Coronary Artery Bypass Graft Surgery in the Elderly
A Review of Postoperative Quality of Life

Leonard Shan, MBBS; Akshat Saxena, MBBS; Ross McMahon, MBBS, FRACP;
Andrew Newcomb, MBBS, FRACS

As a result of a rapidly ageing population and increasing incidence of coronary artery disease (CAD), the demand for coronary artery bypass graft surgery (CABG) in the elderly is growing. Almost 25% of all patients undergoing CABG are >70 years of age.1 Contemporary studies focus on health-related quality of life (HRQOL) following CABG, which is a key measure of operative success in the elderly. However, HRQOL outcomes remain unclear.

This review provides an evidence-based overview of the HRQOL data from the literature in elderly patients undergoing CABG. To identify HRQOL outcomes, a literature search was conducted in August 2012 on PubMed by using the medical subject headings terms (MeSH) “Cardiac Surgical Procedures” and “Coronary Artery Bypass” and “Quality of Life” and “Elderly,” not “Angioplasty, Transluminal, Percutaneous Coronary” not “Heart Defects, Congenital” not “Heart Transplantation.” A manual search of EMBASE, DISCOVERY, and MEDLINE, and bibliographies of included studies, as well, was also conducted to identify any other studies not retrieved by the initial search. We identified 18 studies published in English since the year 2000 (Figure).2–19

The Ageing Population and Burden of Coronary Artery Disease

According to the United Nations Population Division, the world’s population is ageing at a rapid and unprecedented rate. Within developed countries, the proportion of people >60 years of age is projected to double from 11% to 22% by 2050, constituting 2 billion people.20 In this time period, the number of very elderly people >80 years of age is projected to increase by a factor of 26 in comparison with a factor of 3.7 for overall world population.20 Recent data from the American Heart Association’s Heart Disease and Stroke 2012 Update shows >16 million American adults have CAD with a prevalence exceeding 80% in those >80 years of age.21 CAD is the most common cause of mortality and morbidity in the elderly21–23 and the majority of these patients become functionally impaired once symptoms begin.5,24,25 This represents a significant public health problem for the elderly population.

Overview of Coronary Artery Bypass Graft Surgery in the Elderly

CABG is often required in patients with CAD, but being elderly has previously been a relative contraindication. This dogma no longer exists, and, although there are specific risks of operating on elderly patients, these must be considered in relation to the benefits for survival and HRQOL. Contemporary studies show a more favorable perioperative mortality and long-term survival with 30-day mortality and 5-year survival reported at 4.2% to 4.7% and 76.6%, respectively.24,26–28 In addition, the elderly have a demonstrated a survival benefit from CABG over conservative treatment and a postoperative life expectancy sometimes exceeding that of the general population.14,29,30 Despite this, some studies indicate the elderly are still only hesitantly referred for CABG because of a perception of poor postoperative outcomes.14,31–33 Elderly patients can safely undergo CABG, and attention has now shifted to whether they derive worthwhile benefits from surgery.

Traditional indicators of operative outcome such as morbidity and mortality alone do not give enough information on a patient’s physical, functional, emotional, and mental well-being.2 Hence, a positive postoperative HRQOL is increasingly considered a primary goal of surgery in the elderly and is an important aspect for many patients in their decision making.34 It is also an important component of determining the success of CABG in this patient group.10

Health-Related Quality of Life in Cardiac Surgery

HRQOL is defined as not only the absence of disease or illness, but also the presence of physical, mental, social, and functional well-being.35,36 Because HRQOL is not a tangible entity, a standardized method of measurement is required that is reliable, valid, responsive, sensitive, and covers all health domains.36

In cardiovascular disease, disease-specific quality-of-life measures aim to accurately reflect a patient’s experience of a specific illness or its treatment. A common tool is...
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the Seattle Angina Questionnaire, but the New York Heart Association and Canadian Cardiac Score have also been used as substitutes where Seattle Angina Questionnaire is not available. Generic HRQOL instruments are required to facilitate holistic and quantitative assessment of HRQOL. Well-recognized generic HRQOL instruments in cardiac surgery are the Medical Outcomes Survey Short-Form 36 (SF-36), Nottingham Health Profile, EuroQOL, WHO QOL Questionnaire, Medical Outcomes Survey Short-Form 12, and 15D. More detailed descriptions of each scoring system and HRQOL instrument can be found in the appendix (Table I in the online-only Data Supplement).

Evidence is accumulating on the HRQOL benefits of CABG in the elderly. Considering that life expectancy is 17.1 years at 65 years of age and 8.2 years at 80 years of age, there is a significant opportunity for elderly patients to improve their HRQOL if they are offered surgery. In the current climate of an ageing population, it is a very important outcome of surgery to consider by both the clinician and patient.

Methods of Data Extraction and Analysis

Studies included in this review had the following eligibility criteria: (1) elderly patients defined as >70 years of age, (2) >50% operations performed were either CABG or CABG and concomitant valve procedure, (3) comparisons made with preoperative status, younger patients undergoing similar procedures or an age-matched general population, (4) disease-specific and generic HRQOL methods of assessment and results reported, and (5) retrospective and prospective investigative studies. Report characteristics were as follows: (1) publication date during or after the year 2000, (2) fully published status, and (3) English language.

After careful systematic selection, 18 studies were included in this review (Figure). Data extraction was then performed in 2 phases by 2 reviewers with the use of standardized pilot forms. The first phase involved assessment of study quality (Table 1), and the second phase collected results of the studies reviewed (Table 2). All data items were predetermined and specified in these tables. Full details and results of reviewed articles are provided in Tables 1 and 2.

Impact of Coronary Artery Bypass Graft Surgery on Health-related Quality of Life in the Elderly

The First 12 Months

Elderly patients derive significant HRQOL benefits despite a poor preoperative state. Their preoperative baseline SF-36 scores are lower in comparison with the background population, but by 3 months, there are significant HRQOL improvements in role physical, bodily pain, and mental health domains. Elderly patients perceive their own HRQOL as significantly improved especially in terms of symptomatic relief. The amount of attenuation of cardiovascular symptoms such as angina and dyspnea as measured by Canadian Cardiac Score and New York Heart Association is marked. Preoperative depressive symptoms also do not worsen after surgery.

The initial rate of recovery in the first few months after surgery may differ between elderly patients and their younger counterparts. Although all patients experience a decline in HRQOL in the first postoperative month, Conaway et al report a physical limitation score on Seattle Angina Questionnaire consistently lower for those >75 years of age until 1 year, which is consistent with Gjello et al who illustrate superior improvements in the role physical domain on SF-36 in younger patients. Elderly patients return lower SF-36 scores than younger patients in physical functioning, role physical, role emotional, and general health domains, reflecting a slow early recovery of HRQOL. Elderly patients have significant postoperative improvements on most SF-36 domains in comparison with baseline. The steepest improvement occurs during the first 6 months, which then stabilizes at 12 months. Even though elderly patients have a worse preoperative HRQOL in comparison with an age-matched
Table 1. Quality Appraisal

<table>
<thead>
<tr>
<th>Author Year (Study Period)</th>
<th>Patients</th>
<th>Study Design</th>
<th>Validated HRQOL Instrument</th>
<th>Cardiac Specific Measures</th>
<th>Patient Demographics</th>
<th>Method of Follow-Up and HRQOL Assessment</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mittermair², 2002 (1998–1999)</td>
<td>n=124 (&gt;75)</td>
<td>R</td>
<td>NO; Own questions</td>
<td>YES; NYHA</td>
<td>Male 61.3%, Urgent NR%, Location: Germany Diabetes mellitus NR%, HTN NR%, Chol NR% COPD NR%, CRF NR% PVD NR% CVA NR%</td>
<td>Baseline NA By mail Repeat attempts NR</td>
<td>93.6% PR Follow-up: moderate QOL: NR</td>
</tr>
<tr>
<td>Conaway³, 2003 (1999–2000)</td>
<td>n=156 (&gt;75), n=534 (&lt;75)</td>
<td>P</td>
<td>NO;</td>
<td>YES; SAQ (3/5)</td>
<td>&gt;75yo: Male 61.3%, Urgent 18.8%, Location: USA Diabetes mellitus 16%, HTN 79.7%, Chol 71.4% COPD 10.1%, CRF 5.1% PVD 15.9% CVA 21.7%</td>
<td>Baseline NA By telephone Repeat attempts</td>
<td>76% PR Follow-up: NR QOL: wide</td>
</tr>
<tr>
<td>Goyal⁴, 2005 (1997–2002)</td>
<td>n=100 (&lt;80), n=100 (&gt;80)</td>
<td>P</td>
<td>NO; Own questions</td>
<td>YES; NYHA, CCS</td>
<td>70–79yo/80yo: Male 71/66%, Urgent 22/28%, Location: Australia Diabetes mellitus 23/15%, HTN 55/58%, Chol NR% COPD 70/46%, CRF 3/6% PVD 15/15% CVA 5/8%</td>
<td>Baseline NA By mail Repeat attempts</td>
<td>94.5% PR Follow-up: wide QOL: NR</td>
</tr>
<tr>
<td>Wilson⁵, 2005 (1996–2001)</td>
<td>n=73 (&gt;80)</td>
<td>R</td>
<td>YES; Karnofsky scale</td>
<td>Own questions</td>
<td>Male 41%, Urgent NR%, Location: USA Diabetes mellitus 16%, HTN 74%, Chol NR% COPD NR%, CRF 11% PVD 16% CVA 8%</td>
<td>Baseline NR By telephone Repeat attempts NR</td>
<td>94.5% PR Follow-up: NR QOL: NR</td>
</tr>
<tr>
<td>Graham⁶, 2006 (1995–1998)</td>
<td>n=1697 (&lt;70), n=819 (70–80), n=82 (&gt;80)</td>
<td>R</td>
<td>NO;</td>
<td>YES; SAQ</td>
<td>70–79yo/80yo: Male 77.2/74.4%, Urgent NR%, Location: Canada Diabetes mellitus 19/4/19.5%, HTN 42.1/58.5%, Chol 40/9.24.4% COPD 11/6.1%, CRF 2.7/1.2% PVD 1.2/13.4% CVA 9.5/12.2%</td>
<td>Baseline NA By mail or telephone Repeat attempts</td>
<td>NR% PR Follow-up: &gt;73.1% RR QOL: wide</td>
</tr>
<tr>
<td>Jensen⁷, 2006 (2002–2004)</td>
<td>n=120 (&gt;75)</td>
<td>P</td>
<td>YES; SF-36</td>
<td>NO; Onp/Opp: Male 57/64%, Urgent NR%, Location: Denmark Diabetes mellitus 18/19%, HTN 66/56%, Chol NR% COPD NR%, CRF NR% PVD NR% CVA 20/25%</td>
<td>Baseline performed By mail Repeat attempts</td>
<td>96.5% PR Follow-up: NR QOL: moderate</td>
<td></td>
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<tr>
<td>Huber⁸, 2007 (1999–2003)</td>
<td>n=161 (&gt;80)</td>
<td>R</td>
<td>NO;</td>
<td>YES; SAQ, NYHA, CCS</td>
<td>Male 59%, Urgent NR%, Location: Switzerland Diabetes mellitus 11.5%, HTN 61%, Chol 51% COPD NR%, CRF 19% PVD 14% CVA NR%</td>
<td>Baseline NA By telephone Repeat attempts NR</td>
<td>74.5% PR Follow-up: wide QOL: NR</td>
</tr>
<tr>
<td>Loponen⁹, 2007 (2000–2003)</td>
<td>n=302 (all)</td>
<td>P</td>
<td>YES; 15D</td>
<td>NO;</td>
<td>Male 79.1%, Urgent 1.3%, Location: Finland Diabetes mellitus 25.5%, HTN 56.3%, Chol 70.9% COPD NR%, CRF NR% PVD NR% CVA 8.3%</td>
<td>Baseline performed By mail Repeat attempts NR</td>
<td>56.6% PR Follow-up: NR QOL: NR</td>
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</tbody>
</table>

(Continued)
Table 1. Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Year (Study Period)</th>
<th>Patients Study Design</th>
<th>Validated HRQOL Instrument</th>
<th>Cardiac Specific Measures</th>
<th>Patient Demographics</th>
<th>Method of Follow-Up and HRQOL Assessment</th>
<th>Methodological Quality</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jokinen13</td>
<td>2008 (1993)</td>
<td>n=104 (&gt;70) P YES;</td>
<td>YES; NHP</td>
<td>Male 48.1%, Urgent 52.9%, Location: Finland</td>
<td>Baseline performed by outpatients</td>
<td>94% PR</td>
<td>Precision: narrow QOL: NR</td>
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<td></td>
<td></td>
<td>n=699 (&lt;70)</td>
<td></td>
<td>Diabetes mellitus 20.2%, HTN 42.3%, Chol 37.5% COPD NR%, CRF 25% PVD 5.8% CVA 10.6%</td>
<td>Repeat attempts NR</td>
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<tr>
<td>Nwaejike11</td>
<td>2009 (1995–2007)</td>
<td>n=66 (&gt;80) R YES;</td>
<td>Own questions</td>
<td>Male 68%, Urgent 42%, Location: USA Diabetes mellitus NR%, HTN NR%, Chol NR% COPD NR%, CRF NR% PVD NR% CVA NR%</td>
<td>Baseline NA by personal interview Repeat attempts NR</td>
<td>94% PR</td>
<td>Precision: narrow QOL: NR</td>
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<td></td>
<td></td>
<td>(Own questions Barthe)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts NR</td>
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<tr>
<td>Ghanta12</td>
<td>2010 (1994–1999)</td>
<td>n=262 (&gt;80) R YES;</td>
<td>SF-12</td>
<td>Male 50.4%, Urgent 85.1%, Location: USA Diabetes mellitus 25.2%, HTN 74.4%, Chol NR% COPD NR%, CRF 16.0% PVD % CVA 12.2%</td>
<td>Baseline NR by mail Repeat attempts NR</td>
<td>94% PR</td>
<td>Precision: narrow QOL: NR</td>
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<tr>
<td></td>
<td></td>
<td>(70–80)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts NR</td>
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<tr>
<td>Gelsomino13</td>
<td>2011 (1998–2009)</td>
<td>n=1400 (&gt;80) P YES;</td>
<td>SF-36</td>
<td>Male 70–79yo/80yo: Diabetes mellitus 49.3/23.9%, HTN 50.9/58.9%, Chol 37.9/18.9% COPD 4.6/10.9%, CRF 14.1/17.0% PVD 8.9/12.2% CVA 17.9/31.1%</td>
<td>Baseline performed by telephone Repeat attempts NR</td>
<td>94% PR</td>
<td>Precision: moderate QOL: narrow</td>
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<td></td>
<td></td>
<td>n=1230 (70–80)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts NR</td>
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<tr>
<td>Ghanta14</td>
<td>2011 (1994–1999)</td>
<td>n=459 (&gt;80) R YES;</td>
<td>SF-36</td>
<td>Male 51.4%, Urgent 0%, Location: USA Diabetes mellitus 27.0%, HTN 69.7%, Chol NR% COPD NR%, CRF 12.0% PVD NR% CVA 30.3%</td>
<td>Baseline NR by telephone Repeat attempts NR</td>
<td>94% PR</td>
<td>Precision: narrow QOL: NR</td>
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<td></td>
<td>(70–80)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts NR</td>
<td></td>
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<tr>
<td>Gjeilo15</td>
<td>2011 (2004–2005)</td>
<td>n=121 (&gt;75) P YES;</td>
<td>SF-12</td>
<td>Male &gt;75yo: Diabetes mellitus 14%, HTN NR%, Chol NR% COPD NR%, CRF NR% PVD NR% CVA NR%</td>
<td>Baseline performed by mail Repeat attempts</td>
<td>84.6% PR</td>
<td>Precision: narrow QOL: NR</td>
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<td></td>
<td></td>
<td>n=413 (&lt;75)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts</td>
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<tr>
<td>Krane16</td>
<td>2011 (1987–2006)</td>
<td>n=1003 (&gt;80) R YES;</td>
<td>SF-36</td>
<td>Male 48.1%, Urgent 29.4%, Location: Germany Diabetes mellitus 23.2%, HTN 82.7%, Chol 48% COPD NR%, CRF NR% PVD NR% CVA 4%</td>
<td>Baseline NR by NR Repeat attempts NR</td>
<td>94% PR</td>
<td>Precision: narrow QOL: NR</td>
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<td></td>
<td></td>
<td>(70–80)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts</td>
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<tr>
<td>Kurlansky17</td>
<td>2011 (1989–2001)</td>
<td>n=1062 (&gt;80) R YES;</td>
<td>SF-36</td>
<td>Male 61.3%, Urgent 21.7%, Location: USA Diabetes mellitus 26.1%, HTN 65.8%, Chol 31.7% COPD NR%, CRF 13.3% PVD % CVA 15.2%</td>
<td>Baseline NR by telephone Repeat attempts NR</td>
<td>80.3% PR</td>
<td>Precision: follow-up 3.4yrs QOL: wide</td>
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<td></td>
<td></td>
<td>(70–80)</td>
<td></td>
<td>Repeat attempts</td>
<td>Repeat attempts</td>
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</table>

(Continued)
population, their improvement after CABG results in a superior HRQOL in comparison with the same population. The same is not achieved for younger patients. Younger patients also have far better physical reserves and may have fewer comorbidities, so direct comparison with younger patients should not be the only way to evaluate outcome. Despite this, elderly patients can reach HRQOL scores similar to their younger counterparts.

### Long-Term Follow-Up

Long-term follow-up of patients shows that CABG is associated with persistently marked symptomatic relief and emotional benefit leading to the vast majority of patients reporting a better perceived HRQOL and procedural satisfaction, as well. The majority of these patients are willing to undergo surgery again. CABG also allows elderly patients to have a superior HRQOL in comparison with percutaneous coronary interventions in octogenarians. In addition, there appears to be considerable benefits for preserving independence, increasing daily activities and exercise, increased enjoyment of life, less anxiety about having sudden death, and good treatment satisfaction. Even after 18 years of follow-up, octogenarians demonstrate enhanced postoperative HRQOL.

In comparison with an age-matched general population, there is at least a similar HRQOL achieved. Jokinen et al demonstrate that octogenarians undergoing CABG have significantly attenuated pain scores at 15 months and equivalent parameters on Nottingham Health Profile at both 15 months and 8.2 years in comparison with an age-matched population. Loponen et al report that, after considerable improvement in the first 6 months, there is a steady decline of HRQOL from 6 months to 18 months as measured by the 15D instrument. This decline is consistent with the findings by Jokinen et al, and, although the decline appears to be steeper in the older group, this is an expected age-dependent finding. The more significant result is that at the end of follow-up, the HRQOL of these patients is superior to the age-matched population.

Overall, elderly patients who underwent CABG have mental and physical combined scores similar to an age-matched heart disease population and general elderly population. In addition, octogenarians appear to have better mental health composite scores. Even those who had urgent or emergent surgery appear to have HRQOL comparable to the general population. These are favorable results for CABG in the elderly when considering long-term HRQOL.

### Factors That Impact Health-Related Quality of Life

There are few studies that investigate factors affecting postoperative HRQOL in the elderly population. Diabetes mellitus, male sex, previous myocardial infarct, redo CABG, low energy score and high pain score at 15 months, postoperative intensive care unit treatment >3 days, and cardiac symptoms >120 days before the operation have been implicated as predictors of impaired energy, sleep, pain, emotion, mobility, and overall HRQOL after the operation.

### Strength of Evidence

The strength of evidence was analyzed systematically in this review. Detailed results can be found in Table 1. We aimed to minimize reporting bias with a comprehensive search of the literature for all studies that meet our eligibility criteria. Despite the use of multiple online and hospital databases, and directly emailing authors, as well, there was incomplete retrieval of identified research for 1 article.

Heterogeneous data and lack of quantitative results was a limiting factor. There was also a variety of patient characteristics, in particular, varying age definitions for elderly. Nonelective operations also comprised a large proportion of patients in some studies. Despite this, nonelective CABG still appears to confer HRQOL benefits to a level that is equivalent to an age-matched general population. However, these studies by Ghanta et al included only females. There were 8 prospective studies and 10 retrospective studies. The retrospective design has inherent bias and contributes to a lack of data on whether these patients improved from their preoperative state and by what magnitude. Small patient numbers limit the generalizability of these results.

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**Table 1. Continued**

<table>
<thead>
<tr>
<th>Author Year (Study Period)</th>
<th>Patients Study Design</th>
<th>Validated HRQOL Instrument</th>
<th>Cardiac Specific Measures</th>
<th>Patient Demographics</th>
<th>Method of Follow-Up and HRQOL Assessment</th>
<th>Follow-up</th>
<th>Range/CI/ SE/SD of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markou 2011</td>
<td>NA; P</td>
<td>YES; EuroQOL</td>
<td>NO;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Kara 2012 (2004–2010)</td>
<td>n=88 (&gt;80) R</td>
<td>YES; SF-36</td>
<td>NO;</td>
<td>Male 34.1%, Urgent 6.8%, Location: Turkey Diabetes mellitus 37.5%, HTN 68.2%, Chol NR%, COPD 15.9%, CRF 7.9% PVD 23.9% CVA NR%</td>
<td>Baseline NR By telephone Repeat attempts NR</td>
<td>NR% PR</td>
<td>Follow-up: QOL: moderate</td>
</tr>
</tbody>
</table>

CCS indicates Canadian cardiac score; Chol, cholesterol; CI, confidence interval; COPD, chronic obstructive pulmonary disease; CRF, chronic renal failure; CVA, cerebrovascular accident; HRQOL, health-related quality of life; HTN, hypertension; NA, not applicable; NR, not recorded; NYHA, New York Heart Association classification; offp, off-pump; onp, on-pump; P, prospective; PR, participation rate; PVD, peripheral vascular disease; R, retrospective; RR, response rate; SAQ, Seattle Angina Questionnaire; SD, standard deviation; SE, standard error; SF-12, Medical Outcomes Survey Short Form 12 questions; SF-36, Medical Outcomes Survey Short Form 36 questions; yo, years old; and 15D, 15 dimensions questionnaire.
TABLE 2. Results of Studies Reviewed

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Defined as Elderly (Mean Age)</th>
<th>Procedures</th>
<th>Follow-Up Interval</th>
<th>Compared With Baseline</th>
<th>Compared With &lt;12 mo</th>
<th>Compared With &gt;12 mo</th>
<th>Compared With Age-Matched Population</th>
<th>Compared With Younger Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mittermair²</td>
<td>75 y (76.6±2.1)</td>
<td>CABG 59.7%</td>
<td>15.2±5.7 mo</td>
<td>Yes</td>
<td>Yes</td>
<td>—</td>
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<tr>
<td></td>
<td></td>
<td>AVR 16.9%</td>
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<td></td>
<td></td>
<td>CABG+AVR 8.9%</td>
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<td></td>
<td></td>
<td>MVR 7.3%</td>
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<td></td>
<td>NYHA III/IV 69.6% (preop), 3.5% (postop). 99.1% report good or excellent satisfaction with operation, significant improvement in QOL, dramatic functional gains and willingness to undergo a cardiac operation again.</td>
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<tr>
<td>Conaway³</td>
<td>75 y (79.8±3.5)</td>
<td>CABG 100%</td>
<td>1, 2, 3, 4, 5, 6 mo</td>
<td>—</td>
<td>Yes</td>
<td>—</td>
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<td>and 1 y</td>
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<tr>
<td>Goyal⁴</td>
<td>80 y (82.4[90–94])</td>
<td>CABG 60.5%</td>
<td>6–60 mo</td>
<td>—</td>
<td>Yes</td>
<td>Yes</td>
<td>—</td>
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<tr>
<td></td>
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<td>AVR 12.5%</td>
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<td>CABG+AVR 20.5%</td>
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<td>NYHA III/IV NR% (preop), NR% (postop). 1-year SAQ scores (older vs younger): Similar PL (88.9±20.0 vs 90.5±19.0, P=0.569) and AF (96.8±10.9 vs 95.9±13.3, P=0.530). Slightly higher QOL score in elderly (93.4±12.6 vs 89.7±14.6, P=0.03). Change scores not significantly different (older vs younger): PL (21.5±27.0 vs 19.7±27.0, P=0.67), AF (30.1±25.7 vs 24.6±25.6, P=0.07), QOL scores (37.7±21.8 vs 33.6±25.2, P=0.16).</td>
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<td>Wilson⁵</td>
<td>80 y (82[80–88])</td>
<td>CABG 100%</td>
<td>5 y</td>
<td>Yes</td>
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<tr>
<td>Graham⁶</td>
<td>70 y (81.8±NR)</td>
<td>CABG 100%</td>
<td>1, 2, and 3 y</td>
<td>—</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Jensen⁷</td>
<td>&gt;75 y (76±4.8) offp (75±4.2) onp</td>
<td>CABG 100%</td>
<td>Baseline and 3 mo</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Huber⁸</td>
<td>80 y (82.3±2.1)</td>
<td>CABG 44.9%</td>
<td>890 days (69–1853)</td>
<td>Yes</td>
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<td>AVR 25%</td>
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<td></td>
<td>CABG+AVR 30.1%</td>
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<td>NYHA III/IV or CCS 3/4 66% (preop), 28% (postop). Remarkable HRQOL after CABG and a considerable increase in emotional well-being and functional status. 81% were not or little disabled in their daily activities. Physical exercise was not or little limited to 70%. Symptoms decreased post–cardiac surgery in 93%. 72% were free of angina or dyspnea, whereas 8 in the CABG group 77.7% did not have to take nitroglycerin anymore. Overall, 77% were very satisfied and 17.4% were satisfied by the surgery. 92.5% reported no reduction in their QOL. 58% were very optimistic to conserve their present ADLs. Only 14.2% were anxious to have a heart attack or to die suddenly. 97% at follow-up lived in their own homes and preserved a high degree of self-care.</td>
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(Continued)
NYHA III/IV 73.1% (preop), NR% (postop).
Elderly patients have a worse baseline 15D score in comparison with an age and sex matched reference sample (0.8293 vs 0.8709, P<0.001). Patients <65 years, 65–74 years, and >75 years all had considerable improvements on 15D score during the first 6 months followed by a decrease until 18 months. 15D score of the surviving patients still significantly better than before surgery (P<0.001). Elderly patients have significant benefits from CABG at the beginning of their recovery, but may lose a substantial amount in a relatively short time period. Scores are still higher than before surgery. Benefit remains at least through 18 months.

Quantitative results NR.

Jokinen10 (2008)

70 y
(72.9±2.9)
CABG 57.7%
AVR 8.7%
MVR 1.0%
CABG+valve 31.7%
15±3.2 mo
8.2±0.27 y
Yes Yes Yes Yes —
NYHA III/IV 90.3% (preop) 13.0% (15 mo) 30.4% (8.2 y).
Pain at 15 months after cardiac surgery was statistically less prevalent in the study group than in the reference population (P<0.001), but at 8.2 years, there was no difference in any of the HRQOL dimensions. Within the study group itself, scores for energy (P<0.001), pain (P<0.003) and mobility (P<0.042) were significantly worse at 8.2 years compared to 15 months. No difference in HRQOL scores within the CABG, isolated valve, and combination procedure groups at 15 months or 8.2 years. The HRQOL deteriorates over time mostly in physical domains.

Having diabetes mellitus, low energy score, and a high pain score at 15 months, treatment in an intensive care unit >3 days, and a duration of cardiac symptoms preoperatively >120 days were statistically significant predictors of impaired HRQOL in energy, sleep, pain, emotion, and mobility dimensions.

Quantitative results NR.

Nwaejike11 (2009)

80 y
(82.4±1.28)
CABG 55%
AVR 12%
MVR 3%
CABG+valve 25%
NR — — — — —
NYHA III/IV NR% (preop), NR% (postop).
At follow-up, 3 patients had a recurrence of angina and shortness of breath, 2 patients were nursing home residents, and 1 patient was still admitted for rehabilitation. The rehabilitation process is very important because elderly patients may need time to recover from their operation. The mean Barthel’s index was 17.7 (min 0, max 20) where an index of >15 indicates good mobility and an index of 20 is excellent mobility.

Quantitative results NR.

Ghanta12 (2010)

80 y
(82[80–93])
CABG 61%
Valve 7%
CABG+valve 24%
Other 8%
7 y
— — — — —
NYHA III/IV 51.9% (preop), NR% (postop).
Elderly patients have SF-12 scores comparable with US cohorts across all domains. There was no difference in mental and physical combined scores between surgical patients, patients with heart disease, and general elderly patients. There was also no difference between HRQOL in survivors of urgent and emergent cardiac surgery. Emergent operation results in scores comparable to the general population >75 years of age. PCS (42.4 vs 39.5), MCS (44.2 vs 50.9).

Quantitative results NR.

Gelsomino13 (2011)

80 y
(83±2)
CABG 40.9%
Valve 17.5%
CABG+valve 25.3%
Other 16.3%
9 mo (4–13)
Yes Yes — — —
NYHA III/IV NR% (preop), NR% (postop). At follow-up, NYHA functional class was significantly higher in octogenarians (2 [2–3] vs 1 [1–2], P=0.004). Elderly patients have significant improvements RP (P<0.001), BP (P<0.001), GH (P<0.004), SF (P<0.001), and RE (P<0.001), but PF, VT, and MH did not change significantly.

Relative to the unoperated control group, postoperative scores were higher in operative group octogenarians in all domains except PF, VT, and MH. Relative to the healthy controls, elderly patients having surgery had higher BP (P<0.03), SF (P<0.02), and RE (P<0.002) scores, but lower MH score (P<0.003). All scores were significantly higher in younger patients than in elderly patients (P<0.001). The entire cohort showed an improvement in SAQ in all areas in the postoperative period.

Please refer to original article for detailed quantitative results.
Table 2. Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Defined as Elderly (Mean Age)</th>
<th>Procedures</th>
<th>Follow-Up Interval</th>
<th>Compared With Baseline</th>
<th>Compared With Age-Matched Younger Patients</th>
<th>Compared With Age-Matched Population</th>
<th>HRQOL Benefits</th>
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</thead>
<tbody>
<tr>
<td>Ghanta et al.</td>
<td>2011</td>
<td>80 y (82[80–94])</td>
<td>CABG 58.4% Valvular 19.8% CABG+valve 15.7%</td>
<td>7.9 y</td>
<td>—</td>
<td>Yes</td>
<td>Yes</td>
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<td>NYHA III/IV 41.8% (preop), NR% (postop). Survivors' median MCS was higher (55.2 vs 48.9, P&lt;0.05) and PCS was equivalent (39.3 vs 39.8, P&gt;0.66) to that of the general elderly population. There was no significant difference in HRQOL between the surgical subgroups. Quantitative results NR</td>
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<tr>
<td>Gjeilo et al.</td>
<td>2011</td>
<td>75 y (78.2[75.1–86.8])</td>
<td>CABG 68.4% Valvular 14.0% CABG+valve 6.7%</td>
<td>0, 6, and 12 mo</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>NYHA III/IV 59% (preop), 10% (6 mo postop), 11% (12 mo postop). At baseline: PF, RP, and RE were significantly lower in older patients. At 6 months: PF, RP, RE, and VT were significantly lower in older patients. At 12 months: GH, PF, SF, RP, and RE were significantly lower. Both age groups of patients improved substantially after surgery, with similar patterns of recovery for both age groups on most SF-36 scales. Only RP was different where younger patients improved more than older patients (P&lt;0.001). The most striking improvements for older patients were the approximately 20 points increase in RP, BP and PF at 12 months. Both groups had an improvement of 55 points from baseline to 12 months follow-up on the health transition-item. In comparison with general population at baseline, older patients had statistically lower scores (P&lt;0.001) on all subscales except GH (63.3 vs 65.6, P&gt;0.35), but at 12 months, older patients had higher scores on BP (76.1 vs 65.6, P=0.002). Please refer to original article for detailed quantitative results.</td>
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<td>Krane et al.</td>
<td>2011</td>
<td>80 y (92.3[80–94])</td>
<td>CABG 40.2% AVR 30.2% CABG+AVR 29.6%</td>
<td>3.6 y</td>
<td>—</td>
<td>Yes</td>
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<td>NYHA III/IV 68.7% (preop), NR% (postop). Postop mean scores: PF (49.7±1.7), RE (58.5±2.8), SF (76.2±1.6), MH (69.7±1.2), BP (70.5±1.6), VT (48.7±1.3), RP (43.6±2.6), GH (55.5±1.2). Compared with an age-matched population, BP and GH scores were significantly increased (P&lt;0.01), but RP and RE were significantly decreased (P&lt;0.02). PCS was significantly increased (38.2±0.6 vs 35.4±1.2, P&lt;0.05), but MCS showed no difference (48.1±0.7 vs 50.4±0.1, P&gt;0.1) in comparison with the general population. Comparing the summarized scores of patients undergoing the 3 different surgical procedures revealed no significant differences.</td>
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<td>Kurlansky et al.</td>
<td>2011</td>
<td>80 y (83.1±2.8)</td>
<td>CABG 100%</td>
<td>3.4 y (1 mo to 12.6 y)</td>
<td>—</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>NYHA III/IV NR% (preop), NR% (postop). CCS III/IV 89% (preop), 2.9% (postop). 78.9 report similar or improved health status at one year after surgery. There were no differences in the PCS (P=0.188) and MCS (P=0.541) summary scores between the study and age-matched population. The study population performed better on PF (61.5±4.7 vs 45.3±2.0, P&lt;0.001), BP (71.0±27.9 vs 60.9±26.0, P=0.001) and RE (72.2±41.2 vs 63.2±43.0, P=0.004), but was worse on PF (44.9±30.2 vs 53.2±30.0, P=0.001), GH (P=0.492), VT (P=0.547), SF (P=0.335), and MH (P=0.094) were all similar. Independent predictors of PCS: age (P=0.014), diabetes mellitus (P&lt;0.001), and male sex (P&lt;0.001); MCS: diabetes mellitus (P=0.004), previous MI (P=0.022), and redo surgery (P=0.016).</td>
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<tr>
<td>Markou et al.</td>
<td>2011</td>
<td>70 y</td>
<td>CABG 59.6% AVR 40.4%</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
<td>NA</td>
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<td>NYHA III/IV % (preop), % (postop). Mobility, pain and discomfort, and anxiety improve significantly in elderly patients after CABG postoperatively. PDF document unable to be sourced</td>
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<tr>
<td>Kara et al.</td>
<td>2012</td>
<td>80 y (82.8±2.4)</td>
<td>CABG 75%</td>
<td>3.1 y</td>
<td>—</td>
<td>Yes</td>
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<td>NYHA III/IV 39.8% (preop), NR% (postop). Elderly patients achieved SF-36 scores over the 50% mark with the lowest being GH (69.4±7.2) and highest being MH (80.8±4). Except for PF, SF, and RE, all domains were equivalent to or better than the general population. Quantitative results NR.</td>
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ADL indicates activities of daily living; AF, angina frequency; AVR, aortic valve replacement; BP, bodily pain; CABG, coronary artery bypass graft; CCS, Canadian cardiac score; GH, general health; HRQOL, health related quality of life; HTN, hypertension; MCS, mental component summary score; MDI, major depression index; MH, mental health; MVR, mitral valve replacement; NR, not recorded; NYHA, New York Heart Association classification; ofp, off-pump; onp, on-pump; PCI, percutaneous coronary intervention; PCS, physical component summary score; PF, physical functioning; PL, physical limitation; preop, preoperative; postop, postoperative; RE, role emotional; RP, role physical; SAQ, Seattle Angina Questionnaire; SF, social functioning; SF-12, medical Outcomes Survey Short Form 12 questions; SF-36, Medical Outcomes Survey Short Form 36 questions; VT, vitality; and 15D, 15 dimensions questionnaire.
SF-36 or Medical Outcomes Survey Short-Form 12 were the most commonly used HRQOL instruments. A validated HRQOL instrument was not used in 5 studies, which may have resulted in an inadequate assessment of the holistic nature of HRQOL. The subjectivity of patients’ perception of their HRQOL requires validated HRQOL instruments such as SF-36 and Nottingham Health Profile to accurately assess a patient’s HRQOL across all domains. Despite this, New York Heart Association and Canadian Cardiac scores were used in isolation even though they are not originally designed as HRQOL instruments.

According to previous guidelines, a response rate of >85% (loss to follow-up <15%) is considered ideal for treatment-received analyses. This was not achieved in 6 articles. Four studies either did not report their response rates or the response rates were not available owing to an inability to source the original documents. This was despite questionnaires being administered by telephone, which are considered to be more reliable and have higher response rates than self-administered postal questionnaires. Conaway et al attempted to maximize response rates by contacting patients a minimum of 8 and up to 20 times. The precision of HRQOL results depends on the confidence interval, range or standard error of instrument scores, but only 6 articles recorded this information.

The average time point at which follow-up was conducted could be >3 years, which means that the greatest improvements in HRQOL seen within the first 2 years were not observed. Furthermore, many studies were published >5 years after the completion of the study period. In particular, Ghanta et al and Jokinen et al published their findings 11 and 5 years, respectively, after the conclusion of their study period. Surgical technique along with perioperative and postoperative care improves rapidly. Studies published with a long time lag after the conclusion of the specified study period may have results that do not accurately reflect the HRQOL benefits of modern up-to-date operative care relative to the time of publication.

There are discernible obstacles to performing large randomized, controlled trials, because it is unethical to deny patients surgery when operative morbidity and mortality are favorable. Even though the strength of evidence reviewed is limited, the burgeoning elderly population and increasing elderly CABG population necessitates a thorough understanding of available postoperative HRQOL data. This review provides a synthesized reference when considering elderly patients for CABG and builds on the conclusions of previous narrative reviews.

**Summary of Evidence and Interpretation**

The main findings of this review are that elderly patients have (1) improved early and late HRQOL following CABG, (2) better postoperative HRQOL in comparison with preoperative scores, (3) similar or better HRQOL in comparison with an age-matched general population, and (4) HRQOL improvements of a magnitude similar to younger patients after CABG and to a point where HRQOL can be equivalent to younger patients. A slower initial recovery is expected in the elderly who have decreased physical reserve and a greater number of comorbidities, as reflected by poorer baseline scores in comparison with the general population. With appropriate multidisciplinary care and patience with rehabilitation programs, these patients can achieve excellent improvements in their HRQOL to the same level as younger patients. This suggests that surgical units and rehabilitation centers should consider implementing specific protocols for the postoperative care of elderly patients, in particular, focusing on maximizing HRQOL gains.

Multiple studies report positive long-term results with persistent symptomatic relief, psychological and emotional benefit, and excellent satisfaction with the procedure, as well. Furthermore, social independence is preserved which is very important to elderly patients. These results suggest a highly positive experience after CABG such that up to 94.2% of patients were willing to undergo surgery again. Overall HRQOL scores appear to remain positive, but some domains such as physical functioning, bodily pain, energy, and mobility may worsen with time. Despite this, HRQOL is still equal to or better than preoperatively, reinforcing the benefit of CABG for CAD. In particular, mental and emotional health appear to be persistently improved over time. Elderly patients have a marked recovery from CABG and attain significant HRQOL benefits in comparison with both an age-matched general population and their own preoperative state. These patients can also achieve a HRQOL similar to younger patients. This indicates that age should not be the precluding factor for CABG.

The ageing population and increasing life expectancy of patients necessitates consideration of these patients for CABG. Elderly patients are often more refractory to medical treatment and need surgical intervention to improve functional competence and HRQOL. Despite a need for increasing operations in the elderly, referring physicians may have a perception of poor outcomes after surgery. This results in an increased likelihood of elderly patients being inadequately managed with conservative treatment. Patients would be at risk of having to ongoing symptoms until a time is demanded for urgent surgery which can have a 2 to 3 times greater risk of mortality.

There are data to suggest that percutaneous coronary intervention may also be able to provide HRQOL benefits similar to CABG, but follow-up is limited to 3 years. Furthermore, these studies demonstrate that in those >80 years of age, CABG confers superior results to percutaneous intervention. Given that modern surgical care achieves low levels of mortality and morbidity, and excellent long-term survival, as well, delay or exclusion from surgical intervention based solely on age may prevent patients from receiving best practice care. The risk of surgery is much better judged by the presence of significant comorbidities, such as renal dysfunction, cerebrovascular disease, poor clinical state, and valve surgery. Careful selection of patients based on these factors rather than age results in good operative outcomes, and provides these patients the chance at significant HRQOL benefits, as well.

The emphasis is no longer purely about prolonging life, but rather about improving the HRQOL, which is a primary...
intention of surgery in elderly patients. Elderly patients themselves are frequently concerned about their postoperative HRQOL such as their social and mental function.\textsuperscript{13} Information about expected HRQOL allows these patients to have realistic expectations on physical, functional, emotional, and social welfare. This review demonstrates that there is increasing evidence showing worthwhile gains in regard to HRQOL after CABG in selected elderly patients.

The patients from the 18 articles reviewed here span a wide range of developed nations: United States, Canada, Germany, Italy, Switzerland, Denmark, Finland, Norway, Austria, United Kingdom, Australia, and Turkey. Hence, the results of this review are especially relevant to developed countries. Both elderly patients and their families can be more confident about the benefits of having CABG when it is required. Although having surgery in the elderly appears to be less cost-effective than in younger patients, the original authors concede that larger multicenter trials are required to accurately ascertain this information.\textsuperscript{13} Furthermore, cost alone should not be the precluding factor given the excellent operative results and postoperative HRQOL in this age group. Larger prospective trials will also be required to further clarify the findings of this review. Nonetheless, given the increasing evidence demonstrating good HRQOL after CABG and a rapidly increasing elderly population, it is imperative that healthcare providers can now more confidently provide CABG to elderly patients.

**Guidelines for Future Study**

This review identifies a heterogeneous data set that mandates more well-designed prospective studies to better assess HRQOL benefits for elderly patients undergoing CABG. The subjective nature of HRQOL means a consistent method of investigation is required. Our recommendations for future studies on HRQOL after CABG are outlined below.

The most important method of accurately determining HRQOL is by using previously validated, reliable, and reproducible HRQOL instruments such as SF-36. The study should have a prospective design with predetermined follow-up time points. Consistent measurements should be performed at baseline, 1 month, 6 months, and yearly thereafter. Elderly patients should have their preoperative baseline HRQOL scores compared with postoperative scores at each time point, and with an age-matched general population, as well. Because it is unethical to deny patients surgery if they are fit for surgery, it may be possible to compare patients who received surgery with those who either refused or opted for nonsurgical interventions. To highlight that HRQOL results are not dependent on age, the change scores between baseline and postoperative measurements of older patients can be compared with the change scores of younger patients. The caveat is that younger patients tend to have accumulated fewer comorbidities, so the effect of age can only be ascertained if patients are matched for comorbidities. Patients should also be relatively well-matched for other characteristics, especially for age and urgency of operation. Because urgent cardiac operations are associated with worse outcomes and mortality, it would be ideal to conduct studies purely on elective surgical patients who are more likely to receive CABG in the first place. Finally, multicenter involvement should be organized to increase patient numbers and minimize the bias from single-center studies. These guidelines can be used as the basis for consistent future study designs to achieve a standardized data set that would also allow for quantitative analyses to be undertaken.

**Conclusions: A Mandate for Application of Contemporary Evidence in Clinical Practice**

The main findings of this review are that elderly patients have an improved early and late HRQOL following CABG that can allow them to have HRQOL comparable to an age-matched general population. Derived gains in HRQOL may be similar in magnitude to younger patients. These results highlight the positive impact of CABG on HRQOL of elderly patients. This review should encourage doctors to evaluate potential CABG surgical patients on the basis of their comorbidities rather than on the basis of age alone as a precluding factor. We still emphasize that, in the absence of large randomized, controlled trials, this recommendation must be considered in conjunction with clinical decision making tailored to each patient.

**Disclosures**

None.

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44. Ware J. How to score version 2 of the SF-12 Health Survey. Lincoln, RI: Quality Metric; 2005.


Key Words: aged • cardiac surgical procedures • coronary artery bypass • quality of life