Surgical Correction of Mitral Regurgitation in the Elderly
Outcomes and Recent Improvements
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Background—In the elderly, mitral regurgitation (MR) is frequent, but surgery risks are considered high. Benefits and indications of MR surgery are uncertain in the elderly.

Methods and Results—Baseline characteristics, outcome, and trends for surgical results improvement were analyzed in elderly patients (≥75 years of age; n=284) operated on for MR in 1980 to 1995 compared with younger patients (65 to 74 years of age, n=504; and <65 years of age, n=556). Preoperatively, class III to IV symptoms, atrial fibrillation, coronary disease, creatinine, and comorbidity index were more severe in elderly patients (all P<0.002). In the long term after surgery, observed survival stratified by age (≥75, 65 to 74, <65 years) was lower in elderly than in younger patients (at 5 years, 57±3%, 73±2%, and 85±2%, respectively; P<0.001), but ratios of observed to expected survival were similar (83%, 85%, and 88%, respectively). In multivariate analysis adjusted to expected survival, elderly patients showed no difference in life expectancy restoration compared with younger patients (adjusted hazard ratio, 0.89; 95% confidence interval, 0.73 to 1.30; P=0.54). Temporal trends showed that risk of operative mortality, although higher in elderly patients (P<0.001), declined markedly for all ages (27% to 5% in those ≥75 years of age, P<0.01; 21% to 4% in those 65 to 74 years of age, P<0.01; and 7% to 2% in those <65 years of age, P=0.06), with a parallel decline in low cardiac output and length of hospital stay. Over time, valve repair feasibility increased in all age groups (30% to 84% overall and 31% to 93% in degenerative MR; P<0.0001).

Conclusions—Elderly patients undergoing MR surgery display more severe preoperative characteristics and incur higher operative risks than younger patients. However, restoration of life expectancy after surgery is similar in elderly and younger patients, and outstanding recent surgical improvements particularly benefited elderly patients. Thus, elderly patients with MR can now carefully be considered for surgery before refractory heart failure is present. (Circulation. 2006;114:265-272.)

Key Words: aging ▪ echocardiography ▪ mitral valve ▪ prognosis ▪ surgery ▪ survival ▪ valves

Aging of the US population had led to a marked increase in its elderly segment (≥75 years) that is expected to quadruple over the next 50 years.1 Recent epidemiological data show that prevalence of mitral regurgitation (MR) increases with age.2 Thus, elderly patients with MR in whom surgical correction may be considered represent a frequent and growing management problem for which major uncertainties persist. Indeed, mitral surgery is considered high risk in the elderly,3–5 with operative mortality commonly reported between 10% and 20%.3–5 Higher morbidity6–8 and mediocre long-term survival. Consequently, in elderly patients with MR, surgery usually is indicated for severe and persistent symptoms of heart failure12 but may not be performed at all13 on the basis of this purported poor outcome.

Documenting precisely how age affects long-term outcomes is complex, however. In elderly patients, severe preoperative characteristics,14 such as advanced symptoms of heart failure, higher frequency of coronary artery disease (CAD), and associated comorbid conditions, may contribute to poor surgical outcome.15,16 Furthermore, in judging whether a pessimistic appraisal of mitral surgery in the elderly is adequate, the natural age–mortality link has not been accounted for, so long-term survival relative to life expectancy in each age strata after surgery cannot be appreciated.

Recent improvements in surgical techniques suggest a more optimistic view. Indeed, valve repair, which has considerably improved outcome in the younger population,17 has not been taken into account in defining risk and indication of mitral surgery in the elderly. Therefore, doubt persists as to how the large population of elderly patients with MR should be managed. Thus, the purposes of the present study were to

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compare clinical characteristics of elderly and younger populations of patients operated on for MR, to assess long-term survival relative to expected survival in each age strata, and to examine time trends in operative mortality and morbidity. Such data aim at evaluating whether recent results justify a more aggressive approach to MR surgery in the elderly.

Methods
The study was based on our consecutive experience with patients who underwent surgical correction for MR with valve repair or replacement between January 1, 1980, and December 31, 1995, at our institution to allow examination of long-term outcome. Exclusion criteria were associated mitral stenosis, associated aortic or tricuspid valve replacement, previous valve repair or replacement, and associated congenital heart or pericardial disease. No exclusions were based on age, sex, MR origin, CAD, and degree of left ventricular (LV) impairment.

Valve disease was considered degenerative\(^{18,19}\) if it was due to primary floppy valves, flail leaflets, and/or calcified mitral annulus. Clinical characteristics, comorbidity (Charlson index\(^{20}\), and symptoms were based on independent physician assessment of the patients. Atrial fibrillation was diagnosed by ECG. All data obtained clinically and by functional tests were prospectively determined and collected in the study database as initially measured at time of surgery. The study was retrospective by design; follow-up, which was obtained from medical records, questionnaires, and contact with family and/or physician, was complete (last survey or death) in 1322 of the 1344 patients included in the study (98.4%) at 6.8±4.4 years.

Functional Tests
Preoperative echocardiographic examination was performed 25±32 days before surgery, and results were used as reported at examination.\(^{21}\) LV diameters, left atrial diameter, and ejection fraction (EF) were measured.\(^{22-24}\) LV quantitative angiography also was performed in 631 patients. Therefore, in adjustments for EF in the analysis of survival, the echocardiographic and angiographic EF measurements and their average value were used. Coronary angiography was performed in 1177 patients (88%), whereas in the remaining patients, lack of ischemic MR, angina, and history of myocardial infarction and younger age were considered consistent with very low probability of CAD. Overt CAD was considered present with significant stenosis ($\geq 70\%$ in at least 1 vessel with or $\geq 50\%$ in the left main).

Statistical Analysis
Results are presented as mean±SD. Comparison between age groups used ANOVA for continuous variables or $\chi^2$ test for categorical variables. Absolute survival (overall and “late” for operative survivors) was estimated with the Kaplan-Meier method, reported as ± SE, and compared between groups by log-rank test. Multivariate analysis adjusted for other determinants of survival (sex, symptoms, EF, atrial fibrillation, creatinine, repair and coronary bypass performance, year of surgery)\(^{25-27}\) used Cox proportional hazards analysis, with age as the main determinant of interest expressed as categories ($\geq 75$, 65 to 74, $< 65$ years) or as a continuous variable. Comparison of observed with expected survival allowed us to measure relative survival (contrasted with that of age- and sex-matched 1990 US white population based on racial characteristics of the study population) and was tested univariately with the 1-sample log-rank test and in multivariate Cox proportional hazards analysis using an age-adjusted survival time variable\(^{28}\) (dependent variable).

Trends in operative mortality (within the first postoperative month or same hospitalization), low cardiac output (LCO; systolic blood pressure <90 mm Hg and cardiac index $< 1.4\ L \cdot min^{-1} \cdot m^{-2}$ after surgery), length of hospital stay (log-transformed because of non-normal distribution), and feasibility of valve repair were examined in 4 time periods (1980–1983, 1984–1987, 1988–1991, 1992–1995) and tested with the Cochran-Armitage trend test and linear regression. Multivariate analyses of age category association to these end points used stepwise logistic regression. Analyses also were stratified by etiological groups (degenerative and nondegenerative MR). Entry in multivariate analyses required values of $P<0.15$, and values of $P<0.05$ were considered significant.

The authors had full access to the data and take full responsibility for their integrity. All authors have read and agree to the manuscript as written.

Results
Baseline Characteristics
During the study period, 1344 patients (mean age, 65±12 years; 61% male) had mitral valve surgery for isolated MR. MR was degenerative in 856 (64%) and nondegenerative in 488 (36%) (functional/ischemic, 280; rheumatic, 86; endocarditis, 76; miscellaneous causes, 46). At surgery, 284 patients (21%) were ≥75 years of age, 504 (38%) were between 65 and 74 years of age, and 556 (41%) were <65 years of age. Preoperative characteristics by age group are listed in Table 1. At presentation, patients ≥75 years of age displayed more severe characteristics with more advanced symptoms of heart failure, atrial fibrillation, comorbidity, CAD, ischemic MR, and need for combined bypass surgery ($P<0.002$ for all) compared with younger patients. No differences in preoperative LV systolic, LV diastolic, and left atrial size or in EF were found.

Long-Term Survival
Overall Survival
At the latest follow-up, 606 patients had died. Five-year survival stratified by age (≥75, 65 to 74, <65 years) was 57±3%, 73±2%, and 85±2%, respectively ($P<0.0001$). In multivariate analysis, age ≥75 years was independently predictive of lower survival (risk ratio, 1.05 [95% confidence interval (CI), 1.04 to 1.06] per year of increasing age; $P<0.001$). However, when life expectancy was accounted for, 5-year overall relative survival stratified by age was similar (83%, 85%, and 88% of expected). In multivariate analysis of relative survival, age ≥75 compared with <65 years was not associated with long-term excess mortality (adjusted hazard ratio, 0.89; 95% CI, 0.73 to 1.30; $P=0.54$), similar to age as a continuous variable (adjusted hazard ratio, 0.99 [95% CI, 0.98 to 1.01] per year of increasing age; $P=0.71$).

Similarly, in degenerative MR, 5-year absolute survival stratified by age (≥75, 65 to 74, <65 years) was 62%, 84%, and 93%, respectively ($P<0.0001$), but relative survival was similar at 91%, 98%, and 97%. In multivariate analysis of relative survival, age ≥75 compared with <65 years was not associated with excess mortality (adjusted hazard ratio, 1.3; 95% CI, 0.7 to 2.3; $P=0.39$), similar to age as a continuous variable (adjusted hazard ratio, 1.01 [95% CI, 0.99 to 1.04] per year, $P=0.34$). For nondegenerative MR, 5-year absolute survival stratified by age was lower at 46%, 56%, and 71%, respectively ($P<0.0001$), but relative survival was similar at 66%, 65%, and 74% of expected, respectively.

Late Survival
Five-year absolute late survival (in operative survivors) stratified by age (≥75, 65 to 74, <65 years) was 64±3%, 79±2%, and 88±1%, respectively ($P<0.0001$). In multivar-
operative mortality (adjusted odds ratio, 5.7 [95% CI, 2.7 to 11.9] versus <65 years of age [P<0.001], 2.3 [95% CI, 1.3 to 4.3] versus 65 to 74 years of age [P<0.006], or 1.08 [95% CI, 1.04 to 1.12] per year of increasing age as a continuous variable [P<0.0001]), but the excess risk of operative mortality (odds ratio) associated with age ≥75 years decreased from the earliest to the latest period (P=0.004). In degenerative MR also, operative mortality was higher in patients ≥75 versus <65 years of age (adjusted odd ratio, 5.4; 95% CI, 1.5 to 19.6; P=0.01) despite the overall operative risk decline (Figure 2, right).

**Postoperative Morbidity**

LCO trends over time (Table 2) show for all ages a significant decline overall (adjusted odds ratio, 0.84 [95% CI, 0.80 to 0.88] per year [P<0.0001]; 34% in 1980–1983 to 6% in 1992–1995 [P<0.001]) also for both degenerative (26% to 4%; P<0.001) and nondegenerative (45% to 12%; P<0.001) MR. Trends by age (Figure 3, left) show LCO risk decline for patients <65 years of age (26% to 5%; P<0.001) but most impressively for patients 65 to 74 years of age (36% to 6%; P<0.001) and ≥75 years of age (50% to 9%; P<0.001). However, in multivariate analysis accounting for surgery year, age ≥75 years independently predicted higher LCO risk (adjusted odds ratio, 2.4 [95% CI, 1.5 to 3.9]) versus <65 years of age [P<0.001], 2.3 [95% CI, 1.4 to 3.6] versus 65 to 74 years of age [P<0.001], or 1.04 [1.02 to 1.06] per year of increasing age [P=0.0008]) despite lower overall LCO risk. In degenerative MR also, LCO was more frequent in patients ≥75 years of age than in those <65 years (adjusted odds

### TABLE 1. Preoperative Characteristics of the Study Population Stratified by Age

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall Study Group (n=1344)</th>
<th>Patients &lt;65 y of Age (n=556)</th>
<th>Patients 65–74 y of Age (n=504)</th>
<th>Patients ≥75 y of Age (n=284)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Age</td>
<td>65±12</td>
<td>53±10</td>
<td>70±3</td>
<td>79±3</td>
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<td>Male, %</td>
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<td>66</td>
<td>59</td>
<td>58</td>
<td>0.03</td>
</tr>
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<td>NYHA class III–IV, %</td>
<td>57</td>
<td>46</td>
<td>61</td>
<td>70</td>
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<tr>
<td>Overt CAD, %</td>
<td>41</td>
<td>28</td>
<td>47</td>
<td>57</td>
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<tr>
<td>AF at presentation, %</td>
<td>40</td>
<td>34</td>
<td>43</td>
<td>49</td>
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<tr>
<td>Systolic BP, mm Hg</td>
<td>127±20</td>
<td>126±18</td>
<td>127±22</td>
<td>129±19</td>
<td>0.05</td>
</tr>
<tr>
<td>Creatinine, mg/dL</td>
<td>1.3±0.6</td>
<td>1.2±0.7</td>
<td>1.3±0.4</td>
<td>1.4±0.6</td>
<td>0.0001</td>
</tr>
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<td>Comorbidity index</td>
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<td>1.8±2.2</td>
<td>2.5±2.6</td>
<td>3.0±2.9</td>
<td>0.0001</td>
</tr>
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<td>Degenerative MR, %</td>
<td>64</td>
<td>63</td>
<td>62</td>
<td>65</td>
<td>0.19</td>
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<tr>
<td>Ischemic MR, %</td>
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<td>15</td>
<td>23</td>
<td>21</td>
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<td><strong>Echographic characteristics</strong></td>
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<td>LVSD index, mm/m²</td>
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<td>22±10</td>
<td>22±8</td>
<td>21±5</td>
<td>0.62</td>
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<tr>
<td>LVDD index, mm/m²</td>
<td>34±6</td>
<td>34±6</td>
<td>34±5</td>
<td>34±6</td>
<td>0.96</td>
</tr>
<tr>
<td>Left atrial diameter, mm</td>
<td>54±10</td>
<td>53±9</td>
<td>54±10</td>
<td>54±11</td>
<td>0.20</td>
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<td>EF, %</td>
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<td>59±13</td>
<td>57±14</td>
<td>58±13</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>Operative characteristics</strong></td>
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<td>CABG, %</td>
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<td>26</td>
<td>41</td>
<td>53</td>
<td>0.0001</td>
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<td>Repair, %</td>
<td>67</td>
<td>69</td>
<td>62</td>
<td>71</td>
<td>0.009</td>
</tr>
</tbody>
</table>

AF indicates atrial fibrillation; BP, blood pressure; LVSD, left ventricular systolic diameter; and LVDD, left ventricular diastolic diameter.

**Perioperative Complications Trends**

**Operative Mortality**

Operative death trends over time (Table 2) show for all ages significant declines (adjusted odd ratio, 0.86 [95% CI, 0.81 to 0.92] per year [P<0.0001], 16% in 1980–1983 to 3% in 1992–1995 [P<0.001]) for both degenerative (9% to 2%; P<0.001) and nondegenerative (24% to 7%; P<0.001) MR. Trends by age (Figure 2, left) show a decline in operative mortality for patients <65 years of age (7% to 2%; P<0.06) but most impressively for patients 65 to 74 years of age (21% to 4%; P<0.001) and ≥75 years of age (27% to 5%; P<0.001). However, in multivariate analysis accounting for surgery year, age ≥75 years was independently predictive of higher operative mortality (adjusted odds ratio, 5.7 [95% CI, 2.7 to 11.9] versus <65 years of age [P<0.001], 2.3 [95% CI, 1.3 to 4.3] versus 65 to 74 years of age [P<0.006], or 1.08 [95% CI, 1.04 to 1.12] per year of increasing age as a continuous variable [P<0.0001]), but the excess risk of operative mortality (odds ratio) associated with age ≥75 years decreased from the earliest to the latest period (P=0.004). In degenerative MR also, operative mortality was higher in patients ≥75 versus <65 years of age (adjusted odd ratio, 5.4; 95% CI, 1.5 to 19.6; P=0.01) despite the overall operative risk decline (Figure 2, right).

**Postoperative Morbidity**

LCO trends over time (Table 2) show for all ages a significant decline overall (adjusted odds ratio, 0.84 [95% CI, 0.80 to 0.88] per year [P<0.0001]; 34% in 1980–1983 to 6% in 1992–1995 [P<0.001]) also for both degenerative (26% to 4%; P<0.001) and nondegenerative (45% to 12%; P<0.001) MR. Trends by age (Figure 3, left) show LCO risk decline for patients <65 years of age (26% to 5%; P<0.001) but most impressively for patients 65 to 74 years of age (36% to 6%; P<0.001) and ≥75 years of age (50% to 9%; P<0.001). However, in multivariate analysis accounting for surgery year, age ≥75 years independently predicted higher LCO risk (adjusted odds ratio, 2.4 [95% CI, 1.5 to 3.9]) versus <65 years of age [P<0.001], 2.3 [95% CI, 1.4 to 3.6] versus 65 to 74 years of age [P<0.001], or 1.04 [1.02 to 1.06] per year of increasing age [P=0.0008]) despite lower overall LCO risk. In degenerative MR also, LCO was more frequent in patients ≥75 years of age than in those <65 years (adjusted odds...
Valve Repair Trends
Throughout the study period, feasibility of mitral valve repair improved (overall from 30% in 1980–1983 to 84% in 1992–1995; \( P<0.001 \); Table 2) similarly in patients \( \geq 75 \), 65 to 74, and \(<65\) years of age \( P<0.001 \) for all; Figure 4, left). Valve repair was as feasible in patients \( \geq 75\) years of age as in younger patients (Table 1), and the association of valve repair with improved survival in patients \( \geq 75\) years of age was similar to that observed in younger patients \( P=0.21 \). Feasibility of repair improved in both degenerative and nondegenerative MR \( P<0.001 \) for both; Table 2), but as demonstrated in Figure 4 (right), improvements in repair feasibility were considerable in degenerative MR, reaching 93% regardless of age in the most recent period.

Discussion
The present study shows that elderly patients undergoing mitral valve surgery for MR present with more severe baseline characteristics compared with younger patients. Long term after surgery, elderly patients incur higher mortality rates, but after age-specific expected mortality is accounted for, surgery results in similar restoration of life expectancy in all age groups and similar survival benefit after valve repair. The risk of surgery is higher in the elderly with higher operative mortality, higher incidence of LCO, and longer hospital stay, but over time, surgical improvements have resulted in considerable reduction in operative mortality and morbidity, particularly in the elderly population. Furthermore, remarkable increases in valve repair feasibility over time, similar for younger and older patients, resulted in a vast majority of patients undergoing this superior mode of surgical correction of MR. Despite the challenge presented by nondegenerative MR, which is associated with higher risk than degenerative MR, surgery should not be denied or unduly delayed on the basis of age alone and in the elderly can carefully be offered earlier, without waiting for severe or intractable heart failure.

Baseline Characteristics and Operative Risks
Cardiac surgery in the elderly is considered to carry high risks\(^3\)\(^5\) and often is considered to be limited to patients with refractory heart failure.\(^1,2\) However, MR is most prevalent in the elderly\(^2\) and represents the second most common reason for valve surgery in this population.\(^26\) Therefore, evaluating outcome in the elderly and temporal trends for improvement is essential for rational decisions about mitral surgery in the large population of elderly patients with MR.

Among baseline characteristics of elderly patients operated on for MR, age is only one of the unfavorable markers noted. Indeed, worse renal function and higher comorbidity scores are expected but underscore the risky presenta-
tion of elderly patients with MR. There also are cardiac risk factors noted in the elderly, particularly high CAD prevalence either incidental to or causing the MR. Regardless of these potential links to the MR mechanism, CAD has major consequences on outcome of MR surgery. Other cardiac risk factors associated with age are related to the management of patients with MR. Elderly patients are operated on for MR when most have developed severe symptoms and a large proportion have developed atrial fibrillation. Previous studies have demonstrated that despite postoperative improvement in symptoms, there is an adverse impact of preoperative severe symptoms on short- and long-term risk incurred after MR surgery. Atrial fibrillation is directly associated with advanced age regardless of the presence of MR, but it also is a direct consequence of MR, which, when it becomes chronic, rarely reverts to sinus rhythm and is associated with higher risk even after surgical correction of MR. Hence, despite similar preoperative LV and atrial diameters in all age strata, reflecting a similar volume overload, and despite similar preoperative EF, elderly patients accumulate known risk factors for poor outcome of surgery. Whether age is, independently of these characteristics, a direct marker of risk is of limited relevance, and our study shows that elderly patients incur higher operative mortality and morbidity with longer hospital stays than younger patients. However, beyond these relative risks, absolute risks incurred during surgery are

| Table 2. Temporal Trends in Mortality, Morbidity, and Feasibility of Repair Throughout the Study Period |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Operative mortality, %** | | | | | |
| MR, all types | 16 | 8 | 5 | 3 | <0.001 |
| Degenerative MR | 9 | 5 | 2 | 2 | <0.001 |
| Nondegenerative MR | 24 | 12 | 11 | 7 | <0.001 |
| **Prevalence of LCO, %** | | | | | |
| MR, all types | 34 | 28 | 13 | 6 | <0.001 |
| Degenerative MR | 26 | 21 | 9 | 4 | <0.001 |
| Nondegenerative MR | 45 | 36 | 21 | 12 | <0.001 |
| **Time in hospital, days** | | | | | |
| MR, all types | 13.1±11.3 | 14.0±12 | 14.2±16.3 | 11.2±7.7 | 0.009 |
| Degenerative MR | 13.1±10.8 | 12.4±9.3 | 12.1±11.5 | 10.2±6.1 | <0.001 |
| Nondegenerative MR | 13.1±11.9 | 16.0±14.5 | 18.0±22.2 | 13.8±10.1 | 0.79 |
| **Feasibility of repair, %** | | | | | |
| MR all etiology | 30 | 46 | 81 | 84 | <0.001 |
| Age <65 y | 31 | 43 | 87 | 87 | <0.001 |
| Age 65–74 y | 29 | 49 | 71 | 81 | <0.001 |
| Age ≥75 y | 30 | 46 | 86 | 83 | <0.001 |
| Degenerative MR | 31 | 51 | 89 | 93 | <0.001 |
| Nondegenerative MR | 28 | 39 | 65 | 64 | <0.001 |

![Figure 2. Trends in operative mortality throughout 4 periods covering the study duration (1980–1983, 1984–1987, 1988–1991, 1992–1995) for patients ≥75 years of age (solid line), between 65 and 74 years of age (dotted line), and <65 years of age (dashed line) operated on for MR. Left, Trends in operative mortality for all causes of MR. Right, Trends in operative mortality for degenerative MR. The probability value applies to the time trends for all age group patients.](image)

![Figure 3. Trends in LCO risk throughout 4 periods covering the study duration (1980–1983, 1984–1987, 1988–1991, 1992–1995) for patients ≥75 years of age (solid line), between 65 and 74 years of age (dotted line), and <65 years of age (dashed line) operated on for MR. Left, Trends in low output risk for all causes of MR. Right, Trends in low output risk for degenerative MR. The probability value applies to the time trends for all age group patients.](image)
Importantly, elderly patients, as compared with younger patients operated on for degenerative MR in the current era. The probability of repair improved considerably, reaching 93% for patients ≥75 years of age (solid line), between 65 and 74 years of age (dotted line), and <65 years of age (dashed line) operated on for MR. Left, Trends in valve repair for all causes of MR. Right, Trends in valve repair for degenerative MR. The probability value applies to the time trends for all age group patients.

Improvement Trends
From earliest to the most recent period of the present study, outstanding progress in operative care and surgical procedures has resulted in considerable improvement of perioperative outcomes with secular trends for decreased operative mortality, LCO incidence, and hospital stay, particularly in the elderly. Remarkably, the excess operative mortality risk in elderly patients decreased considerably throughout the study period, and because those results were obtained after adjustment for preoperative characteristics, they did not purely reflect improvements in patients’ baseline characteristics. The decline in risks in the elderly is remarkable. Indeed, the last phase of the present study in the mid 1990s, designed to assess long-term outcome, shows that operative mortality in the elderly has declined considerably from 27% to 5%, but further improvements are expected. Declines in morbidity (LCO) and length of hospital stay in the elderly also are remarkable. Another crucial improvement is the increase in valve repair. Valve repair is associated with improved operative and long-term survival over valve replacement and is now widely accepted as the preferred mode of correction of MR. In the present study, feasibility of repair improved considerably, reaching 93% for patients operated on for degenerative MR in the current era. Importantly, elderly patients, as compared with younger patients, saw similar gains in repair feasibility and benefited similarly from the valve repair for survival.

Long-Term Outcome
Direct comparison of survival between populations of patients of different age has little significance. Although older patients display lower survival than younger patients after surgery for MR, essential information is provided by analyses accounting for expected survival. Our data show that in univariate or multivariate analyses, similar long-term relative survival rates are observed in younger and elderly patients. Consequently, restoration of life expectancy provided by mitral surgery is similarly archived in older and younger patients. Indeed, the comparison of observed and expected survival in the present study confirms the good outcome of elderly patients, particularly those operated on for degenerative MR. These results take advantage of temporal improvements and are applicable to current management of elderly patients with MR.

Clinical Implications
In view of our results showing that despite higher operative risk, long-term outcome of MR surgery is good in the elderly, surgical correction of MR should not be denied on the basis of age alone but only on the basis of overwhelming comorbidity. National databases also suggest that current operative mortality for mitral valve repair is low, but for individual patients, it is essential to estimate risk carefully on the basis of the results achieved by the surgical center and the patient’s clinical presentation.

Valve repair is the preferred mode of correction of MR in the young population. Valve repair in the elderly is more disputed, but our data show that it is equally feasible and provides as much survival benefit (compared with valve replacement) as valve repair in the younger population. Therefore, age, even advanced age, should not be considered as warranting valve replacement if valve repair is feasible.

In young patients in whom the risk of surgery is low, an early repair strategy has been promoted as minimizing the long-term risks attached to MR. Recent data on MR natural history have shown that with age, mortality and morbidity risks of MR under medical management increase markedly. The concept of early surgery in the elderly has not been implemented because the operative mortality risks remained too high. The present study showing trends for considerable reduction in surgical risk should lead us to review the postponement rationale in the elderly with MR, in particular the concept that severe and/or refractory heart failure is a rational ground for MR surgery in the elderly. Notable challenges remain, related to nondegenerative MR, which is less reparable and involves higher risk, warranting a careful analysis of MR type and mechanism before surgical decisions are made. In addition, trends for higher repair rates are not specific to our institution and are noted nationally, but they are inhomogeneous and overall lower, so for specific patients, careful interpretation of the patient and institution characteristics is warranted. Despite this prudent approach, however, we believe that a safer surgery should carefully lead surgeons to consider prompt repair after diagnosis in patients with low comorbidity to obtain the best possible postoperative results.

Study Limitations
Elderly patients undergoing mitral surgery may not represent all elderly patients with MR, and the benefit of surgery cannot be defined without a randomized clinical trial, which is not yet available or even ongoing. Therefore, our conclusions apply only to the comparative risks and benefit of surgery in the young and elderly population. The similar relative postoperative survival in the young and elderly populations and the decreasing risks of surgery are encouraging factors in considering surgery in the elderly.
Conclusions
Elderly patients undergoing mitral valve surgery display more severe characteristics and incur higher operative risk. However, outstanding surgical improvements over time have resulted in a marked reduction in operative risks and considerable progress in repair feasibility and in similar restoration of life expectancy in older and younger patients. Therefore, in the present era, surgery should not be denied on the basis of age alone and, in carefully selected elderly patients, should be offered before the occurrence of refractory heart failure.

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Disclosures
Dr Enriquez-Sarano has participated in an advisory board for Edwards LLC; received honoraria from Edwards and Medtronic; and Dr Enriquez-Sarano has participated in an advisory board for Cardiology.

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References
Mitral regurgitation (MR) is frequently a disease of the elderly (mean age at diagnosis, 64 years), which promises an increasing number of patients with aging of the population but also promises increasingly difficult surgical decisions. Surgical correction of MR is the only known treatment of the disease, but in the elderly, it has a poor reputation of high operative mortality rate, poor reparability, and poor long-term outcome, often leading to denial of surgical treatment in the elderly. Thus, we examined the outcome of 1344 patients with MR operated on between 1980 and 1995 to assess the characteristics and outcomes according to age. An important result is that survival compared with the expected survival for age (relative survival) is similar in the younger and older age groups. As expected, older compared with younger age is associated with higher operative mortality and morbidity (low cardiac output, length of stay). However, the absolute risk of surgery shows a considerable trend for decreasing risk (operative mortality decreased in all age groups but particularly in the elderly: 27% to 5% in those ≥75 years of age, 21% to 4% in those 65 to 74 years of age, and 7% to 2% in those <65 years of age from 1980–1983 to 1992–1995). Reparability increased from 30% to 84% (93% in degenerative MR) similarly in all age groups. Thus, restoration of life expectancy after surgery is similar in elderly and younger patients, and outstanding recent surgical improvements particularly benefited elderly patients, who should now carefully be considered for surgery before refractory heart failure is present.
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