Perioperative Outcomes in Octogenarians Undergoing Cardiac Surgery in Puerto Rico

GLORIA COLÓN, MD*; CYNTHIA M. PÉREZ, PhD†; MANUEL GUZMÁN, MD‡.

With the advances in surgical techniques and the advent of an aging population, the application of cardiac surgeries has broadened to include those patients over the age of 80. In order to characterize the in-hospital morbidity and mortality of elderly patients undergoing cardiac surgery at our cardiovascular center, a retrospective review of all medical records of consecutive octogenarian patients was made. Between January 1998 and April 1999, 76 patients (mean age (SD), 82.5 (2.6)) underwent cardiac surgery, of which, 61.8% were males. Surgical procedures consisted of isolated coronary artery bypass grafting (CABG) in 64 patients, isolated aortic valve replacement (AVR) in 4 patients, combined CABG and left carotid endarterectomy in 4 patients, combined CABG and AVR in 2 patients, combined CABG and aortic aneurysm repair in 1 patient and combined AVR and aortic dissection repair in 1 patient. Surgery was elective in 51.3% of patients and seventy-one percent (54) experienced at least one postoperative compli-cation. The most common complication was atrial arrhythmia (28) followed by low cardiac output (23) and pneumonia (16). Hospital mortality occurred in 11 (14.7%) patients, an estimate in agreement with previous published studies on octogenarians. Since the number of patients studied was small, these results require confirmation by other cardiovascular centers in the island. Further research to determine independent predictors of postoperative morbidity and mortality, to assess survival and quality of life after cardiac surgery and to evaluate cost-effectiveness considering new trends in managed health care is warranted.

Key words: Coronary artery bypass grafting, Aortic valve replacement, Combined procedures, Octogenarians, Perioperative outcomes, Puerto Rico

Current estimates of the United States Bureau of the Census have indicated that by the year 2010 there will be 522,000 (12.8%) people in Puerto Rico 65 years or older (1). Cardiovascular disease continues to represent the leading cause of mortality in Puerto Rico in both males and females aged 65 years or older (2). Furthermore, 38.3% of all deaths reported in 1995 in Puerto Rico among those aged 65 years or older were attributed to cardiovascular disease. Therefore, elderly patients represent a potential group in need of cardiac surgical procedures. With the proliferation of a managed care medicine, aimed at reducing costs and allocating funds adequately, the controversy surrounding the cost-effectiveness of cardiac surgery among this subgroup becomes a critical issue.

From the Cardiology Section, Department of Medicine, University Puerto Rico School of Medicine*; the Department of Biostatistics and Epidemiology, University of Puerto Rico, Graduate School of Public Health†; and the Cardiovascular Center of Puerto Rico and the Caribbean‡.

Address for correspondence: Cynthia M. Pérez, PhD; Department of Biostatistics and Epidemiology, Graduate School of Public Health, Medical Sciences Campus, University of Puerto Rico, P.O. Box 365067, San Juan, PR 00936-5067. E-mail: cy_perez@rcmaca.upr.clu.edu.

Advances in surgical techniques have contributed to excellent long-term survival and improvements in functional capacity and quality of life after cardiac surgery in the elderly (3-73). While studies have shown that the elderly demonstrate overall successful rates after cardiac surgery, the short- and long-term mortality and morbidity risks are higher than in younger patients. The elderly patient is more likely to experience postoperative morbidity including adverse cerebral outcomes, renal dysfunction, dysrhythmias, pneumonia, and infection, thereby increasing the utilization of intensive care resources (74). For this reason, some investigators have asked if there is a delay in referral for surgery of elderly patients or if they are just being deferred from cardiac surgery (13, 17, 19, 22, 46, 47, 56, 64, 69). Others have suggested that an earlier referral and a prompt intervention are imperative to ameliorate cardiac outcomes in the elderly (35, 62, 73).

Despite the increased risk of morbidity after among the elderly, the American College of Cardiology/American Heart Association (ACC/AHA) Task Force recommends that age itself should not exclude a patient from being offered treatment with CABG, assuming that there is no excessive morbidity (74). Furthermore, there are instances

in which medical treatment remains largely ineffective and surgery could be the only option to restore functional competence and quality of life. Despite the number of reports on elderly patients, data regarding the short and long-term outcomes and quality of life after cardiac surgery among those aged 80 years or older is scarce. Since limited information is available concerning the value of cardiac surgery in Puerto Rico, the in-hospital morbidity and mortality associated with cardiac surgery in patients aged 80 years or older at our center from January 1998 to April 1999 was investigated.

Methods

Patient group. This study was based on a retrospective review of clinical charts and procedure reports of consecutive patients aged 80 years or older with CAD with or without valvular heart disease who underwent isolated CABG, isolated AVR, isolated mitral valve replacement (MVR) or repair or any combination of these procedures at the Cardiovascular Center of Puerto Rico and the Caribbean between January 1998 and April 1999.

Study variables. Patient characteristics such as clinical characteristics, risk factors for CAD, angiographic findings, type of surgery, intra-operative data, and in-hospital postoperative complications were retrieved from medical records. Left ventricular ejection fraction was assessed by contrast ventriculography or 2D echocardiogram. Hypertensive patients were defined as those with blood pressures > 140/90 mm Hg or those receiving antihypertensive treatment. Patients with a history of stroke, transient ischemic attacks or both were considered to have cerebrovascular disease. Renal insufficiency was defined as a serum creatinine level higher than 1.5 mg/dl. Valvular lesions were determined by cardiac catheterization, hemodynamics and 2D-echocardiogram / cardiac Doppler reports. CAD was assessed by coronary angiogram evaluation. Timing of surgery was classified as follows: emergent operations were those performed the same day of cardiac catheterization and angiography, urgent procedures were those performed within two to six days of cardiac catheterization and angiography, and the remaining procedures were considered elective. In-hospital complications were defined as those occurring during the hospitalization period. A written permission for medical record review was requested to the Ethical and Research Committee of the Cardiovascular Center of Puerto Rico and the Caribbean. Frequency distributions and descriptive statistics were computed for categorical and continuous variables, respectively. Data was entered using Epi-Info Version 6.04c (75) and analysis performed with SAS Version 6.12 (76).

Results

During the study period, 4,000 cardiac surgeries were performed in our center, of which, 76 (1.9%) were in octogenarians, reflecting the experience of all surgeons. Mean age (SD) was 82.5 (2.6) years, ranging from 80 to 89; there were 47 males (61.8%) and 29 (38.2%) females. Significant associated conditions were present in a majority of patients: hypertension in 61 (80.3%) patients, diabetes mellitus in 24 (31.6%) patients, unstable angina in 41 (53.9%) patients, Q wave myocardial infarction in 33 (43.4%) patients, and stable angina in 27 (35.5%) patients (Table 1). More than half of patients were using

Table 1. Preoperative characteristics of 76 octogenarians who underwent cardiac surgery

Characteristic	Number	Percentage
Cardiac risk factors		
Mean age (SD)	82.5 (2.6)	-
Hypertension	61	80.3
Male gender	47	61.8
Hypercholesterolemia	26	34.2
Diabetes mellitus	24	31.6
Smoking	21	27.6
Family history of premature CAD	5	6.6
Pre-existing comorbid conditions		
Unstable angina	41	53.9
Q wave myocardial infarction	33	43.4
Stable angina	27	35.5
Congestive heart failure	13	17.1
Chronic obstructive pulmonary disease	12	15.8
Peripheral arterial disease	11	14.5
Thyroid disease	9	11.8
Aortic stenosis	7	9.2
Renal insufficiency	6	7.9
Non-Q wave myocardial infarction	5	6.6
Cerebrovascular accident	5	6.6
Carotid disease	3	3.9
Transient ischemic attack	2	2.6
Ventricular arrhythmia	2	2.6
Atrioventricular block	2	2.6
Aortic stenosis	2	2.6
Aortic stenosis + aortic regurgitation	2	2.6
Mitral stenosis	1	1.3
Mitral stenosis + mitral regurgitation	1	1.3
Mitral regurgitation	1	1.3
Medication use		
Nitrates	48	63.2
Antiplatelets	40	52.6
Angiotensin converting enzyme inhibitors	31	40.8

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Table 1. Preoperative characteristics of 76 octogenarians who underwent cardiac surgery

Characteristic	Number	Percentage
ACE inhibitors	31	40.8
Diuretics	24	31.6
Beta blockers	22	28.9
Calcium channel blockers	22	28.9
Digitalis	14	18.4
Lipid lowering drugs	9	11.8
Angiotensin II receptor blockers	7	9.2
Warfarin	2	2.6
Antiarrhythmic agents	1	1.3
Angiographic findings		
Three vessel disease	45	59.2
Left main coronary artery	16	21.1
Two vessel disease	10	13.2
Non-obstructive lesion	2	2.6
Mean left ventricular ejection fraction (SD)	51.9% (12.9%)	-

nitrates (63.2%) and antiplatelets (52.6%). Cardiac catheterization revealed that nearly 60% had three-vessel disease, 21.1% had left main CAD, and 13.2% had two-vessel disease. Two patients who underwent aortic valve replacement had non-obstructive coronary artery lesions. Mean left ventricular ejection fraction was 51.9% (12.9%), ranging from 25% to 75%. Nearly 34% had left ventricular dysfunction, of which, 8.6% had an ejection fraction ≤ 30%.

The vast majority of octogenarians underwent isolated CABG (84.2%) (Table 2). The rest of the patients underwent isolated AVR (4), combined CABG and left carotid endarterectomy (4), combined CABG and AVR (2), combined CABG and aortic aneurysm repair (1) and AVR with aortic dissection repair (1). More than half of patients underwent cardiac surgery on an elective basis. Of the seven patients who underwent AVR, five received bioprosthetic valves and two mechanical valves. Of these, four had aortic regurgitation while three had mitral regurgitation. Median cardiopulmonary bypass time and aortic cross-clamp time were 83 minutes and 51 minutes, respectively. Median hospital length of stay was 11 days, including two patients with stays exceeding 60 days.

Table 2. Intraoperative characteristics of 76 octogenarians who underwent cardiac surgery

Characteristic	Number	Percentage
Cardiac procedure		
Isolated CABG	64	84.2
Isolated AVR	4	5.3
Combined CABG and left carotid endarterectomy	4	5.3
Combined CABG and AVR	2	2.6
Combined CABG and aortic aneurysm repair	1	1.3
Combined AVR and aortic dissection repair	1	1.3
Surgical priority		
Elective	39	51.3
Urgent	28	36.8
Emergent	9	11.8
Median number of grafts*	3	1-4
Use of left internal mammary artery graft	71	93.4
Intraoperative intra-aortic balloon pump	2	2.6
Median cardiopulmonary bypass time*	83	26-245
Median aortic cross-clamp time*	51	16-217
Median CPK-MB levels*	27.2	4.1-281
Type of valve		
Bioprosthetic	5	6.6
Mechanical	2	2.6
Median intensive care unit length of stay*	2	<1-45
Median hospital length of stay*	11	2-76

*Data are shown as median (minimum value-maximum value).

Table 3. In-hospital complications among 76 octogenarians who underwent cardiac surgery.

Complication	Number	Percentage
Atrial arrhythmia	28	36.8
Low cardiac output	23	30.3
Pneumonia	16	21.1
Death	11	14.5
Intubation for more than 48 hours	10	13.2
Pleural effusion	10	13.2
Reintubation	8	10.5
Cardiogenic shock	7	9.2
Sepsis	7	9.2
Acute renal failure	6	7.9
Renal impairment	6	7.9
Cardiac arrest	6	7.9
Stroke	4	5.3
Delirium	4	5.3
Need for reoperation other than bleeding	4	5.3
Ventricular tachycardia	3	3.9
Re-exploration for bleeding	3	3.9
Pneumothorax	3	3.9
Postoperative intra-aortic balloon pump	3	3.9
Gastrointestinal bleeding	3	3.9
Sternal wound infection	2	2.6
Pericarditis	2	2.6
Need for electrical cardioversion	2	2.6
Cardiac tamponade	1	1.3
Need for permanent pacemaker	1	1.3

Seventy-one percent (54) of patients experienced at least one complication. The most common complications were atrial fibrillation (28), low cardiac output (23), and pneumonia (16) (Table 3). Four patients required reoperation, two patients due to arterial thrombosis and two patients due to wound infection.

Hospital deaths occurred in 11 patients who underwent cardiac surgery (Table 3). Determination of causes of death revealed that the majority of causes of death were non-cardiac (Table 4). Three patients died of sepsis, two of cardiogenic shock, one of ventricular tachycardia, one of multiple organ failure, one of cerebrovascular accident, one of pulmonary embolism, one of upper gastrointestinal bleeding, and one of unknown cause. Of these patients, seven were males and four females. Six patients were operated on urgently and 5 were operated on electively. The most common presenting conditions were: hypertension (11), unstable angina (7), Q wave myocardial infarction (4) and renal insufficiency (3). Mean ejection fraction was 47.3% (14.0%), and two patients had severe left ventricular dysfunction (ejection fraction <25%). Furthermore, median cardiopulmonary bypass time was significantly longer (107 minutes) than in those patients who survived (81 minutes) (p=0.04).

Table 4. Causes of in-hospital mortality among 11 octogenarians who underwent cardiac surgery

Cause of death	Number
Sepsis	3
Cardiogenic shock	2
Ventricular tachycardia	1
Multiple organ failure	1
Cerebrovascular accident	1
Pulmonary embolism	1
Upper gastrointestinal bleeding	1
Unknown cause	1

Discussion

The number of cardiac surgeries performed has increased markedly over the last four decades. These surgical procedures have been associated with a low morbidity and mortality in the general population (74). From 1990 to 1997, the Society of Thoracic Surgeons (STS) national database reported overall mortality rates of 2.31% for mitral valve repair up to 12% for combined CABG and mitral valve replacement. These estimates significantly increase in the elderly population, especially among those aged 80 years or older, with mortality rates

Table 5. Published operative mortality after cardiac surgery in patients aged 80 years or older.

Investigator	Surgery†	Number of patients	Mortality (%)‡
Deleuze et al. (1990)	AVR	60	28.0
Dixon et al. (1990)	CABG	13	0.0
Mullany et al. (1990)	CABG	159	10.7
Naunheim et al. (1990)	CABG	71	13.0
	AVR	11	9.0
	AVR+CABG	11	18.0
	MVR	4	50.0
	MVR+CABG	3	33.3
	MVR+AVR+CABG	3	67.0
Freeman et al. (1991)	CABG, AVR, AVR+CABG, MVR, MVR+CABG	191	18.8
Ko et al. (1991)	CABG	100	12.0
Weintraub et al. (1991)	CABG	154	10.4
Weintraub et al. (1991)	CABG	146	8.3
Tsai et al. (1991)	CABG	157	7.0
Glower et al. (1992)	CABG	86	10.0
Elayda et al. (1993)	AVR	171	17.5
Kaul et al. (1994)	CABG	205	5.8
Curtis et al. (1994)	CABG	68	14.7
Shah et al. (1994)	CABG, CABG+AVR, AVR, MVR, MVR+ASD repair	56	7%
Tsai et al. (1994)	CABG	303	8.3
	AVR, AVR+CABG	132	4.5
	MVR, MVR+CABG	42	29.0
	MVRP+CABG	31	23.0
	AVR+MVR,AVR+MVR+CABG	20	30.0
Klima et al. (1994)	CABG, AVR, MVR, combined procedures	75	8.0
Sahar et al. (1994)	CABG, AVR, AVR+CABG	35	0.0
Peterson et al. (1995)	CABG	24,461	11.5
Logeais et al. (1995)	AVR	200	11.5
Williams et al. (1995)	CABG	300	11.0
Glock et al. (1996)	AVR, AVR+MVR, CABG	96	9.8-11.0
Morris et al. (1996)	CABG	474	7.8
Gehlot et al. (1996)	AVR	322	13.7
Samuels et al. (1996)*	CABG	8	7.0
	AVR	6	0.0
Ott et al. (1997)	CABG	37	5.4
Akins et al. (1997)	CABG	292	5.8
	AVR	105	7.6
	AVR+CABG	111	6.3
	MVR/MVRP+CABG	42	9.5
	Other	50	18.0
Schmitz et al. (1998)	CABG	45	15.5
	AVR/MVR	33	3.0
	Combined CABG and other procedures	19	21.7
Kirsch et al. (1998)	CABG	47	12.8
	AVR, MVR, AVR+MVR	116	17.8
	CABG + AVR or MVR	26	19.2
	MVR + VSD repair	1	0.0
Khan et al. (1998)	AVR, MVR, MVR/MVRP, CABG+AVR, CABG+MVR/MVRP	61	11.4
Medalion et al. (1998)	AVR	248	5.0
	AVR+CABG	149	11.4
Christenson et al. (1999)	CABG	20	5.0

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Table 5. Published operative mortality after cardiac surgery in patients aged 80 years or older.

Investigator	Surgery†	Number of patients	Mortality (%)‡
Craver et al. (1999)	CABG	388	9.0
	AVR	71	5.7
	MVR	18	16.7
	AVR+MVR	2	0.0
	CABG+AVR	73	9.7
	CABG+MVR	6	33.3
	CABG+AVR+MVR	1	0.0
Sahar et al. (1999)	CABG	45	2.0
	CABG+AVR, CABG+MVR	32	6.0
Miller et al. (1999)*	CABG	11	18.0
Dalrymple-Hay et al. (1999)	CABG	242	5.7
Gilbert et al. (1999)	AVR	103	18.4
Bessou et al. (1999)	AVR	140	9.3
Ralph-Edwards et al. (1999	AVR	102	3.9
	MVR	18	16.7
	AVR+MVR	5	20.0
Fruitman et al. (1999)	CABG, AVR, MVR, CABG + AVR or MVR	127	7.9
Kolh et al. (1999)	AVR	62	9.0
	AVR+CABG	21	24.0

*Cardiac surgeries performed in nonagenarian patients
†CABG=coronary artery bypass grafting, AVR=aortic valve replacement, MVR=mitral valve replacement, MVRP=mitral valve repair, ASD=atrial septal defect, VSD=ventricular septal defect
‡Operative mortality defined as death during the immediate hospitalization or within 30-days of operation.

ranging from 5.4% for mitral valve repair to 18.6% for combined aortic and mitral valve replacement.

The octogenarian patient has a higher incidence of left main CAD, multivessel disease, significant left ventricular dysfunction and more severe valvular disease than any other age group (4, 10, 11, 14, 16, 20, 22, 24, 30, 34, 36, 40, 47, 49, 53, 61, 74). These observations are consistent with the present study, where 60% of patients had three-vessel disease and 21% had left main CAD. In addition, more than one-third had left ventricular dysfunction. Other risk factors and comorbidities such as diabetes mellitus, hypertension, chronic obstructive pulmonary disease, peripheral arterial disease and renal insufficiency increase the risk of fatal and nonfatal but disabling complications.

More than 80% of the patients in our center were hypertensive. Despite the availability of effective pharmacologic agents for the treatment of hypertension, less than 41% of the medical records showed evidence of anti-hypertensive medication use, a finding consistent with a previous study at our institution (77). Clinical trials for hypertension treatment have shown greater efficacy in decreasing the morbidity and mortality due to coronary and cerebrovascular events in older patients (78).

A high percentage of patients presented with unstable angina, history of Q wave myocardial infarction and congestive heart failure, conditions that definitely worsen prognosis after cardiac surgery. The majority (80.3%) of the patients studied had severe CAD requiring revascularization. It is of concern that only 53% of patients were on antiplatelet therapy, a therapy proven to significantly reduce coronary events. This observation should be interpreted with caution because patients may not be using these agents on admission due to established protocols for surgery.

Most of the surgeries were performed on an elective basis, similar to studies performed by Williams et al. (30), Craver et al. (49) and Kirsch et al. (62). This observation contrasts with other studies that noticed an increasing number of octogenarians requiring more urgent or emergent procedures (11, 40, 50). It should be acknowledged that cardiac surgery in the elderly impose a challenge for the cardiothoracic surgeon due to the increased risk of complications and technical difficulty including a more diffuse atherosclerosis, thin and fragile vessel walls and more severe valvular lesions.

Intraoperative data in this group of patients was remarkably similar to a previous series reported in our institution undertaken in younger patients (77) in terms of number of grafts, use of the left internal mammary artery, cardiopulmonary bypass time, CPK-MB levels and intensive care unit length of stay.

The complication rate was frequent and compares favorably to published series (4, 7, 9). The most frequent complication was atrial arrhythmia, an observation consistent with various studies in octogenarians (5, 7, 9, 22, 24, 27, 53, 62, 73). Low cardiac output was recorded in 30% of patients, being the second most frequent complication. This finding is similar to the studies conducted by Shah et al. (22) and Christenson et al. (47). Hospital deaths occurred in 11 patients (14.5%) who underwent isolated CABG. The mortality estimated in this study compares with estimates reported in previous investigations conducted over the last decade (Table 5).

Cost-effectiveness should be an area of study considering new trends in managed medical care requiring to limit healthcare costs in a rapidly growing elderly population. This population will require more complex pre-operative and post-operative care, and will have a higher risk of developing complications leading to prolonged medical care. Studies assessing the cost-effectiveness of cardiac surgical procedures versus medical management are warranted on Hispanic elderly patients.

Elderly patients must be evaluated thoroughly before recommending cardiac surgery in order to identify risk factors that will affect prognosis as well as cautious weighting of benefit versus risk. Although there is a higher procedural-related morbidity and mortality after cardiac

surgery, selected octogenarians experience symptomatic improvement (7, 16, 24, 34, 36, 40, 42, 50-52, 54, 61-63, 66, 73). Therefore, investigators should make an effort to continue collecting data on outcomes after cardiac surgery among the elderly. The design of a database of all patients undergoing cardiac surgery across the island will be useful in estimating the probability of operative death and complications and assessing the quality of care being offered by cardiac surgeons. A risk stratification system should aid both the cardiologist and cardiothoracic surgeon in deciding optimal management for the octogenarian patient (74, 79, 80).

Since the number of patients studied was limited and these results require confirmation by other centers in the island, it would be premature to conclude that octogenarians can undergo cardiac surgery without a higher risk of morbidity and mortality. Further research to determine independent predictors of postoperative morbidity and mortality, to assess quality and duration of life after cardiac surgery and to evaluate cost-effectiveness considering new trends in managed health care is warranted. Individualized decisions that incorporate the patient's preference will aid the medical management of octogenarians with severe cardiac lesions that do not respond to medical therapy.

Resumen

Con los avances en las técnicas quirúrgicas y el envejecimiento de la población, se ha extendido la recomendación de cirugía cardiaca para incluir personas de 80 años o mas. Para caracterizar la morbilidad y la mortalidad intrahospitalaria de pacientes viejos sometidos a cirugía cardiaca en nuestro centro cardiovascular, se revisaron todos los expedientes médicos de octogenarios que se sometieron a estas intervenciones entre enero de 1998 y abril de 1999. La edad promedio de 76 octogenarios que se sometieron a cirugía cardiovascular fue 82.5 (2.6) años, de los cuales 61.8% eran varones. Los procedimientos quirúrgicos consistieron de: cirugía aislada de puente aortocoronario (*CABG*) en 64 pacientes, reemplazo de válvula aórtica (*AVR*) en cuatro pacientes, *CABG* combinada con endarterectomía de la carótida izquierda en 4 pacientes, *CABG* combinada con *AVR* en dos pacientes, *CABG* combinada con una reparación de un aneurisma de la aorta en un paciente y *AVR* combinada con una reparación de una disección de la aorta en un paciente. Las cirugías fueron electivas en 51.3% de los pacientes y 71% (54) de los pacientes desarrollaron al menos una complicación postoperatoria. Las complicaciones mas comunes fueron arritmia atrial (28), gasto cardiaco disminuído (23) y pulmonía (16). La mortalidad intra-hospitalaria ocurrió en 11 (14.7%) pacientes, una cifra consistente con estudios publicados en la literatura científica. Debido a que el número de pacientes estudiados es limitado, estos resultados requieren confirmación por otros centros cardiovasculares en la Isla. Se recomiendan realizar mas investigaciones dirigidas a determinar los predictores de morbilidad y mortalidad, la sobrevivencia, la calidad de vida y la costo-efectividad de estos procedimientos a la luz de las nuevas tendencias en el cuidado dirigido de salud.

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