Aortic valve replacement: Results and predictors of mortality from a contemporary series of 2256 patients

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Objective: The study's objectives were to evaluate results and identify predictors of hospital and mid-term mortality after primary isolated aortic valve replacement; compare early and mid-term survival of patients aged more than 80 years or less than 80 years; and assess the effectiveness of the logistic European System for Cardiac Operative Risk Evaluation in predicting the risk for hospital mortality in octogenarians with a logistic European System for Cardiac Operative Risk Evaluation greater than 15% who are undergoing aortic valve replacement.

Methods: Data from 2256 patients undergoing primary isolated aortic valve replacement between January 2003 and December 2007 were prospectively collected in a Regional Registry (Regione Emilia Romagna Interventi Cardiochirurgia) and analyzed to estimate hospital and mid-term results.

Results: Overall hospital mortality was 2.2%. By multivariate analysis, New York Heart Association III and IV, Canadian Cardiovascular Society III and IV, pulmonary artery pressure greater than 60 mm Hg, dialysis, central neurologic dysfunction, and severe chronic obstructive pulmonary disease emerged as independent predictors of hospital mortality. At 3 years, the survival was 89.3%. The same predictors of hospital mortality plus ejection fraction of 30% to 50% and age more than 80 years emerged as independent risk factors for 3-year mortality. Compared with younger patients, octogenarians had a higher hospital mortality rate (3.72% vs 1.81%; $P = .0143$) and a reduced 3-year survival (82.3% vs 91.3%; $P < .001$). Three-year survival of octogenarians was comparable to the expected survival of an age- and gender-matched regional population ($P = .157$). The observed mortality rate in octogenarians with a logistic European System for Cardiac Operative Risk Evaluation greater than 15% (mean: 22.4%) was 7% ($P < .001$).

Conclusions: This study provides contemporary data on the characteristics and outcome of patients undergoing first-time isolated aortic valve replacement. (J Thorac Cardiovasc Surg 2011;141:940-7)

ACD

During the last few years, advances in perioperative management and increased life expectancy have dramatically changed the characteristics of patients who are referred for aortic valve replacement. Octogenarians and high-risk patients who were contraindicated for surgery in the past currently represent a considerable portion of daily surgical activity, with increased survival and functional benefits being reported afterward.[1-3]

As reported by the Euro Heart Survey on Valvular Heart Disease,[4,5] 33% of patients with symptomatic severe aortic valve stenosis are considered inoperable because of advanced age or a high-risk profile and are not referred for surgery. This has triggered the development of less-invasive transcatheter techniques for aortic valve implantation with expected benefits in terms of mortality, postoperative complications, and social costs. The correct and well-calibrated prediction of the operative risk by different risk models clearly plays a central role in the decision-making process for referring patients to transcatheter aortic valve implantation rather than conventional aortic valve replacement.[6] In particular, a logistic European System for Cardiac Operative Risk Evaluation (euroSCORE) greater than 15% to 20% is considered as the cutoff value to refer patients for less-invasive transcatheter aortic valve procedures.[7,8]

The present study analyzed a series of 2256 patients undergoing a first-time isolated aortic valve replacement between 2003 and 2007 aiming to (1) represent clinical characteristics of contemporary patients referred for aortic valve surgery; (2) estimate short- and mid-term survivals; (3) identify risk factors for hospital and mid-term mortality; (4) compare outcome of octogenarians versus younger patients; and (5) compare predicted (logistic euroSCORE) and observed mortality in patients undergoing aortic valve

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Abbreviations and Acronyms

CI = confidence interval
CCS = Canadian Cardiovascular Society
COPD = chronic obstructive pulmonary disease
euroSCORE = European System for Cardiac Operative Risk Evaluation
HR = hazard ratio
NYHA = New York Heart Association
OR = odds ratio

replacement with age greater than 80 years and logistic euroSCORE greater than 15%.

MATERIALS AND METHODS

Data Source: The Regione Emilia Romagna Interventi Cardiochirurgia Registry

The Regione Emilia Romagna Interventi Cardiochirurgia Registry is a prospective regional database collecting preoperative, intraoperative, and postoperative data from patients undergoing cardiac surgical procedures in the 6 regional cardiac surgery departments (academic hospitals: n = 2, private hospitals: n = 4). Between January 2003 and December 2007, data from 22,490 cardiac surgical procedures in 22,236 patients were collected. The Registry management is centralized: Every 3 months the regional Cardiac Surgery Departments are required to dispatch the data to the Regional Health Care Agency for quality/completeness control and to monitor cardiac surgery results in the Emilia Romagna region (~4 million residents).

The selection of variables, shared by the 6 cardiac surgery departments, is extrapolated from the database of the Italian Society for Cardiac Surgery. The Regional Health Care Agency notifies the Registry of the occurrence of all deaths in regional Registry patients. The present study was approved by the review board of the regional health agency, and informed consent was obtained from each patient.

Patients' Profile

We analyzed data from 2256 Registry patients undergoing primary isolated aortic valve replacement between January 1, 2003, and December 31, 2007. Variable and variables definitions are listed in the Appendix.

The mean age was 70.4 ± 11.2 years (range, 21–91 years). Octogenarians represented 19.1% (n = 430) of the entire cohort of patients. Indication for surgery was severe aortic valve stenosis in 1093 patients (48.4%), severe aortic valve insufficiency in 386 patients (17.1%), and combined severe lesions with predominant stenosis in 777 patients (34.5%).[9]

New York Heart Association (NYHA) class III and IV were documented in 1117 patients (49.5%); an urgent procedure (within the same hospitalization) was performed in 129 patients (5.7%), and an emergency procedure (immediate) was performed in 14 patients (0.6%). Mean standard and logistic euroSCOREs were 6.3% and 7.2%, respectively. A bioprosthesis was implanted in 1710 patients (75.8%) with a mean age of 70.4 ± 8.6 years (range, 21–91 years). The mean age of patients receiving a mechanical prosthesis (n = 546; 24.2%) was 60.0 ± 11.9 years (range, 24–90 years). Compared with younger patients, octogenarians presented a higher-risk profile because of a greater incidence of congestive heart failure (8.9% vs 5.0%; $P < .001$), NYHA III and IV (58.1% vs 47.5%; $P < .001$), recent myocardial infarction (4.4% vs 2.3%), previous coronary percutaneous coronary intervention (7.2% vs 4.6%; $P = .035$), hypertension (74.7% vs 69.1%; $P = .023$), severe chronic obstructive pulmonary disease (COPD) (7.4% vs 4.9%; $P = .03$), extracardiac vasculopathy (26.3% vs 16.1%; $P < .001$), and cerebrovascular disease (6.7% vs 3.7%; $P = .004$). A higher incidence of active infective endocarditis was observed in patients younger than 80 years (3.3% vs 1.1%; $P = .026$). Mean standard and logistic euroSCOREs of the entire cohort of patients were 6.3% and 7.2%, respectively. In the octogenarian group, the mean standard and logistic euroSCOREs were 8.9 ($P < .001$) and 13.1% ($P < .001$), respectively. Patients' preoperative characteristics are listed in Table 1. Complete (100%) survival data at follow-up were obtained for the 1822 patients resident in the region (80.8%).

Statistical Analysis

Continuous variables are expressed as the mean ± 1 standard deviation, and categoric variables are expressed as percentage. All preoperative and intraoperative variables were first analyzed using univariate analysis (unpaired 2-tailed *t* test, chi-square test, or Fisher's exact test when appropriate) to determine whether any single factor influenced hospital mortality. Variables that achieved *P* less than .05 in the univariate analysis were examined using multivariate analysis by forward stepwise logistic regression to evaluate independent risk factors for hospital mortality. Survival curves (taking into account perioperative deaths) were estimated at 1, 2, and 3 years using the Kaplan–Meier method and compared using the log-rank test only in regional patients. Including the dummy of the variable regional residence and extra-regional residence in the logistic regression assessed the possible difference of risk for in-hospital mortality between regional inhabitants and extra-regional inhabitants. For each patient, the corresponding average age- and gender-matched annual mortality rates of the regional (Emilia Romagna, Italy) general population were obtained. These data were taken from the most recent regional life tables of 2006 provided by the Italian Statistical Office. On the basis of these mortality data, the probability of cumulative expected survival was determined for the beginning of each year, which resulted in an expected survival curve. Thus, the log-rank test was used to compare patients' survival with the expected survival of the age- and gender-matched 2006 regional population. Independent predictors of 3-year survival were determined with the Cox proportional hazards analysis, and the proportional hazard assumption was assessed using the test of Harrel and Lee, a variation of Schoenfeld residuals test. Statistical analysis was performed using SAS 9.1 (SAS Institute Inc, Cary, NC).

RESULTS

Early Mortality

Overall hospital mortality was 2.2% (29/2256). On univariate analysis, age more than 80 years, emergency, shock, NYHA class III to IV, Canadian Cardiovascular Society (CCS) class III to IV, systolic pulmonary artery pressure more than 60 mm Hg, creatinine more than 2 mg/dL, dialysis, severe COPD, central neurologic dysfunction, cerebrovascular disease, and infective endocarditis emerged as risk factors for hospital mortality. On multivariate analysis, NYHA III–IV (odds ratio [OR] = 1.9; 95% confidence interval [CI], 1.0–3.7), CCS III–IV (OR = 4.3; 95% CI, 1.8–10.2), pulmonary artery pressure greater than 60 mm Hg (OR = 5.2; 95% CI, 10–25.8), dialysis (OR = 9.8; 95% CI, 2.4–47.5), central neurologic dysfunction (OR = 5.0; 95% CI, 1.1–5.9), and severe COPD (OR = 2.6; 95% CI, 1.6–15.7) emerged as independent predictors of hospital mortality. Hospital mortality for patients in NYHA class I–II and I was 1.2% and 0.8%, respectively. Mean overall hospitalization time was 14.3 ± 8.5 days with an intensive care mean length of stay of 2.3 ± 4.2 days.

TABLE 1. Patients' profile

Preoperative variables	All (N = 2256) No.	%	Age < 80 y (N = 1826) No.	%	Age ≥ 80 y (N = 430) No.	%	*P* value
Age, y	70.4 ± 11.2						
Female	1090	48.3	806	44.1	284	66.0	<.0001
Body mass index ≥ 30	419	18.6	359	19.7	60	14.0	.0062
Emergency status	14	0.6	11	0.6	3	0.7	.8211
Urgency status	129	5.7	95	5.2	34	7.9	.0298
NYHA ≥ 3	1117	49.5	867	47.5	250	58.1	.0001
CCS ≥ 3	90	4.0	67	3.7	23	5.3	.1095
Congestive heart failure	129	5.7	91	5.0	38	8.9	.0018
Hemodynamic instability	11	0.5	9	0.5	2	0.5	.945
Cardiogenic shock	12	0.5	9	0.5	3	0.7	.5958
30% < FE% <50%	335	14.8	275	15.1	60	14.0	.5617
FE ≤ 30%	56	2.5	47	2.6	9	2.1	.5644
Pulmonary artery pressure > 60 mm Hg	14	0.6	8	0.4	6	1.4	.023
Hypertension	1582	70.1	1261	69.1	321	74.7	.0231
Diabetes	321	14.2	261	14.3	60	14.0	.8527
Severe COPD	121	5.4	89	4.9	32	7.4	.0335
Creatinine ≥ 2 mg/dL	57	2.5	45	2.5	12	2.8	.6982
Dialysis	13	0.6	13	0.7	0	0.0	.0801
Cerebrovascular disease	29	1.3		3.7	29	6.7	.0045
Central neurologic dysfunction	32	1.4	24	1.3	8	1.9	.388
Peripheral neurologic dysfunction	27	1.2	20	1.1	7	1.6	.3589
Extracardiac vasculopathy	407	18.0	293	16.1	113	26.3	<.0001
Active infective endocarditis	66	2.9	61	3.3	5	1.1	.0269
Active neoplasm	53	2.4	43	2.4	10	2.3	.9794
Recent myocardial infarction	61	2.7	42	2.3	19	4.4	.0015
Previous PCI	116	5.1	85	4.6	31	7.2	.0356
Logistic euroSCORE	7.2 ± 6.2		5.8 ± 5.0		13.1 ± 7.6		<.0001
Additive euroSCORE	6.3 ± 2.4		5.7 ± 2.1		8.9 ± 1.5		<.0001

NYHA, New York Heart Association; *CCS,* Canadian Cardiovascular Society; *EF*, ejection fraction; *COPD,* chronic obstructive pulmonary disorder; *PCI,* percutaneous coronary intervention; *euroSCORE,* European System for Cardiac Operative Risk Evaluation.

Postoperative neurologic complications occurred in 2.2% of patients (stroke, 1.3%; transient ischemic attack, 0.6%; and paraplegia, 0.3%). Ventilatory support more than 4 days was required in 3.1% of patients. Postoperative renal failure occurred in 2.3% of patients, and 0.8% required definitive dialysis. Acute myocardial infarction and bleeding requiring re-thoracotomy occurred in 0.2% and 3.1% of patients, respectively. Postoperative atrial fibrillation and third-degree atrioventricular block were reported in 34.2% and 2.9% of patients, respectively.

Octogenarians

Octogenarians had significantly higher incidence of both hospital mortality (3.7% vs 1.8%; OR = 2.1; $P = .014$) and postoperative complications, such as renal failure (3.7% vs 2%; $P = .045$), stroke (2% vs 0.9%; $P = .072$), atrial fibrillation (38.6% vs 33.2%; $P = .058$), and third-degree atrioventricular block (4.3% vs 2.5%; $P = .076$). Length of hospital stay for octogenarians was 15.7 ± 8.2 days versus 14.0 ± 8.5 days for younger patients ($P < .0001$).

Octogenarians With Logistic euroSCORE Greater Than 15%

A total of 114 patients aged more than 80 years and a logistic euroSCORE more than 15% (Table 2) had a predicted risk of hospital mortality of 22.4% (n = 26) by logistic euroSCORE. The observed mortality was 7.0% (n = 8; *z* score = –3.94; $P < .001$).

Postoperative complications included stroke (n = 4; 3.1%), ventilatory support more than 4 days (n = 5; 4.1%), renal insufficiency (n = 7; 6.1%), dialysis (n = 3; 2.6%), re-thoracotomy for bleeding (n = 4; 3.1%), atrial fibrillation (n = 44; 39.1%), and third-degree atrioventricular block (n = 4; 3.1%). Length of hospital stay was 16.7 ± 8.8 days, with a mean intensive-care length of stay of 3.3 ± 5.0 days.

Mid-Term Results

Estimated survivals at 1 and 3 years were 94.2% and 89.3%, respectively. NYHA III–IV (hazard ratio [HR] = 1.7; 95% CI, 1.2–2.3), CCS III–IV (HR = 1.8; 95% CI, 1.1–3.3), pulmonary artery pressure greater than 60 mm Hg (HR = 4.1; 95% CI, 1.7–10.1), ejection fraction 30% to 50% (HR = 1.7; 95% CI, 1.2–2.5), age more than

TABLE 2. Octogenarians with logistic euroSCORE less than and more than 15%: Patients' profile

Preoperative variables	euroSCORE logistic < 15% (N = 316) N°	%	euroSCORE logistic ≥15% (N = 114) N°	%	*P* value
Female	208	65.8	76	66.7	.8708
Body mass index ≥ 30	45	14.2	15	13.2	.7755
Emergency status	0	0.0	3	2.6	.0037
Urgency status	16	5.1	18	15.8	.0003
NYHA = 4	18	5.7	17	14.9	.002
CCS 3 or 4	14	4.4	9	7.9	.1595
Congestive heart failure	22	7.0	16	14.2	.0214
Hemodynamic instability	0	0.0	2	1.8	.0179
Cardiogenic shock	0	0.0	3	2.7	.0036
30% < FE% < 50%	36	11.4	24	21.1	.0106
FE ≤ 30%	0	0.0	9	7.9	<.0001
Pulmonary artery pressure > 60	1	0.3	5	4.4	.0014
Hypertension	229	72.5	92	80.7	.0836
Diabetes	41	13.0	19	16.7	.3306
Severe COPD	11	3.5	21	18.4	<.0001
Creatinine ≥ 2 mg/dL	3	0.9	9	7.9	.0001
Dialysis	0	0.0	0	0.0	
Cerebrovascular disease	17	5.4	12	10.5	.0606
Central neurologic dysfunction	0	0.0	8	7.1	<.0001
Peripheral neurologic dysfunction	0	0.0	7	6.2	<.0001
Extracardiac vasculopathy	33	10.5	80	70.2	<.0001
Active infective endocarditis	0	0.0	5	4.1	.001
Active neoplasm	5	1.6	5	4.4	.0871
Previous PCI	20	6.2	11	9.8	.2028

euroSCORE, European System for Cardiac Operative Risk Evaluation; *NYHA,* New York Heart Association; *EF*, ejection fraction; *COPD,* chronic obstructive pulmonary disorder; *CCS,* Canadian Cardiovascular Society; *PCI,* percutaneous coronary intervention.

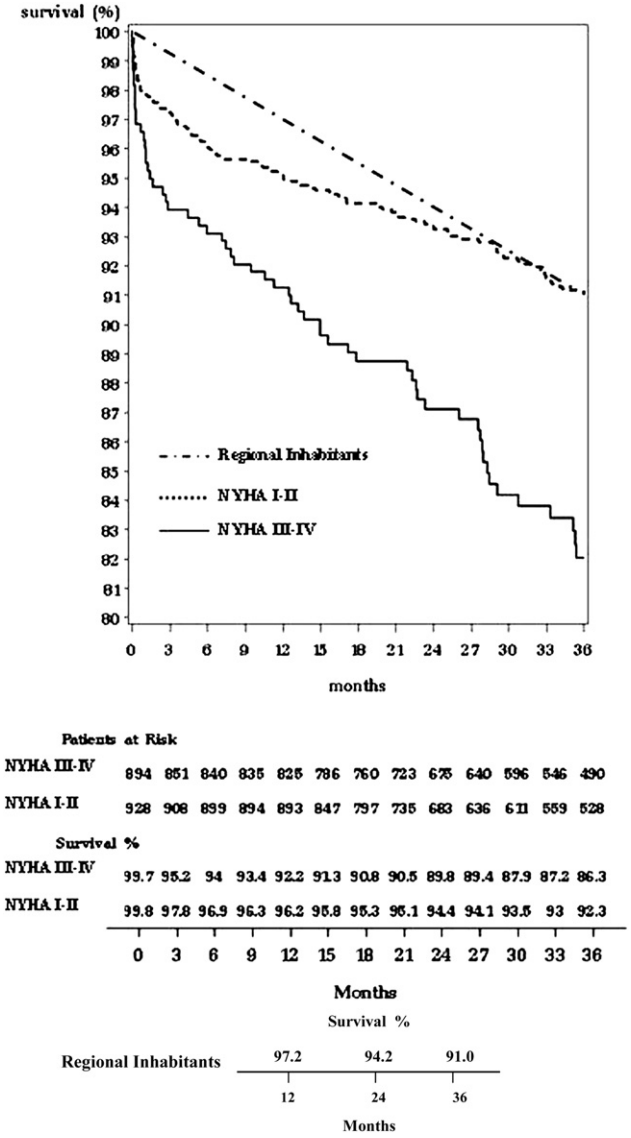

FIGURE 1. Three-year survival of the overall study population stratified according to NYHA class I–II and III–IV, and expected survival of age- and gender-matched 2006 regional population. Survival of patients in class III–IV is significantly lower than survival of patients in class I–II (log-rank $P < .001$) and expected survival. Survival of patients in class I–II is comparable to expected survival of age- and gender-matched 2006 regional population (log-rank $P = .1634$). *NYHA,* New York Heart Association.

80 years (HR = 1.9; 95% CI, 1.4–2.6), dialysis (HR = 7.2; 95% CI, 3.1–16.7), and cerebrovascular disease (HR = 2.4; 95% CI, 1.4–3.9) emerged as independent risk factors for 3-year survival. The 3-year survival of patients undergoing surgery in NYHA class I–II was higher than 3-year survival of patients undergoing surgery in class III–IV ($P = .157$) and similar to the expectancy of life of the age- and gender-matched 2006 regional population ($P = .163$) (Figure 1).

Age greater than 80 years significantly affected mid-term results with 1- and 3-year survivals of 91.2% and 82.3%, respectively ($P < .001$) (Figure 2). However, 3-year survival of octogenarian patients was comparable to the expectancy of life of the age- and gender-matched 2006 regional population ($P = .157$) (Figure 3).

DISCUSSION

As a consequence of ameliorated perioperative care and increased life expectancy, preoperative characteristics and risks and results of aortic valve surgery have been changing over the last 20 years. Thus, a need for up-to-date outcome reports associated with identification of predictors of mortality seems to be evident in our study and others.[10-12]

In particular, we sought to consider a very select population receiving a first-time isolated aortic valve replacement (excluding redo and combined procedures) and to include only preoperative variables in the logistic model to optimize risk stratification and avoid possible confounding factors. Prospective and contemporary enrollment together with

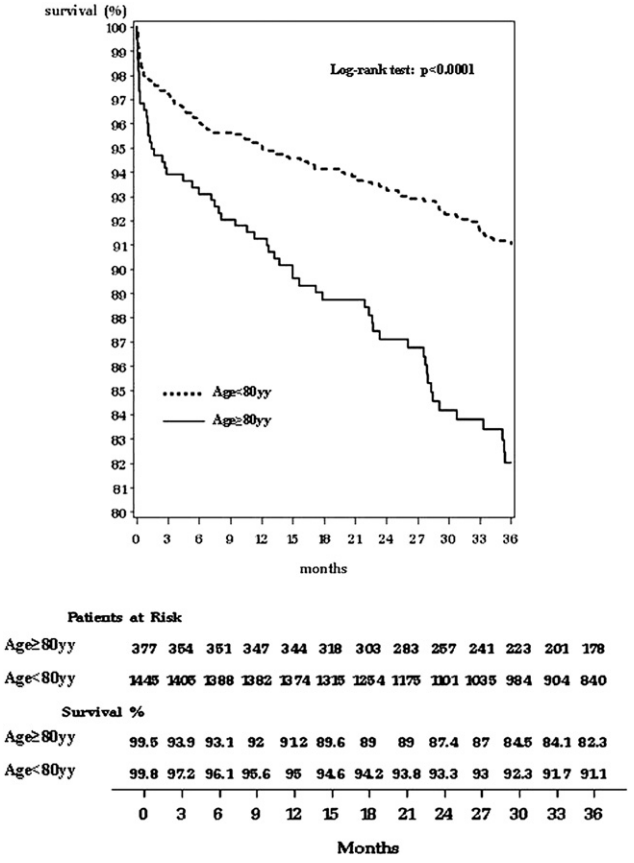

FIGURE 2. Three-year survival of the study population according to age $\geq$ 80 or < 80 years.

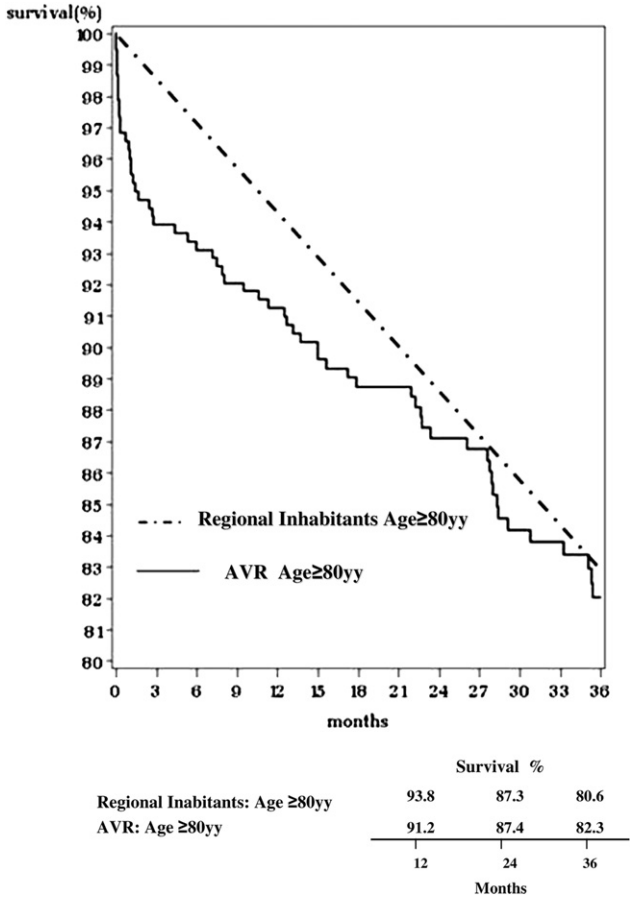

FIGURE 3. Three-year survival of the octogenarian study population compared with expected survival of age- and gender-matched 2006 regional population (log-rank $P = .157$). *AVR,* Aortic valve replacement.

the heterogeneity of the regional surgical departments (academic hospital: n = 2; private hospital: n = 4) allowed us to depict an interesting sample of patients currently referred for aortic valve replacement.

Our preoperative data confirmed that patients who are currently referred for aortic valve surgery in most cases have an aortic stenosis, are elderly, and present severe comorbidities.[4]

Despite a mean predicted mortality risk of 7.2% by logistic euroSCORE, the actual mortality was 2.2%, which favorably compares with that reported by other recent surgical registries, such as the Society of Thoracic Surgeons database (2.6%),[13] the United Kingdom Cardiac Surgical Register (3.2%),[14] and the Euro Heart Survey (2.7%).[4]

According to the American College of Cardiology/American Heart Association guidelines for the management of patients with valvular heart disease, aortic valve replacement is indicated as class 1 in symptomatic patients with severe aortic valve stenosis and recommended in patients with severe aortic valve stenosis and impaired left ventricle function. Valve surgery for asymptomatic patients is considered only as class IIb, in the presence of positive exercise test, and likelihood of rapid progression because the risk of sudden death in asymptomatic patients (1% per year) is supposed to be inferior to the risk of death after surgery and the risk of thromboembolic complication if long-term anticoagulation therapy has to be initiated.[9]

Our data showed that hospital mortality for patients in NYHA class I and I–II was only 0.8% and 1.2%, respectively. The 3-year survival of patients receiving surgery in NYHA class I–II was better than survival of patients operated in NYHA class III–IV and similar to the expectancy of life of the regional age- and gender- matched population. NYHA class III–IV correlated with both increased risk for hospital mortality and reduced survival at 3 years.

Taken together, these findings indicate the short- and mid-term benefits of early referral to surgery for aortic valve replacement. These considerations also might be extended to elderly patients because their symptoms are easily underestimated and a stress test is difficult to be executed.[15]

Compared with younger patients, our 430 octogenarians presented a higher prevalence of cardiac risk factors and comorbidities, which resulted in a higher hospital mortality rate. Nevertheless, short and mid-term results were

encouraging with a hospital mortality of 3.2% and 1-, 2-, and 3-year survivals of 91.2%, 89.7%, and 82.3%, respectively. On multivariate analysis, age more than 80 years did not emerge as a risk factor for hospital mortality, whereas, as expected, it was associated with a decreased 3-year survival compared with younger age.

Our hospital mortality of 3.2% in octogenarians favorably compares with mortality rates reported by other groups, ranging from 4.3% to 10.3%.[16-20] A different bias in patient selection is a possible reason for this. On the other hand, it is plausible that our early results reflect the physiologic progress of contemporary intraoperative and perioperative care, which should be considered when referring (and even more when contraindicating) elderly patients to aortic valve surgery.

Kolh and colleagues[19] reported a 5-year survival of 73.2% in octogenarian patients undergoing aortic valve replacement. Sundt and colleagues[2] reported a 5-year survival of 55%, with a quality of life similar to that predicted for the general population aged more than 75 years. Mihaljevic and colleagues[15] reported that from 2 years after valve replacement, elderly patients have survival similar to that of age, race, and gender-matched population estimates.

At 3 years, the actuarial survival was 82.3% in our series and comparable to the expectancy of life of the age- and gender-matched regional population ($P = .157$).

All these data indicate that the outcome of octogenarians after aortic valve replacement is satisfactory in the short and mid-term. Therefore, aortic valve replacement should not be denied on the basis of age alone, but rather on the basis of associated comorbidities and results of the surgical center.

However, the Euro Heart Survey for Valvular Disease indicated that 33% of patients with symptomatic aortic valve stenosis are considered inoperable because of advanced age and comorbidities (eg, COPD and renal failure) and are not referred for surgery.[4] Thus, transcatheter techniques for aortic valve implantation have been developed and currently offered as alternative options to patients with perceived high operative risk.[7] Operative risk algorithms, such as the euroSCORE, are being used to select patients with prohibitive risk for conventional aortic valve surgery, and in particular, a logistic euroSCORE greater than 15% to 20% is considered as the cutoff value to refer patients to less-invasive transcatheter aortic valve procedures.[7,8] The accuracy of this risk model is still questioned and not yet fully validated.[3,21-23]

Of 2267 patients, we identified 114 patients aged more than 80 years with a logistic euroSCORE greater than 15% aiming to provide target results to transcatheter aortic valve procedures and to estimate the effectiveness of logistic euroSCORE to predict the operative risk of patients undergoing aortic valve surgery. Our results, an expression of contemporary aortic valve surgery, were extremely encouraging. In our series, the mean predicted hospital mortality was 22% and the observed mortality was 7.0%. Postoperatively, stroke occurred in 3.1% of patients, respiratory insufficiency occurred in 4.1% of patients, dialysis occurred in 2.1% of patients, and 3-degree atrioventricular block occurred in 3.1% of patients.

As reported in the literature, transcatheter aortic valve procedures are associated with hospital (or 30 days) mortality rates ranging from 5% to 18%, with a considerable incidence of postoperative strokes (0%–9%), vascular complications (10%–15%), and pacemaker implantations (up to 24%).[8]

These data lead to the following considerations:

1. The logistic euroSCORE per se is not adequate to predict the operative risk of elderly patients undergoing aortic valve replacement. Its central position in the decision-making process for addressing patients to transcatheter aortic valve implantation seems to be hardly defendable.
2. New, more accurate, and calibrated risk-stratification systems weighting other relevant comorbidities, such as porcelain aorta, previous chest wall irradiation, liver insufficiency, and poor nutritional status, are required to provide appropriate indication to transcatheter aortic valve implantation.
3. Only prospective randomized clinical trials comparing short and mid-term outcomes from contemporary aortic valve surgery and transcatheter aortic valve procedures will fairly estimate the survival and functional benefits of conventional versus newer aortic valve procedures.

CONCLUSIONS

The outcome after aortic valve replacement was extremely satisfactory with an overall hospital mortality of 2.2%. The early referral to aortic valve replacement (NYHA I–II) was associated with decreased hospital mortality and increased 3-year survival. Octogenarians did well in the short and mid-term after conventional isolated aortic valve replacement with a hospital mortality of 3.2% and a 3-year survival of 82.3%. At 3 years, the survival was comparable to the life expectancy of the age- and gender-matched regional population. These results should be taken into consideration when aortic valve surgery is contraindicated for octogenarians. New, more accurate and calibrated risk-stratification systems are required to identify patients who might benefit from transcatheter aortic valve procedures.

Limitations of the Study

Mid-term results and relative implications were based on follow-up survival data obtained on regional inhabitants (80.8%). For these patients, follow-up was 100% completed. However, no differences in terms of preoperative risk profile were observed between regional and extra-regional inhabitants, except that congestive heart failure

and creatinine greater than 2 mg/dL were more represented in the regional patients. Hospital mortality rates between the 2 groups were comparable, and surgery in extra-regional inhabitants was not associated with an increased risk of hospital mortality on multivariate analysis.

The excellent results observed in patients operated in functional class I–II make early surgery a reasonable option. However, only prospective randomized trials can establish the superiority of early surgery over conservative management in asymptomatic patients with severe aortic valve stenosis.

Because of a referral bias, octogenarian patients in our series may not represent all patients requiring aortic valve surgery in our region. This possible bias of selection may have affected our patients' outcome and conclusions. Nevertheless, our contemporary series of 430 octogenarians represents an interesting sample of ''real life'' in aortic valve surgery, and our favorable outcome may be applicable to the current management of elderly patients undergoing aortic valve replacement.

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APPENDIX 1

Variable	Definition
Body mass index	kilograms (weight)/meters squared (height)
Hypertension	History of hypertension on medication, diet, physical activity; AP > 140/90 mm Hg
Diabetes	History of diabetes or medication
Dialysis	Dialysis at admission
Creatinine	milligrams/deciliter
Peripheral neurologic dysfunction	Disease severely affecting ambulation and day-to-day function
Central neurologic dysfunction	Disease severely affecting ambulation and day-to-day function
Extracardiac vasculopathy	Claudication or carotid artery stenosis > 50% or previous/scheduled procedure on abdominal aorta, carotid artery, or limb arteries
Active infective endocarditis	Receiving antibiotics
Severe COPD	FEV_1 < 50% or P_{O_2} < 60 or P_{CO_2} > 50
Cerebrovascular disease	Coma > 24 h Cerebrovascular accident > 72 h Transient ischemic attack < 24 h Carotid artery stenosis > 50%
Active neoplasm	
Congestive heart failure	Orthopnea; exertional dyspnea with diuretics and digital; pulmonary venous congestion on chest x-ray
CCS	0–I–II–III–IV
NYHA	I–II–III–IV
Hemodynamic instability	AP > 80 mm Hg or cardiac index > 1.8 L/min/m^2 with IV inotropic support or IABP
Cardiogenic shock	PA < 80 mm Hg or Cardiac Index < 1.8 L/min/m^2 despite inotropic or IABP support
Cardiopulmonary reanimation	
Ejection fraction	As estimated by echocardiography or angiography
Pulmonary hypertension	Systolic pulmonary artery pressure > 60 mm Hg as estimated by preoperative catheterization or Swan–Ganz catheter before surgery
Urgency	Surgery performed during the same hospitalization
Emergency	Immediate surgery

AP, Arterial pressure; *COPD,* chronic obstructive pulmonary disorder; *FEV_1,* forced expiratory volume in 1 second; *PA,* pulmonary artery; *IABP,* intraaortic balloon pump; *IV,* intravenous; *CCS,* Canadian Cardiovascular Society; *NYHA,* New York Heart Association.