation for medical therapy, was conducted to ascertain whether previously unmeasured clinical factors or nonclinical factors may have precluded a PTCA/CABG recommendation. **RESULTS:** Hispanics with severe disease were significantly less likely than whites to be given a recommendation for PTCA/CABG following angiography [odds ratio (OR) = 0.39; 95% confidence interval (CI) (0.17, 0.92)]. Blacks were 67% as likely as whites to be given such a recommendation [OR = 0.67; 95% CI (0.17, 2.71)]. Medical records, reviewed for 35 of 40 of these patients given a recommendation for medical therapy, revealed that 6 patients eventually had PTCA/CABG within 6 months due to precipitating ischemic events; 9 had such severe or diffuse disease that revascularization did not appear to be an alternative, and 2 patients opted for medical therapy. **CONCLUSIONS:** Racial differences were manifested in the recommendations made following angiography and may be explained by previously unmeasured clinical as well as nonclinical factors.

J Am Coll Cardiol, 2001 ;37(1):144-52

When to stress patients after coronary artery bypass surgery? Risk stratification in patients early and late post-CABG using stress myocardial perfusion SPECT: implications of appropriate clinical strategies.

Zellweger MJ, Lewin HC, Lai S, Dubois EA, Friedman JD, Germano G, Kang X, Sharir T, Berman DS

**OBJECTIVES:** The study compared the prognostic significance of myocardial perfusion single-photon emission computed tomography (SPECT) (MPS) in patients early and late after coronary artery bypass graft surgery (CABG). **BACKGROUND:** The long-term effectiveness of CABG is limited by graft stenosis. The greatest

incidence of graft occlusion occurs between five and eight years after surgery. However, little is known regarding the appropriate time to stress patients post-CABG with respect to risk stratification. METHODS: We identified 1,765 patients, who underwent MPS 7.1 +/- 5.0 years post-CABG. All patients underwent rest Tl-201/stress Tc-99m sestamibi MPS and were followed up > or =1 year after testing. Patients with early CABG or PTCA (<60 days after MPS) were censored. The prognostic population consisted of 1,544 patients. A semiquantitative visual analysis employing a 20-segment model was used to define summed stress score (SSS), summed rest score (SRS), summed difference score (SDS), and the number of nonreversible segments (NRS). RESULTS: During follow-up, 53 cardiac deaths (CD) occurred. There was a significant increase in annual CD rates as a function of SSS. A multivariate analysis identified age, ischemia (SDS), and infarct size (NRS) as independent predictors of CD. Nuclear variables added incremental value to prescan information. The annual CD rate was relatively low (1.3%) in patients < or =5 years post-CABG. In this subgroup only age and infarct size (NRS) were predictive of CD. CONCLUSION: MPS is strongly predictive of subsequent CD in post-CABG patients and adds incremental value over clinical and treadmill test information. Our data suggest that symptomatic patients < or =5 years and all patients >5 years post-CABG may benefit from testing.

Table 3. Independent Predictors of Cardiac Death

Figure 4. Global chi-square values with respect to prescan information and nuclear variables (n = 1,544).

\*Significant increase of chi-square (p < 0.001).

Figure 5. Global chi-square values with respect to clinical, treadmill, and nuclear variables (n = 703). \*,#

Significant increase of chi-square (p < 0.05).

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