Valve surgery in octogenarians: does it prolong life?§
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Abstract

Objectives: Age-related degenerative heart-valve disease is a health issue in the present era. Octogenarians are frequently affected by concomitant diseases and, with the present lack of resources, the risk/benefit of valvular replacement therapy poses serious medical, economical and political challenge. We analysed the long-term survival of 346 octogenarians who underwent 352 operations between 1 January 1987 and 1 January 2009 and we compared it with the survival of the general population, matched for age, sex and operative year. Methods: The total follow-up was of 1352 years, maximum 15.7 years and was nearly complete except for a single foreigner. Heart diseases, concomitant pathologies, complications and actuarial survival of this study group were compared with 4649 younger counterparts, who received 5416 operations during the same time frame. Octogenarians were sorted by age, sex and operative year and the expected survival was calculated by applying US survival rate and added to the Kaplan–Meier plot for visual comparison. Results: A total of 279 aortic, 38 mitral and 35 mitro-aortic valves were replaced or repaired using 357 bioprostheses, 18 mechanical prostheses, 12 reparative operations and 24 re-operations. A total of 75% of patients were younger than 84 years, 95% were younger than 87 years and 99% younger than 90 years. Sex prevalence was 215 female versus 131 male. Operative (30 days) mortality was 5.5% and overall survival was 84.3% at 1 year, 65.4% at 5 years, 27.3% at 10 years and 5.4% at 15 years. The expected survival of the age-, sex-, operative year-matched population was 26.9% at 10 years and 7.9% at 15 years. Female operative mortality was 5.9% and survival was respectively 86.3%, 70.2%, 27.5% and 9.1%, male mortality was 4.5% and survival was respectively 81%, 56.7%, 28.8% and 0% (p = 0.16). Expected female survival was 30% at 10 years and 10% at 15 years versus 22% and 5.6%, respectively, in males. Six octogenarians underwent re-operation, with one death. Conclusions: Despite the highest prevalence of concomitant diseases and the requirement of additional resources for the detection and neutralisation of risk factors, heart-valve operations in octogenarians offer excellent results that compare favourably with the expected survival of the age-, sex- and operative year-matched population, particularly after primary operations.

Keywords: Valve prostheses; Octogenarian; Outcome; Epidemiology; Surgery; Statistics

1. Introduction

The life expectancy of the population of Western world is increasing. Our national statistical institute (ISTAT) forecasts 2.8% of the Italian population will be older than 85 years in 2010.1 United States predicts 20 million citizens 85 years or older by 2050.2 Parallel to ageing, there has been a constant increase in the demand of valve surgery, especially for dystrophic calcification of the aortic valve, causing a shift of valvular diseases’ prevalence: in our centre, the ratio of mitral versus aortic operations has inverted since 1990. At the same time, the prevalence of coronary artery bypass graft (CABG) has increased to more than one-third of all valvular operations in aged patients.

Ageing is associated with concomitant diseases requiring larger use of diagnostic and therapeutic resources. The risk/benefit balance of surgical interventions in aged patients was questioned in Europe [1]; therefore, octogenarians are often denied surgery, medically treated or more recently, sent to catheter-based procedures. We have therefore collected all patients aged 80 years or more operated on for valve diseases, with or without concomitant procedures with the purpose to evaluate how their characteristics differ from younger patients and to compare their actuarial long-term results with the expected survival of a matched general population.

2. Materials and methods

At our institution, between 1 January 1987 and 1 January 2009, 4995 adult patients received 5768 valve operations. Octogenarian patients were 346 (6.9%) and received 352...
(6.1%) operations. The female proportion was 62% (215); median operative age was 82 years with interquartile range (IQR) 81—84 years and maximum age 91 years.

The female proportion of younger patients was 45% and the median age was 65 years, with IQR 55—72 years.

The prevalence of risk factors in octogenarians versus younger patients is summarised in Table 1. The selection of candidates for cardiac operations was always initiated from a thorough evaluation by the referring cardiologist and the cardiac surgeon. Doppler evaluation of cerebral arteries, abdominal aorta and peripheral vessel were performed routinely. The main goals of postoperative therapy were early extubation and mobilisation.

Stented porcine or pericardial valves, with little exception due to personal preferences or operative requirements, were the preferred prostheses [2]. In aortic position, the most frequently used prostheses were Biocor valves (Standard 25%, Epic 21% and Supra 9%) and Carpentier—Edwards valves (Perimount 27% and Magna 9%). The Biocor Standard was used in 38% of mitral replacements, Epic in 35% and Carpentier—Edwards Perimount in 11%. Standard cardiopulmonary bypass techniques were used. Anti-fibrinolytic drugs were administered in most re-operations. All operations were performed with moderate iopthermia (range 32—28°C) according to case complexity) and with antegrade or combined antegrade/retrograde cold—blood cardioplegia. Minimal access procedures were only occasionally used.

Median aortic cross-clamping time was 80 min with IQR 64—99 min, median extracorporeal circulation time was 109 min with IQR 93—141. Median extubation time was 1 day, IQR 0.5—4 days.

Median aortic prosthesis label size was 23 with IQR 21—25 and median mitral prosthesis label size 29 with IQR 29—31.

The time frame of the study includes the first octogenarian valve operation performed in 1987 up to the date of follow-up completion. All valve operations performed within this time frame were retrieved from our database with the follow-up completion. All valve operations performed within this time frame were retrieved from our database with the follow-up completion. All valve operations performed within this time frame were retrieved from our database with the follow-up completion.

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2.1. Follow-up

Follow-up by means of telephone interviews and review of outpatient files was limited to the octogenarian patients and was concluded on the common closing date, 1 January 2009. The total follow-up was of 1352 years, maximum 15.7 years. One patient from the Netherlands could not be traced.

2.2. Statistical analysis

Continuous variables were presented as mean ± standard deviations or medians and IQR, according to their distribution. Categorical variables were summarised with percentages. The chi-square test was used to evaluate differences in proportions. The overall survival rate with 95% confidence limits (CLs) was calculated by using Kaplan—Meier product-limit estimates and the log-rank test was used for comparisons. Univariate logistic analysis was applied to confounders and determinants of operative (30 days) mortality. Similarly, Cox analysis was applied to determinants and confounders of patients surviving the postoperative period. Thousand bootstraps of a stepwise backward removal (p = 0.1) and forward addition (p = 0.05) were done to identify independent odds ratios (ORs) with the logistic model and hazard ratios (HRs) with the Cox model, with their 95% confidence intervals.

Patients were sorted by age, sex and the operative year and the observed survival was compared with their expected survival. This was calculated by using the Hakulinen method [3], applying to each patient his unique reference rate, freely available within the R package ‘Survexp.us’. This methodology has the advantage to provide a measure of disease’s mortality without the need for information on the cause of death. Some bias, possibly favouring the actuarial cohort, is introduced by applying the least available population rates of the year 2000 to patients operated on in more recent years.

The estimates were added to the Kaplan—Meier plot for visual comparison, assuming a non-significant survival difference if within the cohort 95% CLs. The data were managed and analysed using STATA (StataCorp. 2007. Stata statistical Software: release 10. College Station, TX, USA) [4]. All statistical tests were two sided.

3. Results

Between 1 January 1987 and 1 January 2009, 352 operations (387 prostheses/repairs) were performed in 346 octogenarians versus 5416 operations (6080 prostheses/repairs) in 4649 younger patients. The yearly number of operated octogenarians versus younger patients and the operative mortality are summarised in Fig. 1.

The aortic valve was involved in 279 cases (79.3%), the mitral valve in 38 cases (10.8%) and the mitro-aortic valve in 35 (9.9%). Biologic prostheses were used in 357 (92.2%) cases and mechanical prostheses in 18 (4.7%). Conservative operations on natural valves or prostheses were 12 (3.1%). Re-operations were 24 (6.8%); six of them were done on patients who received their primary operation as octogenarians, to treat three dehiscences of aortic prostheses, one iatrogenic ventricular septal repair, one thrombosed bio-prosthesis and one mitral valve replacement combined with
prophylactic replacement of a previous biologic aortic prosthesis. A tricuspid prosthesis was implanted in five (1.4%) octogenarians.

In the younger group, the aortic valve was involved in 2908 (54%, \( p < 0.0001 \)) cases, the mitral in 1903 (35%, \( p < 0.0001 \)) and the mitro–aortic in 664 (12%, \( p = 0.02 \)). Biologic valves were used in 2140 cases (35%), mechanical valves in 3272 (54%) and conservative procedures in 668 (11%, \( p < 0.0001 \)). Re-operations were 1217 (22.5%, \( p < 0.0001 \)), tricuspid prostheses 214 (4%, \( p = 0.016 \)) and 21 as isolated prostheses.

Several (one or more) associated procedures were required by 141 octogenarians (40%): 107 coronary artery bypass grafting (CABG) (30.4%), 12 ascending aorta replacements (3.4%) including two modified Bentall operations, nine (2.6%) Manouguian aortic annular enlargements, nine LVOT myectomies (2.6%) and 11 carotid endarterectomies (CEAs) (3.1%). Other procedures were performed in 15 cases (4.3%).

Younger patients underwent 1806 associated procedures (33%, \( p = 0.002 \)): 935 CABG (17.3%, \( p < 0.0001 \)), 233 ascending aorta replacements (4.3%, \( p < 0.0006 \)), 256 modified Bentall (4.7% \( p < 0.001 \)), 77 carotid endarterectomies (1.4%, \( p = 0.012 \)). Septal myectomies and annular enlargements were 83 (1.53%). The number of grafts per octogenarian was 1.5 versus 1.7 in younger patients. Grafts were two or more in 25% of the cases. The prevalence of one or more arterial graft was 50% versus 80% in younger patients.

Octogenarian’s euroSCORE was heavier \( (p = 0.0001) \) than in younger patients and it was available for a subset of 213 patients operated on since 2001 (Table 1).

### 3.1. Operative (30 days) deaths and complications

There were 19 operative deaths (5.4%) versus 254 (4.7%) in younger patients \( (p = 0.52) \). Cumulative mortality in octogenarians was almost identical to mortality observed in patients aged 60–80 years (5.5%) and significantly higher than in patients younger than 60 years (3.2%, \( p < 0.0001 \)).

Operative mortality was 5.9% in females and 4.5% in males \( (p = 0.57) \). It was 4.1% in 261 primary aortic replacements (3.3% in 91 cases with associated CABG), 3.1% in primary mitro–aortic operations and 10% in primary mitral operations. It was higher in re-operations (16.7%) and in re-operations for prosthetic dehiscence (50%). Nonetheless, only one of the six re-operated octogenarians died (17%).

The most frequent mode of death was cardiac in eight cases, due to haemorrhage in two cases, brain damage in one and multiple organ failure in two. There were two respiratory failures, three deaths related to bowel infarction and one to acute renal failure. The cardiac mode of death was less frequent than in younger patients (42% vs 65%, \( p = 0.05 \)) despite a similar prevalence of the New York Heart Association (NYHA) class 3–4 (39% vs 41.5%, respectively).

The logistic analysis of 40 determinants of operative mortality is summarised in Table 2. Bootstrapped multivariate

### Table 2

Risk factors for operative (30 days) death: univariate logistic analysis.

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Odds ratio</th>
<th>SE</th>
<th>p-value</th>
<th>Risk factors</th>
<th>Odds ratio</th>
<th>SE</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female sex</td>
<td>1.32</td>
<td>0.51</td>
<td>0.59</td>
<td>Associated procedures</td>
<td>1.36</td>
<td>0.490</td>
<td>0.53</td>
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<td>Operative age</td>
<td>1.00</td>
<td>0.11</td>
<td>0.98</td>
<td>CABG</td>
<td>1.84</td>
<td>1.435</td>
<td>0.04</td>
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<tr>
<td>Body surface area</td>
<td>0.98</td>
<td>0.015</td>
<td>0.31</td>
<td>Modified Bentall</td>
<td>1.79</td>
<td>1.076</td>
<td>0.59</td>
</tr>
<tr>
<td>NYHA class</td>
<td>3.14</td>
<td>0.288</td>
<td>&lt;0.0001</td>
<td>Ascending aorta replacement</td>
<td>0.86</td>
<td>0.236</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>NYHA class 4</td>
<td>7.51</td>
<td>0.521</td>
<td>&lt;0.0001</td>
<td>Manouguian</td>
<td>0.86</td>
<td>0.236</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Urgent/emergent (1–2)</td>
<td>6.22</td>
<td>0.392</td>
<td>&lt;0.0001</td>
<td>Carotid (CEA)</td>
<td>1.79</td>
<td>1.076</td>
<td>0.59</td>
</tr>
<tr>
<td>Urgent</td>
<td>7.72</td>
<td>0.873</td>
<td>0.02</td>
<td>Other associated procedures</td>
<td>1.27</td>
<td>1.063</td>
<td>0.82</td>
</tr>
<tr>
<td>Emergent</td>
<td>29.3</td>
<td>0.808</td>
<td>&lt;0.0001</td>
<td>All associated procedures</td>
<td>1.37</td>
<td>0.473</td>
<td>0.51</td>
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<tr>
<td>Aortic valve replacement</td>
<td>0.72</td>
<td>0.538</td>
<td>0.54</td>
<td>Preop. risk factors</td>
<td>0.86</td>
<td>0.580</td>
<td>0.79</td>
</tr>
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<td>Mitral valve operations</td>
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<td>0.591</td>
<td>0.15</td>
<td>Cardiovascular</td>
<td>1.56</td>
<td>0.479</td>
<td>0.36</td>
</tr>
<tr>
<td>Double-valve operation</td>
<td>0.49</td>
<td>1.043</td>
<td>0.49</td>
<td>Metabolic</td>
<td>3.83</td>
<td>0.502</td>
<td>0.007</td>
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<tr>
<td>Tricuspid replacement</td>
<td>4.57</td>
<td>1.144</td>
<td>0.18</td>
<td>Diabetes</td>
<td>1.03</td>
<td>1.057</td>
<td>0.98</td>
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<tr>
<td>Mechanical prosthesis</td>
<td>1.18</td>
<td>1.061</td>
<td>0.88</td>
<td>Neurological</td>
<td>1.03</td>
<td>1.057</td>
<td>0.98</td>
</tr>
<tr>
<td>Biologic prosthesis</td>
<td>1.59</td>
<td>1.047</td>
<td>0.66</td>
<td>Gastro-enteric</td>
<td>No deaths</td>
<td></td>
<td>NS</td>
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<td>Aortic incompetence</td>
<td>3.03</td>
<td>3.351</td>
<td>0.32</td>
<td>Renal diseases</td>
<td>3.96</td>
<td>0.606</td>
<td>0.02</td>
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<td>Mitral incompetence</td>
<td>1.51</td>
<td>0.215</td>
<td>0.003</td>
<td>Neoplastic disease</td>
<td>1.45</td>
<td>0.776</td>
<td>0.63</td>
</tr>
<tr>
<td>Re-operation</td>
<td>4.17</td>
<td>0.608</td>
<td>0.02</td>
<td>Collagen diseases</td>
<td>0.06</td>
<td>0.236</td>
<td>0.0001</td>
</tr>
<tr>
<td>Cross-clamp time (min)</td>
<td>1.00</td>
<td>0.111</td>
<td>0.84</td>
<td>Respiratory diseases</td>
<td>1.01</td>
<td>0.647</td>
<td>0.98</td>
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<tr>
<td>Mean pulmonary pressure</td>
<td>1.03</td>
<td>0.032</td>
<td>0.39</td>
<td>Haemato logical diseases</td>
<td>6.11</td>
<td>1.180</td>
<td>0.13</td>
</tr>
<tr>
<td>Ejection fraction (%)</td>
<td>0.97</td>
<td>0.019</td>
<td>0.13</td>
<td>Euroscore</td>
<td>1.01</td>
<td>0.004</td>
<td>0.01</td>
</tr>
<tr>
<td>Cardiac index (l/m²)</td>
<td>0.96</td>
<td>0.074</td>
<td>0.62</td>
<td>Previous operations</td>
<td>2.74</td>
<td>0.518</td>
<td>0.05</td>
</tr>
</tbody>
</table>

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*a* Cardiac re-operation.

*b* Includes non-cardiac operations.
analysis identified three highly significant ($p < 0.0001$) independent risk factors: grade of urgent/emergent indication with an OR of 6.9, diabetes with an OR of 6.4 and re-operation with an OR of 6.2 (Table 4).

Operative complications were 141: IABP was required by 18 (5.5%) octogenarians versus 3.3% younger patients ($p = 0.074$). Respiratory failure occurred in 12 (3.4%) octogenarians versus 1.5% younger patients ($p = 0.005$), renal failure in 11 (3.1%) versus 0.98% ($p = 0.0002$) and enteric complications affected five (1.4%) octogenarians versus 0.24% younger patients ($p = 0.0001$). The rates of stroke, low-output syndrome, myocardial infarct, haemorrhage, atrio-ventricular block, infection and tamponade were not significantly different from younger patients. A single patient needed left ventricle assist device (LVAD) support.

### 3.2. Late deaths

A total of 134 of the operative survivors died in the course of follow-up due to several causes. The most common mode of death was cardiac in 30 patients, including eight sudden deaths. The second most common was cancer in 22 cases (16.4%). Brain damage and other organ failure were next with 14 and 13 deaths, respectively. Respiratory failure and sepsis were the cause of six deaths each. Thirty-seven deaths were unexplained, including eight in which cardiac problems were nonetheless excluded. The oldest patient died at 99.5 years of age.

### 3.3. Late events

Cerebral damage occurred 29 times in 27 patients with a linearised incidence of $2.1 / C6^1.5\%$ patient-years; it was fatal in five cases and caused 14 permanent cerebral damages with nine following deaths. Ten patients had TIA or full recovery. A pacemaker implantation was required in 13 patients. Other complications were rare and included three visceral and one fatal cerebral haemorrhages, two infarcts (one was fatal) and one angina, two endocarditis and one bioprosthetic thrombosis with fatal coronary embolism.

### 3.4. Overall survival

Out of 346 patients, 286 were at risk at 6 months with a survival rate of 86.5% (95% CL 82—90%) 267 at 1 year (84.3%, 80—88%); 118 at 5 year (65.4%, 59—71%), 23 at 10 years (27.3%, 20—35%) and two at 15 years (5.4%, 0.5—20%), with a relative risk similar to that of the general population after 3 years of follow-up (Fig. 2).

Female survival was, respectively, 86.3%, 70.2%, 27.5% and 9.1%, male survival was, respectively, 81%, 56.7%, 28.8% and 0% ($p = 0.16$). By log-rank test, sex differences were not

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### Table 3

Cox model: univariate analysis of late death determinants.

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Hazard ratio</th>
<th>p-value</th>
<th>Risk factors</th>
<th>Hazard ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.06</td>
<td>0.16</td>
<td>Postoperative complications</td>
<td>23.1</td>
<td>0.04</td>
</tr>
<tr>
<td>Female sex</td>
<td>0.73</td>
<td>0.08</td>
<td>IABP</td>
<td>5.36</td>
<td>0.0002</td>
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<tr>
<td>Body surface area $m^2$</td>
<td>1.00</td>
<td>0.85</td>
<td>Low-output syndrome</td>
<td>2.69</td>
<td>0.23</td>
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<td>NYHA class (1 to 4)</td>
<td>1.27</td>
<td>0.04</td>
<td>Myocardial infarct</td>
<td>2.68</td>
<td>0.40</td>
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<td>NYHA class 4</td>
<td>3.03</td>
<td>0.0002</td>
<td>A–V block</td>
<td>1.24</td>
<td>0.65</td>
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<tr>
<td>Urgent/emergent (1–2)</td>
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<td>&lt;0.0001</td>
<td>Haemorrhage</td>
<td>0.45</td>
<td>0.12</td>
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<td>Aortic-valve replacement</td>
<td>0.75</td>
<td>0.17</td>
<td>Stroke</td>
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<td>0.13</td>
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<td>TIA</td>
<td>4.21</td>
<td>0.25</td>
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<td>Double-valve operation</td>
<td>1.36</td>
<td>0.27</td>
<td>Respiratory failure</td>
<td>2.57</td>
<td>0.034</td>
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<td>0.81</td>
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<td>0.0004</td>
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<td>Mechanical prosthesis</td>
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<td>Infection/sepsis</td>
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<td>Biologic prosthesis</td>
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<td>3.23</td>
<td>0.0003</td>
<td>Enteric complications</td>
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<td>0.0001</td>
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<td>Metabolic</td>
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<td>Cross-clamp time</td>
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<td>Diabetes</td>
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<td>Mean pulmonary pressure</td>
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<td>Ejection fraction</td>
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<td>Gastro-enteric</td>
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<td>0.01</td>
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<td>Associated procedures</td>
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<td>CABG</td>
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<td>Manouguian</td>
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<td>Haematological diseases</td>
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<td>0.03</td>
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<td>Carotid (CEA)</td>
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<td>Previous operations*</td>
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<td>Other associations</td>
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<td>0.05</td>
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<tr>
<td>All associations</td>
<td>0.92</td>
<td>0.68</td>
<td></td>
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</tr>
</tbody>
</table>

* Cardiac re-operation.

b Includes non-cardiac operations.
significant ($p = 0.14$) but favoured the female sex with a Cox hazard ratio of 0.72 (Fig. 3).

CABG, the most common associated procedure in 107 patients, was performed concomitantly to aortic valve replacement in 91 octogenarians, to mitral operations in 11 and to double-valve operations in five. It was associated to a better survival than No-CABG patients with a hazard ratio of 0.75. Five-year survival was 72.4% versus 63.1% and 10-year survival 37.7% versus 24.6%, but the differences were statistically not significant. The oldest surviving patient in our series has 97 years and a left internal mammary graft.

### 3.5. Comparison with general population

The 95% CLs of actuarial survival include the general population survival 3 years since operation (Fig. 2). Observed actuarial survival was overlaid on expected survival of the general population matched for operative age, sex and operative year. Expected female survival was 64% at 5 years versus 54% in males, 30% at 10 years versus 22% in males and 10% versus 5.6% at 15 years and is shown in Fig. 3(a).

Comparison of CABG patients with survival of the general population is shown in Fig. 3(b): the expected survival was 60% at 5 years and 25% at 10 years.

The cohort of patients with independent operative or late-risk factors included 110 patients with 68 deaths: the actuarial survival was 42% at 5 years and 11% at 10 years, significantly less than the expected survival of 60% and 27% of the matched population (Fig. 4, panel A). Comparison of patients with operative complications (IABP or renal or respiratory failure, $n = 39$) is shown in Fig. 4, panel B, NYHA class 4 ($n = 31$) in panel C and re-operations ($n = 24$) in panel D.
3.6. NYHA class and quality of life

A total of 76 (39%) of 192 traced patients are in NYHA class 1 and 94 (49%) in NYHA class 2 and generally declare an improved quality of life. Nineteen patients (10%) are in class 3 with notably restricted activity. One patient has recurrent CHF (class 4). Nine patients (3.6%) suffer severe disability and need continuous assistance. Eleven patients experienced 12 embolic events, five of them with permanent damage; all had bioprostheses and two were on warfarin. Two patients have angina, one patient had a gastric haemorrhage and five received a pacemaker. There was
one acute endocarditis. Warfarin is consumed by one-fourth of the patients.

4. Discussion

Age is a known confounding factor because it is strongly related to an increasing probability of aortic and/or coronary degenerative disease and it has been uniformly identified as a significant independent predictor of postoperative mortality [5]. Therefore, the incidence of ‘surgery-related premature deaths’ in this extreme age group must be confronted with the expected survival of a general population matched to the surgical cohort.

The perception of advanced age and its associated comorbidities as risk factor for poor outcomes and for increased requirement of resources have questioned the advantages offered by surgery to the elderly population. The Euro Heart Survey study of Lung and colleagues [1] found that 33% of elderly patients with severe symptomatic aortic stenosis were denied surgery. Many cardiologists continue medical therapies to the extreme or follow the promises of newly available minimally invasive or percutaneous techniques designed to treat the inoperable or very high-risk patients [6].

According to the model of ‘continuity of nature’ [7] any splitting of age is arbitrary. In this case, it is justifiable for practical and theoretical reasons: (1) comparison with results presented in the literature, (2) identification of octogenarian age with the wear-out phase of the bathtub hazard curve similar to identification of the paediatric age with the early hazard phase. Therefore, the determinants of geriatric surgical survival must be scaled on the rapidly declining expected survival of the matched population.

Our data show that the geriatric population has indeed a significant prevalence of cardiac (mainly hypertensive cardiomyopathy) and metabolic (mainly diabetes) risk factors. Impaired renal function is also significantly more frequent as well as neoplastic diseases. Lung function is more often affected by chronic obstructive pulmonary disease (COPD) and emphysema.

On the one hand, the need for more complex operations is due to a significantly higher incidence of CABG and associated carotid endarterectomies. On the other hand, replacement of the ascending aorta and root operations (modified Bentall) are significantly less frequent, reflecting a less aggressive attitude of the surgeons in this subset of patients, due to the increased risk of aorta replacement [5].

Outcomes after simple operations, such as aortic valve prosthetic replacement of degenerative aortic stenosis, have been recently reported by many papers [8–11], suggesting that this traditional operation can be performed in octogenarians with acceptable morbidity and short-term mortality.

The operative risk ranges from 5.7% in a series of 88 octogenarians reported by Thourani and colleagues’ [9] to 4.2% of Filsoofi and colleagues [8] in 192 patients and 4.5% reported by Ngaage and colleagues [12] in 89 patients. In our series of 261 primary aortic valve replacements (AVRs), the operative mortality was 4.1%. Based on these four recent studies and according to 28 events in 620 patients, we can therefore reasonably estimate a risk of 4.5% with 95% CLs of 3.0–6.5%.

There is consensus among different reports that in octogenarians the risk compares to the risk observed in 60–80-year-old patients and that the higher incidence of risk factors, which are generally agreed upon, is related more to risk than age.

In our analysis, univariate incremental risk factors of operative results in octogenarians were severity of heart failure, urgent/emergent operations, re-operations, modified Bentall procedures, diabetes and renal disease. Octogenarians had a similar incidence of the NYHA class 3–4 as did younger patients but a higher prevalence of cardiogenic shock patients (0.9% vs 0.6%), requiring rescue operations. They also needed IABP more frequently and suffered more TIA, respiratory failures, renal failures and enteric complications than their younger counterparts.

Independent incremental risk factors of the late survival were preoperative NYHA class 4, need of IABP and renal and respiratory failure. These risk factors largely coincide with those described by Melby and colleagues [10] and probably reflect a similar pattern of patient selection and operative results. Specific to Melby’s report is the presence of extensive aortic calcification, which may require alternative or percutaneous techniques. Specific to our experience are three events of deadly postoperative bowel infarction, a deceiving complication which requires an early diagnosis and aggressive early surgery.

An advice to patients and referring physicians, recently published by Cohn and Narayanasamy [11], recommends not delaying surgery for aortic stenosis until the patient is in congestive heart failure and has organ dysfunction, even though the patient is relatively asymptomatic. This is even truer in patients with aortic regurgitation, who have an increased early and late risk in Adkins and colleagues [13] and Melby and colleagues’ articles [10]. Our experience was limited to seven patients with one operative and four late deaths, all of them related to complex or rescue operations. In aortic regurgitation, traditional surgical markers are insensitive predictors of advanced stage of left ventricular diastolic dysfunction [14] and operations are often delayed and associated with excess mortality.

According to Cohn’s advice, there is evidence that long-term survival of octogenarians is equal or even better than the expected survival of an age-, sex- and operative year-matched population (Fig. 2). This is the case not only for simple AVR but also for the most common associated procedure: CABG (Fig. 3). In our series, octogenarians received basically lesser grafts than younger patients and had a lower proportion of arterial conduits. Nonetheless, they fared better both in the perioperative and in long-term periods as reported by Adkins and colleagues [13] and Melby and colleagues [10]. Stoica and colleagues [15] also reported a long-term survival of a composite series of operated octogenarians that far exceeded the life expectancy of their age- and sex-matched peers. In this study 5-year survival was 82% versus 56%, (p < 0.001). Thourani and colleagues [9] survival estimates for the octogenarian group were 87% at 1 year, 68% at 3 years and 61% at 5 years. Sundt and colleagues [16] from the Mayo Clinic noted a 1-year survival of 80% and a 5-year survival of 55% in octogenarians undergoing AVR with or without concomitant CABB. Chiappini and colleagues [17] reported a 69.4% survival at 5 years, whereas Melby and
colleagues [10] a 56% survival at 5 years. In our study, the observed survival was comparable to the expected survival up to 12 years. At 5 years it was 72% versus an expected 60% and at 10 years 38% versus 25%.

It is important to highlight that when more complex or rescue operations are performed and/or several risk factors are present, premature deaths are more common (Fig. 4). Therefore, new technical solution must be investigated to neutralise the risk factors, particularly those related to reoperations that, contrary to Krane’s conclusions [18], were plagued in our experience by a significant incidence of premature death (Fig. 4). In this difficult subset of patients, Cohn and Narayanamsny [11] advocate to minimise trauma using minimally invasive operations or hybrid techniques. With the same purpose we have recently started a programme of trans-apical valve positioning in selected patients.

There is some concern that the use of biological valve prostheses will expose octogenarians to the risk of reoperations in their 90s. Our experience was very limited: there were six re-operations with 1 death but none was due to structural valve degeneration and none would have benefited from alternative new strategies.

Heart disease is known as the ‘widow maker’. In our data, female sex was a late survival advantage. In developed countries, women outlive men, an average of 5—6 years, because of genetic selection [19] and a more temperate way of live. Why should it be different in octogenarian females with a mended heart?

Stroke/TIA occurrence, due to cardiac or carotid embolism or cerebral hemorrhage, was 2.1 ± 1.5/100 patient—years and significantly higher (p = 0.0008) than the rates reported by Ruel and colleagues [20] in 3189 patients and 20 000 years of follow-up: 1.3 ± 0.20/100 patient—years in aortic and 1.3 ± 0.30/100 patient—years in mitral bioprostheses. Most of our patients (75%) do not receive warfarin. New thrombin inhibitors such as dabigatran [21] should be tested in this risky population.

5. Conclusion

Comparison of postoperative survival with survival of the age-, sex- and operative year-matched population is a simple and reliable method to discriminate between palliative and curative interventions. It gives an immediate appreciation of the scale of the involved risk factors.

Heart valve operations in octogenarian patients of both sexes, ‘including operative deaths’, has a survival that compares with the survival of the general population. Despite the highest prevalence of concomitant diseases and requirement of adjunctive resources, cardiac surgery may offer excellent results in this group of patients with a frail physiology [22], providing that careful evaluation of the concomitant pathologies, a multidisciplinary approach and selection of the proper techniques are granted.

6. Clinical implications

Refusal to operate on octogenarians based on age limits is not justified. Pressure for trans-aortic valvular interventions (TAVIs) due to consumer demands must not be encouraged; aortic patients with overt ventricular failure or needing reoperations or complex repairs are reasonable candidates for this alternative procedure.

References

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patients that you refuse operation? The problem with octogenarians is that the operation must be straightforward. There shouldn’t be any complication, including bleeding, perfusion problems, haemodilution, haemofiltration, and so on, because they are not able to tolerate any complication. If there are no complications, they go beautifully.

Dr Rizzoli: Well, I don’t think we prolong life.

Concerning the first question, may you just repeat it?

Dr Rizzoli: The selection of patients really shouldn’t exist. I mean, if you have a patient with severely symptomatic aortic disease, as the 33% that was refused treatment in the European study, you should operate on them because they are severely symptomatic and have a poor quality of life. I think that we should treat all severely symptomatic patients despite their risk. Of course, the patient must be informed of the risk and must consent to the operation.

About the expected risk, we use, as do most Europeans, the logistic EuroSCORE. This is, in my opinion, just an approximate selection method. We should really try to improve it. For instance, in this series, 10% of patients had a score over 39 and the median score was 11. So we operated on many patients that for the EuroSCORE would be considered prohibitive. These patients would be sent nowadays to the available alternative procedures.

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Dr Rizzoli: First of all, the relative risk doesn’t show ‘better survival’ because the line of identity of the risks is included in the confidence limits of the operated cohort, and, as I explained, the expected rate for survival in the U.S. population is limited to the last census evaluation in the year 2000. So there is unknown degree of systematic bias in this case, because in the recent nine years the U.S. general population has probably increased its life expectancy as well.

are not able to tolerate any complication. If there are no complications, they go beautifully.

I leave you with a couple of questions. How do you select your group of patients? Do you use a risk factor score? How many patients do you refuse when you select your patients? This is one question. Another question that is probably related to the small sample that we have (even if you have more than 300 cases, it is a small sample) how do you explain that you have better results with associated CABG than when you have an isolated operation?

Dr Rizzoli: Well, I will start with this last question because I recall it better. I have always been told by my teachers, among them Professor Kirklin, that a patient must undergo an operation that cures his disease. So if an octogenarian patient needs a concomitant coronary bypass graft because he has ischaemia, then we have to provide him with treatment for ischaemia, aiming to give this patient the same chances of survival as the general population, maybe even better.

Concerning the first question, may you just repeat it?

Dr Pinho: How do you select the patients? What is the percentage of patients that you refuse for operation?

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Dr Kappetein: So the reference population is not well chosen.

Dr Rizzoli: The U.S. population is the best international reference for many medical and non-medical reasons. The census bias may give an explanation to your surprise.

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