CLINICAL STUDIES

Early Postoperative Complications After Coronary Artery Bypass Grafting at the San Juan Veterans Affairs Medical Center

JOSÉ ESCABÍ-MENDOZA, MD, FACC; JOSÉ ACEVEDO, MD; ELENA RUCABADO, MS*; CYNTHIA M. PÉREZ, PhD*; LUIS RODRÍGUEZ-OSPINA, MD, FACC

Objectives. Describe the perioperative characteristics of the patients undergoing coronary artery bypass grafting (CABG) in San Juan, Veterans Affairs Medical Center (SJ-VAMC). Determine the in-hospital and 30-day morbidity and mortality following CABG and identify adverse predictors for postoperative complications.

Background. Preoperative risk factors for complications post-CABG have been identified; however limited data is available regarding the value of these predictors in the Puerto Rican Population.

Methods. Perioperative characteristics and 30-day complications were gathered from all patients undergoing CABG (n=252) at the SJ-VAMC (2001-2003). Logistic regression analysis was performed to determine factors associated with the occurrence of complications.

Results. The population's mean age was 66.9 ± 8.1 years. Associated illnesses included: hypertension (95.6%), diabetes (57%), past smoking (61%), COPD (26%), chronic renal insufficiency (CRI-11.5%), cerebrovascular disease (CVD-20.6%), disabling angina (78%), 3-vessel coronary disease (75.8%), significant left main stenosis (20%), and non-elective surgical intervention (54%). The most frequent primary complications were postoperative myocardial infarction (MI-4.8%) and congestive heart failure (4.8%). The 30-day mortality was 1.2%. Upon multivariate analysis PRBC transfusions > 3 units was associated to increased risks of primary complications, in patients with prior history of CVD. CRI and LVEF ≤ 40% were independently associated to development of primary complications, in patients with prior MI and CVD.

Conclusion. The preoperative characteristics are suggestive of an older and sicker patient that is undergoing CABG at the SJ-VAMC. Despite this, the death rate was low and the frequency of other complications comparable to the Society of Thoracic Surgeons (STS) National Adult Cardiac Database.

Key words: Coronary artery bypass grafting, Veterans Affairs Medical Center, Puerto Rico, Postoperative complications.

Heart disease is the leading cause of death in the United States (US) with about 700,000 cases reported in 2002, mainly related to coronary artery disease (1). This mortality rate has been decreasing in the last three decades, mostly related to a more aggressive primary and secondary risk factor reduction, better medical therapy, and revascularization procedures such as coronary artery bypass grafting (CABG) and coronary percutaneous procedures. In Puerto Rico, the age-adjusted mortality rate for cardiovascular disease decreased from 432.7 per 100,000 population in 1980 to 290.8 per 100,000 population in 1998 (2). The economic burden associated to cardiovascular disease has a significant impact on the US health care system and will continue to increase as the population ages. The direct and indirect costs of cardiovascular diseases and stroke in the United States in 2003 was estimated at $351.8 billion (3).

Surgical revascularization for atherosclerotic heart disease is known to offer significant survival benefit since its early stages of development besides providing relief of angina and improvement in exercise tolerance. Data from the early CABG versus medical treatment trials revealed that the patients with survival benefit from CABG were those with left main coronary artery (LM) stenosis >50%, three vessel coronary artery disease (CAD) with more than 50% diameter stenosis or less than two vessel disease with proximal left anterior descending artery (LAD) with over 70% stenosis. Survival benefit was most notable in patients with poor left ventricle function and/or those with severe ischemia.

Several studies have shown that CABG can be performed with acceptable morbidity and mortality and excellent long-term results (4-10). The Society for Thoracic Surgeons (STS) national database showed that nearly 1,500,000 isolated CABG surgeries were performed in the US between 1993 and 2003. The unadjusted operative mortality from CABG during this period has gradually decreased from 3.5 to 2.6% (11).

Preoperative risk factors identified for increased morbidity and mortality in patients undergoing isolated CABG surgery include advanced age, female sex, left ventricular dysfunction, symptomatic congestive heart failure (CHF), critical LM stenosis and emergency surgery (12). Additional variables that are related to mortality include coronary angioplasty during index admission, recent myocardial infarction (MI), history of angina, ventricular arrhythmias, CHF and mitral regurgitation. Associated comorbidities include diabetes, cerebrovascular accidents (CVA), peripheral vascular disease (PVD), chronic obstructive pulmonary disease (COPD), and chronic renal insufficiency (CRI) (12).

While clinical outcomes following CABG surgery and its predictive factors have been widely described in the medical literature, a systematic review in the San Juan Veterans Affairs Medical Center (SJ-VAMC) has not been obtained. The aims of this study were: 1) to describe the preoperative and intraoperative characteristics of patients undergoing CABG in the SJ-VAMC, 2) to determine the in-hospital and 30-day morbidity and mortality following CABG surgery and 3) to identify predictors of in-hospital and 30-day morbidity and mortality following CABG surgery.

Methods

A retrospective review was performed of all the patients that underwent isolated CABG in the SJ-VAMC from January 19, 2001 to June 4, 2003. During this time, all the patients have been operated by two cardiothoracic surgeons and the perfusion teams contracted by the hospital. A total of 294 patients underwent cardiac surgery, and 42 patients were excluded from the analysis based on the following criteria: 15 patients underwent valvular replacement or repair without bypass surgery, 24 patients underwent both valvular and bypass surgery, and three females.

The data was collected from: computerized electronic records, patient's medical chart, coronary angiographic report, surgical risk assessment report and the surgical report. The information gathered included: demographics, medical history, cardiac risk factors, severity of angina using the Canadian Classification Society scale (CCS), cardiac studies, body mass index, preoperative medications, laboratory tests, chest x-rays, electro-cardiograms, angiographic and hemodynamic data, operative data, post-operative data including in-hospital and 30-day morbidity and mortality data and length of stay from the date of surgery.

Early postoperative complications were defined as any adverse event not present on admission, occurring between the time of CABG and discharge from the hospital or up to 30 days after surgery. Primary complications, those considered to be life-threatening, included death, MI, cardiogenic shock, low cardiac output requiring inotropics after initial 6 hours, CHF, cardiac tamponade, re-operation to control bleeding, major cardiac arrhythmias, acute renal failure (ARF), acute CVA or re-hospitalization from cardiac causes. The diagnosis of a new postoperative MI was made by a peak elevation of troponin-T over 2.0 ng/dl, from prior normal values or without a recent MI (less then 2 weeks from surgery), with a concomitant elevation of creatine kinase-MB (CK-MB) more than five times the upper limit of normal (diagnostic of MI) and with a CK-MB/CK ratio more than 5.0. However, if related to a recent MI, the baseline troponin T must have decreased to less than 1.0 ng/dl or with evidence of decreasing values. In the absence of serial troponin tests new or worsening pathologic Q waves was to be accepted. Major cardiac arrhythmias included cardiac arrest, severe bradyarrhythmias that required pacing therapy or tachyarrhythmias with hemodynamic compromise requiring electric cardioversion.

Secondary endpoints included prolonged endotracheal intubation (>24 hours), re-intubation, pulmonary embolism, vascular events (deep venous thrombosis, arterial embolization, or aortic dissection), pericarditis, post-pericardiotomy syndrome, atrial tachyarrhythmias (including fibrillation, flutter, or ectopic tachycardia), and infectious complications such as sepsis, pneumonia, osteomyelitis and wound infection.

Surgical priority was defined as emergency surgical procedure (those performed within 24 hours of the coronary angiography), urgent procedure (those performed from 24 hours up to six days from the coronary angiography), and urgent but delayed (those done as inpatient, but after six days from the coronary angiography). Other surgical interventions performed on a separate hospitalization from the coronary angiography were considered as elective and mostly with stable angina.

Continuous variables that were normally distributed were expressed as mean ± standard deviation (SD) and range; those that did not follow a normal distribution were presented as median and 25th and 75th percentiles. Frequency distributions were obtained for categorical variables. Unadjusted odds ratios (OR_U) were estimated

with a 95% confidence interval to determine factors associated with the occurrence of primary and secondary complications, respectively. Variables with a p value less than 0.10 in the bivariate analysis were included in unconditional logistic regression models to estimate adjusted odds ratios (OR_A) for primary and secondary complications, respectively. Two-way interactions between independent variables were assessed in each logistic model. Data entry was performed using Epi-Info 2000 (Atlanta, GA: CDC), and statistical analysis was performed using Stata version 8 (College Station, TX: Stata Corporation).

Results

A total of 252 patients were included in the analysis. The mean age of patients at the time of surgery was 66.9 ± 8.1 years, ranging from 36 to 83 years. A total of 172 patients (68.3%) were 65 years or older. The most frequent cardiac risk factor was hypertension (95.6%), followed by dyslipidemia (80.6%), smoking history (61.5%) and diabetes (56%) (Table 1). From the nearest fasting lipid profile pre-CABG, the following lipid abnormalities were present: total cholesterol > 200 mg/dl in 38%, HDL cholesterol < 40 mg/dl in 43%, triglycerides >150 mg/dl in 57%, and LDL cholesterol >100 mg/dl in 47%. Only 21.3% of the patients were active smokers, while about 61% of the total smokers had quit more than a year before surgery. Upon calculating body mass index (BMI), nearly 27% of the patients were obese (BMI ≥ 30 kg/m²), 52% were overweight (25.0 kg/m² ≤ BMI ≤ 29.9 kg/m²) an 21% were within adequate weight (18.5 kg/m² ≤ BMI < 25.0 kg/m²).

The patients' medical conditions and cardiac history prior to CABG are summarized in Table 2. These include MI (50%), CHF (26.2%), COPD (24.2%), PVD (21%), cerebrovascular disease (20.6%), CRI (11.5%), anemia (12.7%) and cardiac arrhythmias (6.4%). Cerebrovascular disease (CVD) was defined by the presence of a prior CVA, transient ischemic attack, prior endarterectomy or a carotid stenosis of more than 75%. Most of the patients (78%) had disabling angina (CCS ≥3) and 31 patients (12.3%) had prior percutaneous angioplasty. More than half of the patients (58.7%) had a normal left ventricular ejection fraction, and only 3.9% had severe left ventricular dysfunction. The extent of CAD as determined by angiography was: three vessel disease in 75.8%, two vessel disease in 21.8%, single vessel disease in 2.4%, and significant LM stenosis in 20.2%. Of all the patients, 91% had LAD disease, of which 89% had proximal LAD stenosis.

Prior to surgery, the most frequently used cardiac medications were β-blockers (92.5%), nitrates (85%),

Table 1. Demographic and Preoperative Characteristics of 252 Patients that Underwent CABG in the SJ-VAMC, January 2001- June 2003

Preoperative characteristics	Frequency	Percentage (%)
Age		
<65 years	80	31.7
≥65 years	172	68.3
Mean age: 66.9 ± 8.1		
Hypertension	241	95.6
Diabetes mellitus	141	55.9
Hyperlipidemia	203	80.6
Preoperative lipid profile		
Total cholesterol		
<200 mg/dl	151	59.9
≥200 mg/dl	95	37.7
Unknown	6	2.4
LDL cholesterol		
≤100 mg/dl	83	33.0
> 100 mg/dl	119	47.2
Unknown	50	19.8
HDL cholesterol		
≥40 rng/dl	105	41.7
< 40 mg/dl	108	42.8
Unknown	39	15.5
Triglycerides		
≤150 mg/dl	88	35.0
> 150 mg/dl	145	57.5
Unknown	19	7.5
Smoking history	155	61.5
Active smoking within 1 month of surgery	33	21.3
Quit within 1 year from surgery	28	18.0
Quit more than 1 year from surgery	94	60.7
Body mass index		
18.5-24.9 kg/m²	53	21.0
25.0-29.9 kg/m²	132	52.4
≥30.0 kg/m²	67	26.6

aspirin (81%), angiotensin-converting enzyme inhibitors (58.7%) and antilipidemic therapy (52.8%). Thirty-five percent of the patients were on anticoagulants including: unfractionated heparin, low molecular weight heparin (enoxaparin) or coumadin, mostly related to a previous acute coronary syndrome or atrial fibrillation. Heparin was discontinued at least one day prior to surgery and coumadin with enough time for the international normalized ratio (INR) to normalize. Fourteen percent of the patients were on a glycoprotein IIb-IIIa inhibitor (eptifibetide) that was also discontinued prior to surgery.

Selective operative characteristics of the patients that underwent CABG are described in Table 3. Regarding procedure status, 46% were hospitalized electively for CABG in view of stable angina. The rest of the patients were already hospitalized (inpatient) upon referral for CABG (54%). Seven percent were operated as an emergency,

Table 2. Preoperative Cardiac History and Comorbidities of 252 Patients that Underwent CABG in the SJ-VAMC (2001-2003)

Cardiac history	Frequency	Percentage (%)
Prior myocardial infarction	126	50.0
Prior congestive heart failure	66	29.4
Prior percutaneous coronary intervention	31	12.3
Cardiac arrhythmias	16	6.4
Left ventricular systolic function		
Normal (≥55%)	148	58.7
Mild dysfunction (54-41%)	52	20.6
Moderate dysfunction (40-31%)	40	15.9
Severe dysfunction (≤30%)	10	3.9
Unknown	2	0.8
Angina severity		
CCS I	11	4.4
CCS II	40	15.9
CCS III	124	49.2
CCS IV	73	28.9
Unknown	4	1.6
Angiographic data		
Single vessel disease	6	2.4
Two vessel disease	55	21.8
Three vessel disease	191	75.8
Left main ≥50%	51	20.2
Comorbidities		
COPD	61	26.2
Peripherovascular disease	53	21.0
CVD	52	20.6
Chronic renal insufficiency	29	11.5
Anemia	32	12.7
Preoperative medications		
β-blocker	233	92.5
Nitrates	214	84.9
Aspirin	203	80.6
Angiotensin converting enzyme inhibitors	148	58.7
Diuretics	59	23.4
Anti-lipidemic therapy	133	52.8
Heparin	89	35.3
Clopidogrel	56	22.2
Eptifibatide	35	13.9
Digoxin	8	3.2

Table 3. Operative Data of 252 Patients that Underwent CABG in the SJ-VAMC, (2001- 2003)

Operative Data	Frequency	Percentage (%)
Procedure status		
Elective	117	46.5
Emergent	18	7.1
Urgent	85	33.7
Other in hospital-delayed	32	12.7
Left internal mammary artery use	241	95.6
Right internal mammary artery use	2	0.8
Number of grafts		
1	6	2.4
2	48	19.0
3	125	49.6
4	68	26.6
5	6	2.4
Ischemic time ≤60 minutes	202/247	83.0
Total bypass time ≤90 minutes	176/249	71.0
Packed red blood cell transfusions	232	92.0
Type of surgery		
Complete	170	67.5
Incomplete	82	32.5

33.7% and were operated urgently, while 12.7% were operated during the same hospitalization but delayed until other medical conditions were corrected.

The number of grafts used ranged from one to five and the majority of patients (79%) received three or more grafts. The left internal mammary artery was used in 95.6% of the cases while only in two cases (0.8%) the right internal mammary artery was used. The mean cardiopulmonary bypass time was 81.4 minutes ± 17.4 minutes (range: 27-257), whereas the mean ischemic time was 50.2 minutes ± 11.1 minutes (range: 16-170). Only one patient was operated

off-pump with a beating heart. Surgery was considered a complete revascularization procedure in nearly 70% of the cases. The median length of stay after surgery was six days and 58% of the patients were discharged within six days. There was a high frequency of packed red blood cell transfusion perioperatively (92%), and the mean number of transfusions was 3.5 ± 2.2 units (range: 1-16).

Table 4 summarizes the procedural-related primary complications within 30 days of the CABG. The most frequent primary complications were postoperative MI (4.8%) and CHF (4.8%). The average troponin T level was 1.00 ± 0.56 ng/dl, based on 234 patients that had serial troponin T test done postoperatively. The rest of the patients either had troponin I, or not enough serial troponin tests were performed (at least more than eight hours from surgery). All the patients had postoperative serial EKG available and analyzed, without evidence of new or worsening Q waves, against the presence of any significant transmural MI. Other primary complications included serious cardiac arrhythmias in 4%, re-operation related to mediastinal bleeding in 4%, acute renal failure in 4%, low cardiac output syndrome in 3.2%, cardiac tamponade in 1.2%, acute CVA in 1.2%, and death in 1.2%. In the patients complicated with serious cardiac arrhythmias, six needed permanent pacemaker implants. Also, there were seven patients (2.8%) that required re-hospitalization due to cardiac causes within 30 days from surgery. These included MI (1.2%), unstable angina (0.8%) and decompensated CHF (0.8%). The most frequent secondary complications were related to atrial tachyarrhythmias, mostly atrial fibrillation, with a total of 27% (or 25.8%

Table 4. Primary and Secondary Complications of 252 Patients that Underwent CABG at the SJ-VAMC, (2001-2003)

Complications	Frequency	Percentage (%)
Primary complications		
MI	12	4.8
Congestive heart failure	12	4.8
Serious cardiac arrhythmias	10	4.0
Re-operation due to bleeding	10	4.0
Acute renal failure	10	4.0
Low cardiac output	8	3.2
Cardiac re-hospitalization*	7	2.8
Cardiac tamponade	3	1.2
Acute CVA	3	1.2
Death	3	1.2
Cardiogenic shock	1	0.4
Secondary complications		
Atrial fibrillation or flutter	68	27.0
Re-intubation	12	4.8
Pericarditis	6	2.4
Pulmonary embolism	4	1.6
Post-pericardiotomy syndrome	4	1.6
Vascular events'	4	1.6
Prolonged endotracheal intubation > 24 hours	3	1.2
Infections	38	15.1

*Within 1 month from CABG including: acute coronary syndrome and D-CHF.
'Arterial thrombo embolism, deep venous thrombosis or aortic dissection

considered as new not present preoperatively). Need for re-intubation occurred in 4.8%, pulmonary embolism in 1.6%, vascular events in 1.6% (including arterial thromboembolism, deep venous thrombosis or aortic dissection), and prolonged endotracheal intubation in 1.2%. Other infectious-related complications occurred in 16.3%, including: saphenectomy or wound infection in 8.7%, pneumonia in 4.4%, sepsis in 1.2%, mediastinitis 0.4% and one urinary tract infection (0.4%).

Bivariate analysis revealed that prior CVD (p<0.00001), CRI (p=0.0015), prior MI (p=0.0097), LV systolic dysfunction ≤40% (p=0.004), and packed red blood cell transfusions over three units (p=0.0025) were significantly associated with increased odds of primary complications (Table 5). Ischemic time of 70 minutes or longer was marginally associated to primary complications (p=0.07). On the other

hand, prior smoking history (p=0.03), COPD (p=0.04), CVD (p=0.03), and CRI (p=0.007) were significantly associated with an increased odds of secondary complications. However, PVD (p=0.097), ischemic time ≥ 70 minutes (p=0.06), three-vessel disease (p=0.067), performance of an incomplete revascularization (p=0.08), and packed red blood cell transfusions over three units (p=0.06) were marginally associated with secondary complications.

A significant interaction (p<0.05) between CVD and MI was found in the logistic model of primary complications; therefore, the adjusted odds ratio was estimated according to the presence or absence of prior CVD and prior MI. This analysis showed that among patients with a prior history of CVD and a prior MI, those with a decreased LV systolic function (≤40%) had 1.51 (95% CI: 1.06-2.15) times the odds of developing a primary complication than patients with a LV systolic function >40% after adjusting for packed red blood cell transfusions and a prior history of CRI. Moreover, those with a history of CRI had 1.43 (95% CI: 0.95-2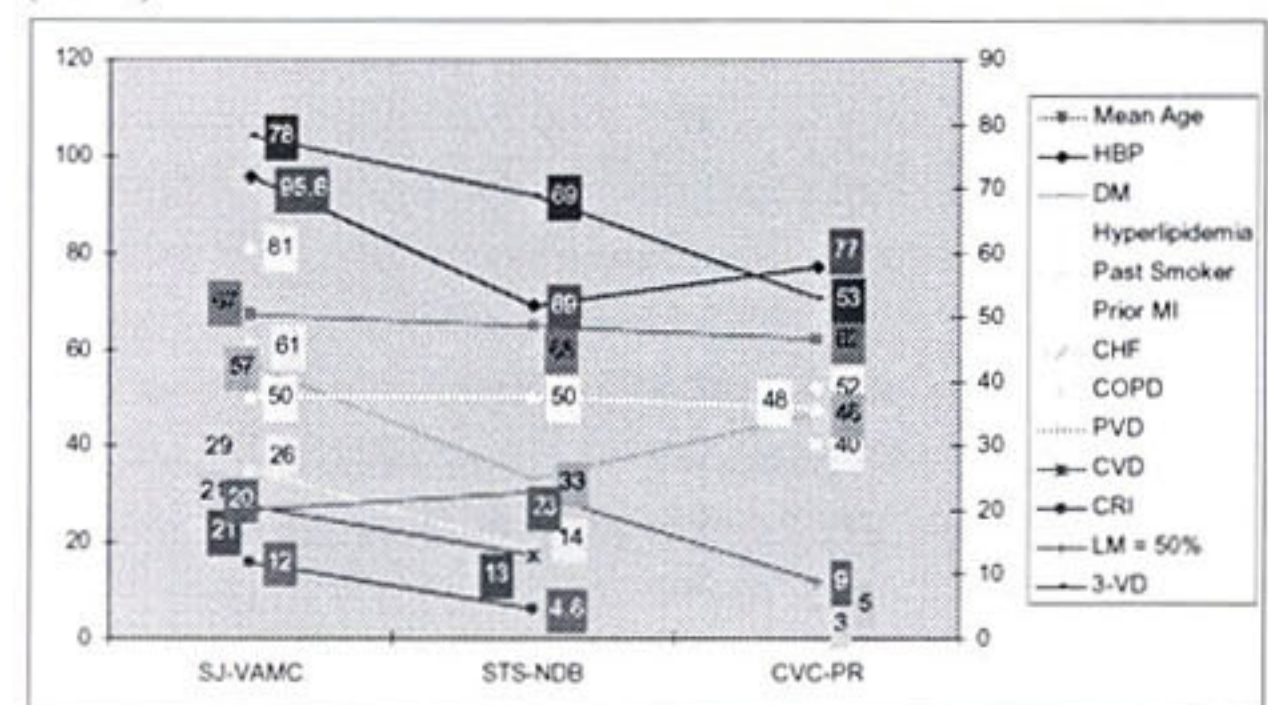.16) times the odds of developing a primary complication compared to patients without CRI after adjusting for packed red blood cell transfusions and LV systolic function; however, this association was marginally significant. Among patients with a prior history of MI and no prior CVD, those with a history of CRI had 1.39 (95%

Table 5. Bivariate Analysis of Characteristics Associated with Primary and Secondary Complications Post-CABG at the SJ-VAMC (2001-2003)

Characteristics	Primary complications			Secondary complications		
	OR$_U$	95%CI	P value	OR$_U$	95% CI	P value
Age ≥ 65 years	1.66	0.83-3.33	0.14	1.53	0.89-2.62	0.11
BMI category						
≥ 30.0 kg/m²	0.67	0.29-1.56	0.35	1.00	0.48-2.08	0.99
25.0-29.9 kg/m²	0.62	0.30-1.30	0.20	0.95	0.50-1.81	0.87
18.5-24.9 kg/m²*	1.00	-	-	1.00	-	-
Dyslipidemia	1.11	0.51-2.40	0.79	1.04	0.56-1.96	0.89
Smoking history	1.38	0.73-2.59	0.32	1.76	1.04-2.95	0.03
COPD	1.56	0.80-3.03	0.19	1.83	1.01-3.44	0.04
PVD	1.21	0.59-2.48	0.59	1.71	0.90-3.23	0.097
CVD	4.16	2.08-8.33	< 0.0001	2.04	1.05-3.93	0.03
CRI	3.50	1.54-7.98	0.0015	3.41	1.32-8.84	0.007
Prior MI	2.25	1.20-4.24	0.0097	1.34	0.81-2.21	0.25
CCS III-IV angina	1.68	0.74-3.85	0.21	1.11	0.59-2.06	0.75
Prior CHF	1.51	0.78-2.90	0.21	1.41	0.79-2.51	0.24
Prior percutaneous coronary intervention	1.86	0.81-4.26	0.13	1.77	0.79-3.94	0.16
LVEF ≤ 40%	2.65	1.32-5.32	0.004	1.23	0.65-2.31	0.52
LM disease ≥ 50%	0.98	0.46-2.07	0.96	0.78	0.42-1.44	0.42
Bypass grafts ≥ 3	0.92	0.44-1.90	0.82	1.10	0.60-2.04	0.75
Ischemic time ≥ 70 minutes	2.44	0.89-6.69	0.07	2.86	0.90-9.04	0.06
Bypass time ≥ 100 minutes	1.01	0.44-2.27	0.99	1.09	0.55-2.16	0.79
3 vessel coronary disease	1.36	0.65-2.84	0.41	1.71	0.95-3.07	0.07
Incomplete revascularization	0.79	0.41-1.52	0.48	1.61	0.93-2.79	0.08
PRBC transfusions > 3 units	2.59	1.37-4.92	0.0025	1.67	0.97-2.86	0.06

*Reference category.

Table 6. Multiple Logistic Regression Analysis of Factors Associated with Primary Complications at the SJ-VAMC (2001-2003)

Patient subgroup	Characteristics	OR$_A$	95%CI	P value
Prior CVD and MI	CRI	1.43	0.95-2.16	0.09
	LVEF ≤ 40%	1.51	1.06-2.15	0.02
	Packed red blood cell transfusions >3 units	1.32	0.94-1.85	0.11
Prior MI and no CVD	CRI	1.39	1.03- 1.86	0.03
	LVEF ≤ 40%	1.07	0.88- 1.30	0.52
	Packed red blood cell transfusions >3 units	1.12	0.94- 1.35	0.21
Prior CVD and no MI	CRI	0.95	0.53-1.71	0.86
	LVEF ≤ 40%	0.65	0.39- 1.09	0.10
	Packed red blood cell transfusions >3 units	1.81	1.14-2.87	0.01
No prior CVD nor MI	CRI	1.08	0.86-1.36	0.51
	LVEF ≤ 40%	0.87	0.66-1.14	0.32
	Packed red blood cell transfusions >3 units	1.09	0.96-1.23	0.17

CI: 1.03-1.86) times the odds of having a primary complication compared to those without CRI after adjusting for packed red blood cell transfusions and LV systolic function. Among patients with a history of CVD and without a prior MI, those that received over three units of packed red blood cell transfusions had 1.81 (95% CI: 1.14-2.87) times the odds of developing a primary complication after adjusting for CRI and LV systolic function. Among patients without a prior CVD or MI, none of the variables were significantly associated to the odds of developing primary complications. No significant interaction terms (p>0.05) were found in the logistic model of secondary complications. Patients with a history of CRI had 1.25 (95% CI: 1.03-1.51) times the odds of developing a secondary complication compared to those without CRI after adjusting for smoking history, COPD, and prior CVD (data not shown).

Discussion

This review was conducted to describe the preoperative and intra-operative characteristics of our veteran patients undergoing isolated CABG, to assess complication rates and to determine factors associated with increased morbidity and mortality. This study evaluated the resultsof the first two years since The Open Heart Surgical Program at the SJ-VAMC started in January 2001. The average age for CABG in the SJ-VAMC was close to two years older than the mean age of CABG patients as recorded by the Society of Thoracic Surgeons (STS) National database in

1999 and five years older than that reported at the Cardiovascular Center of Puerto Rico and the Caribbean (see Figure 1) (13-14). In addition, the frequency of cardiac risk factors and comorbidities (hypertension, diabetes, hyperlipidemia, past smoking, COPD, CRI, and CVD) was also higher. There was also a high percent of patients with disabling angina, and a high non-elective surgical intervention rate. The frequency of three vessel disease was also higher, although LM stenosis and mean left ventricular systolic function was similar to that reported by the STS. These findings are suggestive that CABG surgery in the SJ-VAMC is being performed in an older and sicker patient, with a higher prevalence of comorbidities and CAD severity.

Preoperative medications findings are indicative that most of the patients are receiving reasonable cardiac

Figure 1. Summary of Preoperative Characteristics of Patients that Underwent Isolated CABG from the SJ-VAMC (2001-2003), the STS National Database (1999)* and the CVC-PR (1997)

*STS-NDB= Society of Thoracic Surgeons National Adult Cardiac Database (US & Canada); CVC-PR= Cardiovascular Center of Puerto Rico and the Caribbean

medications, without including analysis for documentation of contraindications, to justify absence of therapy. More than 90% of the patients were in β-blockers and at least one anti-platelet therapy (either ASA or clopidogrel) before the surgery. More than half of the patients were on ACEI therapy. These values are close to the rate of adherence of discharge medications from the leading centers, upon discharge after a non-ST segment elevation acute coronary syndrome from the CRUSADE data (15). This is a National Quality Improvement Initiative that strives to monitor and improve adherence to the ACC/AHA guidelines for the management of patients with unstable angina and non-ST segment elevation myocardial infarction. However, only 53% of the patients were in anti-lipidemic therapy prior to surgery. The most commonly used drug was statins. This rate of treatment falls significantly low for the prevalence of hyperlipidemia documented in this study population, besides the known secondary prevention benefits (in this group of patients with known CAD) from reduction of MI,

cardiac mortality and total mortality. It has also been shown that preoperative statin administration improves cardiovascular outcomes after CABG (16). Another reflection on the seriousness of this issue and under-treatment with statins may be appreciated upon analysis of the preoperative lipid profiles. Approximately half of the patients with known lipid profile pre-CABG had LDL cholesterol above 100 mg/dl, and about one-fifth had unknown levels. In addition, these lipid abnormalities in the presence of a high prevalence of hypertension, diabetes or insulin resistance, and obesity, it is clear that many of these patients also have a metabolic syndrome, certainly predisposing them to higher risk for future cardiovascular events. Explaining why, to some extent, we have to be more aggressive with this population with known CAD who are undergoing cardiac surgery.

The 30-day death rate was significantly lower, with nearly half of what is usually reported. In general, the frequency of the major complications post-CABG was low. The most frequent primary complication was postoperative MI with 4.8%, slightly higher than what is usually reported. However, this diagnosis was mostly made by postoperative troponin T serial testing, associated to a lower threshold set by cardiac marker criteria. None of the patients developed new or worsening Q waves. It has been suggested by the STS that the elevation of troponin T above 2.0 ng/dl should be a result of myocardial necrosis, although no specific value is considered standard for the diagnosis of MI. Another possible explanation for this observation is a high frequency of incomplete surgical revascularization in view of poor target issues, although this has to be analyzed further from our data. Jannuzi et al. also found that postoperative values of troponin T above 1.58 ng/dl was associated to increased risk of adverse cardiac outcomes (17).

The need for re-operation immediately after CABG, related to mediastinal bleeding, was also mildly higher compared to those reported by the STS during 2000-2002 (4.0% vs. 2.5%, respectively). Upon review of the 10 patients that required re-operation for bleeding control, this revealed a higher incidence of emergent or urgent related interventions, in addition to a large recent use of aspirin (90%) and plavix (30%) within five days prior to CABG, known to be related to increase bleeding complications. There was also a high rate of perioperative packed red blood cell transfusions without a specific documentation of transfusion criteria, besides amount of bleeding, low hematocrit and/or altered hemodynamics. This is suggestive of a lower threshold for PRBC transfusions by our cardiothoracic surgeons. This has been reported as a general practice by surgeons to be more aggressive with transfusions, with the intention to restore a normal physiology. However, this is not necessary the norm since this may be altered according to the time of blood storage, besides the risks of these products to initiate systemic inflammatory responses, induce a nonspecific immunosuppresion, and microvascular occlusion, causing local tissue hypoxemia (18). Other known consequences of blood transfusion include: viral infections, nosocomial bacterial infections, cancer related deaths and decrease of long-term survival after cardiac surgery (18-19).

Packed red blood cell transfusions over three units was associated to increased risks of primary complications in patients with prior history of CVD. This association in patients with CVD may reflect a more diffuse atherosclerotic disease leading to the above microvascular ischemia issues that may result in organ damage and increased morbidity and mortality. Meanwhile, those with concomitant history of CVD and MI, both CRI and decreased LVEF, were independently associated with the development of primary complications. In general, left ventricular systolic dysfunction has been associated to a higher perioperative early and late morbidity and mortality (12). The lower the LVEF, the higher the risk for adverse outcomes. However, it is also known that with worse left ventricular systolic function the higher the benefit from CABG, in terms of long-term survival, symptoms and functional capacity improvement. While renal insufficiency has also been described to increase risk of worsening renal function, need for dialysis and hospital mortality (12). It is likely that CRI is a surrogate for advanced comorbid disease and predisposition for major complications, although part of the correlation with primary complications is the propensity for developing acute renal failure or worsening of the renal function from suspected renal hypoperfusion insult related to the use of the bypass machine during CABG.

In conclusion, isolated CABG in this institution (SJ-VAMC) is being performed with a low rate of complications and similar to that reported by the Society of Thoracic Surgeons, despite pre-operative characteristics suggestive of an older and sicker patient population.

Resumen

Este estudio describe las características peri-operatorias y las complicaciones pos-operatorias (hasta 30 días) de los pacientes masculinos que se sometieron a cirugía de puente coronario en el Hospital de Veteranos de San Juan, Puerto Rico. Se analizaron retrospectivamente un total de 252 pacientes que fueron operados entre enero de 2001 y junio del 2003. La edad promedio fue de 66.9 ± 8.1 años. Los factores de riesgo más frecuentes fueron hipertensión

(95.5%) e hiperlipidemia (80.6%). La frecuencia de otras comorbilidades importantes fueron: diabetes (56%), historial de fumar (60.5%), enfermedad pulmonar obstructiva crónica (26%), enfermedad cerebrovascular (20.6%) e insuficiencia renal crónica (11.5%). Dentro del historial cardiaco los hallazgos más importantes fueron: infarto cardiaco previo (50%), fallo cardiaco congestivo (29%), angina incapacitante (78%) y enfermedad severa de tres vasos coronarios (75.8%). La mayoría de los pacientes recibieron puente coronario con la arteria mamaria izquierda (95.6%). Un alto porcentaje de pacientes recibió transfusión sanguínea (92%). Las complicaciones primarias mas frecuentes fueron infarto cardiaco (4.8%) y fallo cardiaco congestivo (4.8%). Esta frecuencia de infarto fue mayor que la reportada por la Sociedad Torácica de Cirugía (STC) debido al uso de una definición diferente. La necesidad de re-intervención (exploratoria) por sangrado mediastinal ocurrió con más frecuencia (4%), probablemente relacionado a un mayor número de cirugías de urgencia y uso de terapia antiplaquetaria. Complicaciones tales como arritmias cardiacas, fallo renal agudo, embolia pulmonar, apoplegía cerebral aguda, entubación endotraqueal prolongada y mortalidad a 30 días de cirugía fueron bajas o similares a las reportadas por la STC. Luego de un análisis multivariado, la transfusión sanguínea de más de tres unidades se asoció a un aumento en el riesgo de complicaciones primarias en pacientes con historial de enfermedad cerebrovascular previa. También se encontró que la insuficiencia renal crónica o la función del ventrículo izquierdo $\leq 40\%$ se asociaron al desarrollo de complicaciones primarias en pacientes con historial de infarto previo y enfermedad cerebrovascular.

En conclusión, la cirugía de puente coronario aislada en esta institución (SJ-VAMC) se está realizando con una frecuencia baja de complicaciones y similar a la reportada por la STC, a pesar de que las características pre-operatorias sugieren que nuestros pacientes son de mayor edad y tienen mas comorbilidades.

Acknowledgements

References

1. Kochanek KD, Smith BL. Deaths: Preliminary data for 2002. National Vital Statistics Reports; Vol. 52, no. 13. National Center for Health Statistics, Hyattsville, Maryland: 2004.

2. Pérez CM, Suárez E, Pérez R, Román K. Trends in total and specific cardiovascular disease mortality in Puerto Rico: 1980-1998. Can J Cardiol 2003;19:96A.

3. American Heart Association. Heart disease and stroke statistics – 2003 update. Dallas, Tx: American Heart Association, 2002.

4. Myers WO, Davis K, Foster ED, Maynard C, Kaiser GC. Surgical survival in the coronary artery surgery study (CASS) registry. Ann Thorac Surg 1985;40:245-260.

5. Alderman EL, Bourassa MG, Cohen LS, et al. Ten-year follow-up of survival and myocardial infarction in the randomized coronary artery surgery study. Circulation 1990;82:1629-1646.

6. Weintraub WS, Wenger NK, Jones EL, et al. Changing clinical characteristics of coronary surgery patients. Circulation 1993;88:79-86.

7. Rumsfeld JS, Plomondon ME, Peterson ED, Shlipak MG, Maynard C, Grunwald GK, et al. The impact of ethnicity on outcomes following coronary artery bypass graft surgery in the Veterans Health Administration. J Am Coll Cardiol 2002;40:1786-93.

8. Serruys P, Unger F, Sousa E, et al. Comparison of coronary artery bypass surgery and stenting for the treatment of multivessel disease. N Engl J Med 2001;344:1117-1124.

9. Goodney PP, Siewers AE, Stukel TA, Lucas FL, Wennberg DE, Birkmeyer JD. Is surgery getting safer? National trends in operative mortality. J Am Coll Surg 2002;195:219-227.

10. Grover FL, Shroyer LW, Hammermeister K et al. A decade's experience with quality improvement in cardiac surgery using the Veterans Affairs and Society of Thoracic Surgeons National Database. Ann Surg 2001;234:464-474.

11. STS National Database Spring 2003 Executive Summary. Retrieved on December 10, 2004 from www.ctsnet.org/doc/4502

12. Eagle KA, Guyton RA, Davidoff R, et al. ACC/AHA 2004 guideline update for coronary artery bypass graft surgery: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to update the 1999 guidelines for Coronary Artery Bypass Graft Surgery). J Am Coll Cardiol 2004;44:213-310.

13. Ferguson T, Hammill B, Peterson E, et al. A decade of change-risk profile and outcomes for isolated coronary artery bypass grafting procedures, 1990-1999: A report from the STS National Database Committee and the Duke Clinical Research Institute. Ann Thorac Surg 2002;73:480-490.

14. Guzmán M, Pérez CM. Early postoperative complications after coronary artery bypass grafting at the Cardiovascular Center of Puerto Rico and the Caribbean. PR Health Sci J 1998;17:353-357.

15. Ohman E, Roe M, Smith S, et al. Care of non-ST-segment elevation patients: Insights from the CRUSADE national quality improvement initiative. Am Heart J 2004;148:34-39.

16. Dotani M, Elnicki D, Jain A, et al. Effect of preoperative statin therapy and cardiac outcomes after coronary artery bypass grafting. Am J Cardiol Nov 2000; 15;86:1128-30.

17. Januzzi JL. A comparison of cardiac troponin T and creatine kinase-MB for patient evaluation after cardiac surgery. J Am Coll Cardiol 2002;39:1518-1523.

18. Englesbe M, Pelletier S, Diehl K, et al. Transfusion in surgical patients. J Am Coll Surg 2005;200:249-254.

19. Engoren MC, Habib RH, Zacharias A, et al. Effect of blood transfusion on long-term survival after cardiac operation. Ann Thorac Surg 2002;74:1180-1186.