A systematic review on the quality of life benefits after aortic valve replacement in the elderly

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Background: Surgical aortic valve replacement is being increasingly performed in elderly patients with good perioperative outcomes and long-term survival. Evidence is limited on health-related quality of life after aortic valve replacement, which is an important measure of operative success in the elderly.

Methods: A systematic review of clinical studies after January 2000 was performed to identify health-related quality of life in the elderly after aortic valve replacement. Strict inclusion and exclusion criteria were applied. Quality appraisal of each study also was performed using predefined criteria. Health-related quality of life results were synthesized through a narrative review with full tabulation of the results of all included studies.

Results: Health-related quality of life improvements were shown across most or all domains in different health-related quality of life instruments. Elderly patients experienced marked symptomatic improvement. Health-related quality of life was equivalent or superior to both an age-matched population and younger patients undergoing identical procedures. There were excellent functional gains after surgery, but elderly patients remain susceptible to geriatric issues and mood problems. Concomitant coronary artery bypass did not affect health-related quality of life. There was a diverse range of study designs, methods, and follow-up times that limited direct comparison between studies.

Conclusions: Aortic valve replacement results in significant health-related quality of life benefits across a broad range of health domains in elderly patients. Age alone should not be a precluding factor for surgery. Data are heterogeneous and mostly retrospective. We recommend future studies based on consistent guidelines provided in this systematic review. (*J Thorac Cardiovasc Surg* 2013;145:1173-89)

According to the United Nations Population Division, the world's population is aging at a rapid and unprecedented rate that is expected to persist at least until 2050.¹ Within developed countries, the proportion of people aged more than 60 years is projected to double from 11% to 22% (2 billion people) by 2050.¹ By 2025, people aged more than 65 years will account for 21.3% of the population.¹ The number of very elderly people aged more than 80 years is projected to increase by a factor of 26 compared with a factor of 10 and 3.7 for those aged more than 60 years and the total world population, respectively.¹ The increasingly aging population will create an increased demand for treatment of degenerative aortic valve diseases, the most common site of valvular pathology in the elderly.^{2,3} A quarter of the

population aged more than 65 years will have aortic sclerosis,^{2,4} and 9% of these patients will progress to aortic stenosis over 5 years.⁵ A large population study estimates a prevalence of 2.8% for aortic stenosis and 2.0% for aortic regurgitation in those aged more than 75 years.⁶

Aortic stenosis has a dismal natural course and remains one of the most common causes of morbidity and mortality in the elderly.⁷ Without surgical intervention, 2-year mortality rates reach 90% in symptomatic patients, which is a 12-fold increased mortality risk compared with surgically treated patients.⁸⁻¹⁰ Attempts at conservative treatment also are largely unsuccessful.¹¹ Rapidly improving surgical standards and postoperative care have resulted in improved survival while maintaining low operative mortality after aortic valve replacement (AVR) in the elderly.^{2,10,12-15}

Despite good operative morbidity and mortality, these parameters alone do not give enough information on a patient's physical, functional, emotional, and mental well-being.¹⁶ Postoperative health-related quality of life (HRQOL) is a primary goal of surgery in the elderly and an important aspect for many patients in their decision-making.¹⁷ The challenge of surgery in this population is to provide a good HRQOL in the mid- to long-term. Evidence is accumulating on the positive HRQOL outcomes after AVR,^{8,12,14,15,18-32} and it remains the only effective treatment option for aortic valve disease.²⁹ AVR is also highly cost-effective in the elderly population,³³ yet it is still withheld from elderly

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Abbreviations and Acronyms

AVR	= aortic valve replacement
HRQOL	= health-related quality of life
NHP	= Nottingham Health Profile
NYHA	= New York Heart Association
QOL	= quality of life
SF-36	= Medical Outcomes Survey Short-Form 36
WHO	= World Health Organization

patients. Up to one third of patients do not receive necessary operations^{7,13,34} despite current guidelines recommending that all elderly patients with symptomatic aortic stenosis should be considered for AVR.³⁵ Considering that life expectancy is 17.1 years at age 65 years and 8.2 years at age 80 years,¹ there is a significant opportunity for elderly patients to improve their HRQOL and survival if they are offered surgery.

OBJECTIVES

We conducted a systematic review of publications from the start of this millennium to investigate the effect of AVR on HRQOL in elderly patients aged more than 70 years. This systematic review aims to (1) summarize the literature and clarify strengths and weaknesses of current evidence on HRQOL after AVR in the elderly, (2) demonstrate whether there is a HRQOL benefit in elderly patients after AVR and whether it is enough to justify surgery, and (3) outline guidelines for future research.

MATERIALS AND METHODS

The structure of this systematic review followed previously recommended guidelines³⁶ and was written in accordance with the PRISMA checklist for systematic reviews.³⁷

Definition and Measurement of Health-Related Quality of Life

The World Health Organization (WHO) has defined health as being “not only the absence of disease and infirmity but also the presence of physical, mental, and social well-being.”³⁸ HRQOL encapsulates an individual’s physical, emotional, and psychologic health, as well as social and functional status.³⁹ Because HRQOL is not a tangible entity, a standardized method of measurement is required that is reliable, valid, responsive, and sensitive, and that covers all health domains.³⁹

In valvular heart disease, disease-specific quality of life (QOL) measures aim to accurately reflect a patient’s experience of a specific illness or its treatment. A common tool is New York Heart Association (NYHA) classification,⁴⁰ but the Minnesota Living with Heart Failure Questionnaire⁴¹ and Kansas City Cardiomyopathy Questionnaire⁴² also have been used. Generic HRQOL instruments are required to facilitate holistic and quantitative comparisons between different groups of patients. According to the WHO’s QOL group, any generic HRQOL instrument should include physical, psychologic, social, functional, and well-being domains.⁴³ Well-recognized HRQOL instruments in cardiac surgery are the Medical

Outcomes Survey Short-Form 36 (SF-36),⁴⁴⁻⁴⁷ Nottingham Health Profile (NHP),^{48,49} EuroQOL (EQ-5D),⁵⁰ and Medical Outcomes Survey Short-Form 12.^{51,52} More detailed descriptions of each scoring system and HRQOL instrument are shown in Table 1.

Eligibility Criteria

Study characteristics were as follows: (1) elderly patients defined as aged more than 70 years; (2) greater than 50% operations performed were AVR or AVR and concomitant CABG; (3) comparisons made with preoperative status, younger patients undergoing similar procedures, or an age-matched general population; (4) HRQOL methods of assessment and results reported; and (5) retrospective and prospective investigative studies. Report characteristics were (1) publication date during or after the year 2000, (2) fully published status, and (3) English language.

Literature Search and Information Sources

A literature search was conducted using a MeSH keyword search via PubMed. Strict inclusion criteria for study characteristics were applied as described. On August 29, 2012, a search was conducted as described in Figure 1. A subsequent additional manual search was conducted to identify studies not covered by the initial MeSH keyword search. These manual search articles were sourced from the EMBASE, DISCOVERY, and MEDLINE databases, as well as bibliographies of each included study. Authors were e-mailed when original PDF documents could not be sourced.

Study Selection

Two reviewers screened titles and abstracts after both MeSH keyword and manual searches. Studies were excluded if they did not meet eligibility criteria. If the information required to determine eligibility was not in the abstract, a second pass was run after data extraction. Reviewers were not blinded.

Data Items and Collection Process

Data extraction was then performed in 2 phases by 2 reviewers using standardized pilot forms. The first phase involved assessment of study quality (Table 2), and the second phase collected results of the studies reviewed (Table 3). All data items were predetermined and specified in these tables.

Assessment of Risk of Bias

Risk of bias in individual studies was mainly assessed by evaluating the (1) study design, (2) number of patients, (3) use of a generic HRQOL instrument, and (4) questionnaire response rates.

RESULTS

After careful systematic selection, 19 studies were included in this systematic review.^{8,12,14,15,18-24,26,28-32,53,54} Full details and results of reviewed articles are provided in Tables 2 and 3.

Early Mortality

The studies included in this review showed an acceptable early mortality after AVR (Table 4). Early mortality was generally low in contemporary studies and in isolated AVR procedures.

Cardiac-Specific Quality of Life Measures

Elderly patients appear to have marked symptomatic improvements after AVR. Within the first 18 months after operation, only 0% to 20% of patients are in NYHA III/IV.^{12,21,29} The improvement in NYHA class persists

TABLE 1. Description of scoring systems and health-related quality of life instruments

System	Components
MLHFQ ⁴¹	Effects of heart failure on QOL asked through 21 questions covering physical and emotional dimensions
	Physical Lower-limb edema, limiting ambulation, difficulty leaving the house, limiting occupation, limiting recreational activities, limiting sexual activity, shortness of breath, fatigue, hospitalization, treatment side effects,
	Emotional insomnia, difficulty relating/interacting with people, eat less foods previously enjoyed, financial costs, feel like burden to family or friends, feel like losing control of life, worry, difficulty concentrating or remembering, feeling depressed
NYHA ⁴⁰	Class I No limitations on physical activity, no symptoms with ordinary activity
	Class II Slight limitation on physical activity, mild symptoms on ordinary activity
	Class III Marked limitation on physical activity, symptomatic at less than ordinary activity levels
	Class IV Unable to perform any activity, discomfort with any activity, symptomatic at rest
KCCQ ⁴²	There are 23 items measuring self-reported health status in patients with heart failure. Scales measured are physical limitation, symptom stability, symptom frequency, symptom burden, total symptoms, self-efficacy, QOL, social limitation, overall summary, and clinical summary.
SF-36 ⁴⁴⁻⁴⁷	36 (or 12) items measuring 8 conceptual domains or dimensions of health:
SF-12 ^{51,52}	General health Measurement of perceived overall health, including past and present health
	Physical functioning Indicates level of limitations in lifting, bending, kneeling, or walking moderate distance
	Bodily pain Represents the intensity, frequency, and duration of bodily pain and limitations in normal activities due to pain
	Mental health Measures the emotional, cognitive, and intellectual status of the patient
	Role physical Measures the degree in performing of usual activities for age and social status
	Role emotional Measures personal feeling of job performance at work or other activities
	Vitality Measures feeling of energy, fatigue, and tiredness
	Social functioning Indicates ability to develop and maintain mature social relationships.
	The SF-36 scores can be related to activities of daily living. For example, 80% of responders who judged their general health as being good, very good, or excellent had a score of 61 in the general health scale of SF-36. ⁶¹
	Note: Both SF-36 and SF-12 surveys can provide 2 summary measures—physical component score and mental component score.
NHP ^{48,49}	38 yes/no statements on health problems covering 6 dimensions of subjective health:
	Physical mobility Only walk indoors, difficult to bend, unable to walk, trouble with stairs, difficult to reach for things, difficult to dress, hard to stand for long times, needs help walking outside
	Pain Pain at night, unbearable pain, pain on movement, pain on walking, pain on standing, constant pain, pain with stairs, pain on sitting
	Sleep Require sleeping tablets, early morning wakening, awake most of the night, takes a long time to get to sleep, insomnia
	Energy level Tiredness, everything is an effort, easily run out of energy
	Emotional reactions Feeling down, anhedonia, feeling on edge, day seems to drag, easily lose temper, feel like losing control, ruminating at night, feel like life is not worth living, wake up feeling depressed
	Social isolation Feeling lonely, difficult to make contact with people, feels close to no one, feel like a burden to people, difficulty interacting with people
EuroQOL ⁵⁰	5 domains of EQ-5D index:
	Mobility Ability to walk
	Self-care Ability to dress
	Usual activities Activities of daily living
	Pain/discomfort Level of pain
	Anxiety/depression Level of anxiety of depression

QOL, Quality of life; MLHFQ, Minnesota Living with Heart Failure Questionnaire; NYHA, New York Heart Association; KCCQ, Kansas City Cardiomyopathy Questionnaire; SF-36, Medical Outcomes Survey Short-Form 36; SF-12, Medical Outcomes Survey Short-Form 12; NHP, Nottingham Health Profile.

long-term, with 35% to 81.7% less patients in NYHA III/IV compared with preoperatively.^{8,18,19,22,23,26,29} Some studies demonstrate 0% of patients in NYHA III/IV at follow-up.^{15,18} Salazar and colleagues²⁹ reported 62.4%,

0%, and 3.8% of patients with a preoperative, 1-year, and 5-year NYHA III/IV, respectively. The eventual increase in NYHA scores at 5 years is small and consistent with a natural age-related decline.

FIGURE 1. Search algorithm. *HRQOL*, Health-related quality of life.

Generic Health-Related Quality of Life Instruments

Only 2 authors investigated preoperative compared with postoperative HRQOL. At 1, 6, and 12 months, elderly patients had had highly statistical and clinically significant

improvements in Medical Outcomes Survey Short-Form 12 and EQ-5D scores compared with their preoperative status.^{24,54}

Comparison with an age-matched general population shows that elderly patients have equivalent or superior HRQOL scores after surgery.^{12,14,20,23,30,31,53} There were 4 studies published by Vicchio and colleagues^{14,31,53} included in this review, and all demonstrated significantly higher SF-36 scores than the age-matched general population in most or all of the 8 domains. Sundt and colleagues¹² and Lam and Hendry²³ corroborate these results with their finding that octogenarians have better bodily pain, social function, general health, and mental health scores than the general elderly population, including those 5 years younger. Studies using other HRQOL instruments also appear to demonstrate significantly better scores. Ennker and colleagues²⁰ studied the use of stentless bioprosthetic valves in octogenarians and found NHP scores better in all domains except for energy. A significant gender difference was found. Women had a slower recovery on Minnesota Living with Heart Failure Questionnaire scores and may benefit from discharge to a convalescence resource.³⁰

Elderly patients can achieve a similar or better HRQOL compared with younger patients undergoing the same procedure. Lam and Hendry²³ found that compared with patients aged less than 80 years, patients aged more than 80 years had better postoperative bodily pain, vitality, social function, and mental health scores and equivalent scores in all other domains on the SF-36.

Self-Constructed Measures of Quality of Life

Elderly patients derived significant functional gains from AVR. Up to 90% were able to resume normal activities for their age,^{21,29} and most could undertake moderate to heavy levels of activity.^{18,19,22} This is reflected by a large proportion of patients feeling as good as or better than they did preoperatively,^{21,22,26} such that many patients reported they were independent of their activities of daily living.^{18,21,26,28} Approximately 100% of patients were satisfied with their decision to undergo surgery and would be willing to undergo another operation.^{18,19,21,22,26}

Maillet and colleagues⁸ studied frailty and HRQOL in octogenarians and had less positive results. A lower proportion of patients reported positive general self-rated health or QOL scores. Only 66.1% of patients considered that their health had improved since the operation, and 60.7% of patients would have another AVR. Geriatric parameters, especially gait problems and falls, reflected a frail cohort of patients after operation. Self-rated mood also was less optimistic, with half of patients admitting to having "sad ideas" and 33.9% having anhedonia.

Concomitant Coronary Artery Bypass Grafting

Despite improvement on functional and social domains of HRQOL being less for AVR compared with CABG, HRQOL still strongly increases within each procedure group.²⁴ Furthermore, Vicchio and colleagues²⁴ report no differences in long-term HRQOL according to the presence of concomitant CABG.

DISCUSSION

Strength of Evidence and Bias

The strength of evidence was analyzed systematically in this review. Detailed results are shown in Table 2.

Heterogeneous data and lack of quantitative results^{12,14,15,20,23} prevented direct comparison of results or meta-analyses. There was also a variety of patient characteristics. In particular, the proportion of men ranged from 21% to 65.5%. Urgent operations comprised 45.5% of procedures in the study by Nikolaidis and colleagues,²⁶ and 10 studies did not record this information.^{8,14,20,21,23,29,30,32,53} Only 2 studies were retrospective.^{23,54} 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.

The SF-36 was the most commonly used HRQOL instrument.^{12,14,23,30-32,53} A validated HRQOL instrument was not used in 9 studies, which may have resulted in inadequate coverage of the WHO's HRQOL definition.^{8,15,18,19,21,22,26,28,29} The subjective nature of a patient's perception of his or her HRQOL requires validated HRQOL instruments, such as SF-36 and NHP, to accurately assess a patient's HRQOL across all domains. Despite this, NYHA scores were used in isolation even though they are not originally designed as HRQOL instruments.^{8,12,15,18,19,22,23,26,29,30}

According to previous guidelines, a response rate of more than 85% (loss to follow-up < 15%) is considered ideal for treatment-received analyses.³⁶ Only 3 articles did not achieve this mark.^{23,26,30} There were 4 studies that did not report their response rates or were not available because of the inability to source the original documents.^{8,18,21,24} Authors were contacted, but there was no reply. A relatively good follow-up consistency was demonstrated in the population studied. This may be attributed to questionnaires administered by telephone,^{12,19,20,28,31,53} which are considered to be more reliable and to have higher response rates than self-administered postal questionnaires.⁵⁵ The precision of HRQOL results is dependent on the confidence interval, range, or standard error of instrument scores, but only 4 articles recorded this information.^{19,20,30,54}

Whereas there were abundant data with a late follow-up time point of greater than 2 years,^{8,14,15,18-20,22,23,26,28-32,53} evidence on early HRQOL outcomes after AVR remains

scarce.^{12,21,54} Furthermore, 4 studies were published 5 or more years after the completion of the study period.^{8,15,23,28} Rapid advances in surgical technique and postoperative care mean these results may be less reflective of potential HRQOL benefits with modern operative care.

More well-designed prospective studies are required to make a more reliable assessment on the HRQOL benefits for elderly patients undergoing AVR. We recognize the obstacles to performing large randomized controlled trials because it is unethical to deny patients surgery when operative morbidity and mortality are excellent. Subsequently, the strength of evidence reviewed in this article is limited. Yet there is a burgeoning elderly population, and AVR is increasingly being performed and required in this age group. This systematic review summarizes the best available evidence on HRQOL after AVR in the elderly.

Summary of Evidence and Interpretation

The main findings of this systematic review are that elderly patients have (1) noticeable improvements in cardiac symptoms after AVR,^{8,12,15,18,19,21-23,26,29,30,54} (2) equal or better HRQOL compared with an age-matched general population,^{12,14,20,23,30,31,53} (3) equivalent or superior HRQOL compared with younger patients who underwent AVR,²³ and (4) significant functional gains after surgery.^{18,19,21,22,26,28-30}

The long-term symptomatic and functional gains after AVR in both septuagenarians and octogenarians^{8,12,15,18,19,21-23,26,28,29} are important in elderly patients and lead to a highly positive experience. This is reflected in most or all patients being satisfied with their decision to undergo surgery or willing to have another operation.^{18,19,21,22,26} Elderly patients maintain their HRQOL benefits after surgery that allow them to have superior HRQOL than their age-matched counterparts in most studies.^{12,14,20,23,31,53} Age seems to be less important in consideration for surgery, especially when the longer-term HRQOL can be superior to the level of younger patients.²³

The aging population and increasing life expectancy of patients will lead to continuing increases in degenerative aortic valve disease, necessitating consideration for AVR. There is currently no effective medical treatment for aortic valve lesions. Although there are specific risks of operating in elderly patients, this must be considered in relation to benefits for HRQOL. Despite a need for increasing operations in the elderly, referring physicians may have a perception of poor outcomes after surgery.^{7,34} This results in an increased likelihood of elderly patients being inadequately managed with conservative treatment. Patients are likely to have ongoing symptoms until a time is demanded for urgent surgery, which is a risk factor for increased mortality.²²

Despite increases in the age of patients undergoing surgery, mortality after AVR is progressively decreasing.⁵⁶

TABLE 2. Quality appraisal

Author year (study period)	Patients	Study design	Methodological quality				Precision		Overall vstudy quality
			Validated HRQOL instrument	Cardiac-specific measures	Patient demographics	Method of follow-up and HRQOL assessment	Follow-up consistency	Range/CI/SE/SD of results	
Sundt and colleagues ¹² 2000 (1993-1998)	n = 133 (>80)	R	Yes; SF-36	Yes; NYHA	Male 46.6%, Urgent 10.5%, Location: United States Diabetes 17.3%, HTN 67.7%, Chol NR% COPD 12%, CRF 5.3% PVD 12.8% CVA 11.3%	Baseline NR By mail or telephone Repeat attempts NR	48.9% PR 98% RR	Follow-up: wide QOL: NR	Excellent
Chiappini and colleagues ¹⁹ 2004 (1982-2003)	n = 115 (>80)	R	No; own questions	Yes; NYHA	Male 40.9%, Urgent 14.7%, Location: Italy Diabetes 13.8%, HTN 44.9%, Chol 22.2% COPD 19.8%, CRF NR%, PVD NR%, CVA 5.2%	Baseline N/A By telephone interview Repeat attempts NR	73.0% PR 100% RR	Follow-up: wide QOL: moderate	Good
Lam and Hendry ²³ 2004 (1995-1999)	n = 58 (>80)	P	Yes; SF-36	Yes; NYHA	Male 62%, Urgent NR%, Location: Canada Diabetes 12%, HTN 35%, Chol 5% COPD 7%, CRF 9%, PVD 16%, CVA NR%	Baseline performed By mail and telephone Repeat attempts NR	100% PR 35% RR	Follow-up: wide QOL: NR	Poor
Salazar and colleagues ²⁹ 2004 (1991-2002)	n = 117 (>70)	R	No; own questions (NR)	Yes; NYHA	Male 61.5%, Urgent NR%, Location: Mexico Diabetes 14.5%, HTN 43.6%, Chol NR% COPD 32.5%, CRF 4.3%, PVD NR%, CVA 3.4%	Baseline N/A By NR Repeat attempts NR	85.5% PR 78% RR	Follow-up: wide QOL: NR	Poor
Ennker and colleagues ²⁰ 2006 (1996-2002)	n = 76 (>80) n = 427 (<80)	R	Yes; NHP	No;	Male 28%, Urgent NR%, Location: Germany Diabetes 22%, HTN 53%, Chol 29% COPD NR%, CRF 14%, PVD NR%, CVA NR%	Baseline NR By mail and telephone Repeat attempts NR	78.7% PR 77% RR	Follow-up: wide QOL: narrow	Poor
Kolh and colleagues ²² 2007 (1992-2004)	n = 220 (>80)	R	No; own questions	Yes; NYHA	Male 21%, Urgent 20%, Location: Sweden Diabetes 12%, HTN 41%, Chol 11% COPD 5%, CRF 4%, PVD NR %, CVA NA%	Baseline N/A By clinic visits and annual letters Repeat attempts NR	73% PR 99% RR	Follow-up: narrow QOL: NR	Good
Vicchio and colleagues ³¹ 2007 (1988-2005)	n = 681 (>70)	R	Yes; SF-36	No;	Male 43.9%, Urgent 7.6%, Location: Italy Diabetes 20.1%, HTN 64%, Chol NR% COPD 22.5%, CRF 3.1%, PVD NR%, CVA NR%	Baseline NR By outpatient review, ambulatory clinic, and telephone interview Repeat attempts NR	84.9% PR 96.2% RR	Follow-up: wide QOL: NR	Good

Vicchio and colleagues ⁵³ 2008 (1988-2005)	n = 147 (>70)	R	Yes; SF-36	No;	Male 19.7%, Urgent NR%, Location: Italy Diabetes 21.2%, HTN 68.6%, Chol NR% COPD 20.1%, CRF NR%, PVD NR%, CVA NR%	Baseline NR By outpatient review and telephone interview (late) Repeat attempts NR	97.8% PR 100% RR	Follow-up: wide QOL: NR	Poor
Vicchio and colleagues ¹⁴ 2008 (1992-2006)	n = 160 (>80)	R	Yes; SF-36	No;	Bio Prosthesis/mechanical Prosthesis: Male 45.6/41.3%, Urgent: NR %, Location: Italy Diabetes 26.5/23.9%, HTN 66.2/66.3%, Chol NR% COPD 32.4/34.8%, CRF 2.9/ 4.3%, PVD NR%, CVA NR%	Baseline NR By institutional ambulatory activities Repeat attempts NR	75.6% PR 97.6% RR	Follow-up: wide QOL: NR	Good
Maillet and colleagues ⁸ 2009 (1998-2001)	n = 84 (>80)	R	No; own questions	Yes; NYHA	Male 37%, Urgent NR%, Location: France Diabetes NR%, HTN NR%, Chol NR% COPD 22.6%, CRF 16.7%, PVD 20.2%, CVA NR%	Baseline N/A By telephone interview Repeat attempts NR	66.7% PR NR% RR	Follow-up: wide QOL: NR	Poor
Aoyagi and colleagues ¹⁸ 2010 (1994-2008)	n = 60 (>80) n = 1387 (<80)	R	No; own questions	Yes; NYHA	Male 38.3%, Urgent 16.7%, Location: Japan Diabetes 11.7%, HTN 63.3%, Chol % COPD 13.3%, CRF 6.7%, PVD 20.0%, CVA 26.7%	Baseline N/A By review of hospital records, direct patient contact, or mail Repeat attempts NR	NR% PR NR% RR	Follow-up: wide QOL: NR	Poor
Ferrari and colleagues ¹⁵ 2010 (1990-2005)	n = 124 (>80)	R	No; own questions	Yes; NYHA	Male 37%, Urgent 3.0%, Location: Switzerland Diabetes 10%, HTN 57%, Chol 23% COPD NR%, CRF 22%, PVD NR%, CVA NR%	Baseline N/A By NR Repeat attempts NR	94.4% PR 90% RR	Follow-up: NR QOL: NR	Poor
Folkmann and colleagues ²¹ 2010 (2005-2007)	n = 154 (>80)	R	No; own questions	No;	Male 33.8%, Urgent NR%, Location: Austria Diabetes 30.3%, HTN NR%, Chol NR% COPD 54.9%, CRF 38.7%, PVD 14.7%, CVA 15.1%	Baseline N/A By telephone Repeat attempts NR	81.8% PR NR% RR	Follow-up: NR QOL: NR	Poor
Spaziano and colleagues ³⁰ 2010 (2003-2006)	n = 161 (>80)	R	Yes; SF-12 MLHFQ	Yes; NYHA	Male 50%, Urgent NR%, Location: Canada Diabetes NR%, HTN NR%, Chol NR% COPD NR%, CRF NR%, PVD NR%, CVA NR%	Baseline NR By mail and telephone Repeat attempts NR	82.6% PR 64.4% RR	Follow-up: moderate QOL: wide	Poor
Markou and colleagues ²⁴ 2011			Yes; EuroQOL						PDF not sourced*

(continued)

TABLE 2. Continued

Author year (study period)	Patients	Study design	Methodological quality				Precision		Overall ystudy quality
			Validated HRQOL instrument	Cardiac-specific measures	Patient demographics	Method of follow-up and HRQOL assessment	Follow-up consistency	Range/CI/SE/SD of results	
Nikolaidis and colleagues ²⁶ 2011 (2000-2008)	n = 345 (>80)	R	No;	Yes; NYHA	Male 65.5%, Urgent 45.5%, Location: UK Diabetes 6.9%, HTN NR%, Chol NR% COPD 11.6%, CRF 3.4%, PVD 3.7%, CVA 4.9%	Baseline N/A By mail Repeat attempts NR	81% PR 62% RR	Follow-up: wide QOL: NR	Poor
Oliveira and colleagues ²⁸ 2012 (2002-2006)	n = 144 (>75)	R	No; own questions	No;	Male 38.6%, Urgent 28.1%, Location: Portugal Diabetes 18.4%, HTN 63.2%, Chol 42.3% COPD NR%, CRF 57%, PVD NR%, CVA NR%	Baseline N/A By telephone interview with patient or next of kin, or at outpatient clinic Repeat attempts NR	76.3% PR 99.1% RR	Follow-up: wide QOL: NR	Poor
Reynolds and colleagues ⁵⁴ 2012 (2007-2009)	n = 216 (TF) n = 84 (TA)	P	Yes; SF-12 EQ-5D	Yes; KCCQ	Cohort TF/TA: Male 55.6%/59.5%, Urgent NR%, Location: United States Diabetes NR%, HTN NR%, Chol NR% COPD 7.4%/7.1%, CRF NR %, PVD 35.7%/62.7%, CVA 22.7%/29.8%	Baseline performed By scheduled follow-up visits or by mail Repeat attempts N/A	89.8% PR >80% RR	Follow-up: N/A QOL: wide	Excellent
Vicchio and colleagues ³² 2012 (1991-2010)	n = 520 (>70)	R	Yes; SF-36	No;	Group A/B: Male 42.6/64%, Urgent NR%, Location: Italy	Baseline NR By institutional ambulatory activities Repeat attempts NR	96.9% PR 98.3% RR	Follow-up: wide QOL: NR	Good

HRQOL, Health-related quality of life; *CI*, confidence interval; *SE*, standard error; *SD*, standard deviation; *R*, retrospective; *P*, prospective; *SF-36*, Medical Outcomes Survey Short Form 36; *NYHA*, New York Heart Association; *HTN*, hypertension; *Chol*, cholesterol; *NR*, not recorded; *COPD*, chronic obstructive pulmonary disease; *CRF*, chronic renal failure; *PVD*, peripheral vascular disease; *CVA*, cerebrovascular accident; *PR*, participation rate; *RR*, response rate; *QOL*, quality of life; *N/A*, not applicable; *NHP*, Nottingham Health Profile; *SF-12*, Medical Outcomes Survey Short Form 12; *MLHFQ*, Minnesota Living with Heart Failure Questionnaire; *TF*, transfemoral cohort; *TA*, transapical cohort; *KCCQ*, Kansas City Cardiomyopathy Questionnaire. *Full PDF document not able to be sourced, hence unable to extract study details such as study period.

TABLE 3. Results of studies reviewed

Author (year)	Objective	Defined as elderly (mean age, y)	Procedures	Comparison group on generic QOL	Follow-up interval	Conclusions
Sundt and colleagues ¹² (2000)	To assess perioperative mortality and morbidity rates, late survival and functional outcome, and HRQOL in patients aged > 80 y undergoing AVR Results: (SF-36, NYHA) NYHA III/IV 81.2% (preoperative), 20.0% (postoperative). Mean NYHA functional class improved from 3.1 to 1.7 ($P < .001$). Scores on the SF-36 were comparable to those for the general population aged > 75 y. Study patients scored higher than the control population in 5 areas: BP, GH, SF, RE, and MH. Quantitative results NR.	80 (83.5 ± 2.6)	AVR 26.3% AVR + CABG 53.4% AVR + MVR 3.0% Other 17%	General population (and younger) > 75 y	3-18 mo	Gratifying late results may be achieved with AVR in patients aged > 80 y with excellent results on NYHA and SF-36. An excellent HRQOL can be anticipated in a significant proportion of elderly people.
Chiappini and colleagues ¹⁸ (2004)	To analyze whether valve surgery in elderly patients can improve mortality, morbidity, and HRQOL in otherwise mentally and physically healthy patients Results: (NYHA) NYHA III/IV 79.3% (preoperative), 5.9% (postoperative). Mean NYHA class improved from 2.90 ± 0.6 to 1.6 ± 0.6 ($P < .01$). Some 56.3% and 44.7% rated their activity level as heavy or moderate, respectively; 98% of patients who underwent AVR were satisfied with their choice.	80 (82.3 ± 2.1)	AVR 62.1% AVR + CABG 37.9%	N/A	37.1 ± 32.4 mo	Octogenarians with aortic valve disease should not be denied the survival and HRQOL benefits of surgery if they are reasonably good surgical candidates, physically and mentally able to stand the stress of surgery, and motivated to improve their lifestyle. It is prudent to avoid delays and risk LV dysfunction.
Lam ²³ (2004)	To investigate the HRQOL after AVR of patients aged > 80 y compared with that of younger counterparts to determine functional outcomes Results: (SF-36, NYHA) NYHA III/IV 38% (preoperative), 3% (postoperative) Postoperative SF-36 scores, when compared with patients aged <80 y, were better for BP, VT, SF, and MH ($P < .05$). When compared with the general population aged ≥75 y, they were better for BP, GH, VT, SF, and MH ($P < .05$). Quantitative results NR.	80 (83.7 ± 3.4)	AVR 52% AVR + CABG 48%	General population aged > 75 y Postoperative vs younger patients	35.3 ± 25.3 mo	Despite higher operative risk and greater morbidity, HRQOL indicators in patients aged ≥ 80 y were equivalent to or better than their younger counterparts.
Salazar and colleagues ²⁹ (2004)	To evaluate the results of AVR in patients aged > 70 y who underwent operation at Instituto Nacional de Cardiología Ignacio Chávez Results: (NYHA) NYHA III/IV 62.4% (preoperative), 0% (postoperative 1 y) 3.8% (postoperative 5 y) Some 90% of patients resumed normal activities for their age.	70 (73.8 ± 3.8)	AVR 78.6% AVR + CABG 18.8% AVR + MVR 2.6%	Preoperative vs postoperative of same patients	42.9 ± 33.2 mo	In a selected patient population, AVR in the elderly is associated with acceptable mortality and morbidity. There is significant lessening of symptoms and excellent improvement of HRQOL. Elderly patients should not be denied AVR on the basis of age alone.

(continued)

TABLE 3. Continued

Author (year)	Objective	Defined as elderly (mean age, y)	Procedures	Comparison group on generic QOL	Follow-up interval	Conclusions
Ennker and colleagues ²⁰ (2006)	To determine whether there is an increased risk of adverse perioperative and mid-term outcome for octogenarians and whether they benefit from AVR with stentless bioprostheses Results: (NHP) NYHA III/IV 58% (preoperative), NR% (postoperative) Patients have better NHP scores in 7 of 8 domains (except energy) after AVR with stentless bioprostheses. Women after AVR and in the general population showed higher scores, indicating a lower QOL. Quantitative results NR.	80 (82 ± 2)	AVR 60% AVR + CABG 40%	General population aged > 80 y	35 ± 23 mo	Because HRQOL and life expectancy after AVR with stentless valves were equal to the general population, AVR with stentless bioprostheses should not be withheld from octogenarians.
Kolh and colleagues ²² (2007)	To assess factors influencing operative and long-term outcome in octogenarians undergoing aortic valve surgery Results: (NYHA) NYHA III/IV 64% (preoperative), 19% (postoperative) Some 91% of patients were angina free. The majority of patients were able to undertake moderate or heavy activity (74%); 91% of patients believed that undergoing heart surgery after the age of 80 y was a good choice, and 88% felt as good as or better than they had preoperatively.	80 (82.8 ± 2.4)	AVR 74% AVR + CABG 26%	N/A	58.2 mo Completed within 2 mo	AVR in octogenarians can be performed with acceptable mortality, although significant morbidity. These results stress the importance of early operation on elderly patients with aortic valve disease, avoiding urgent procedures. Associated coronary artery disease is a harbinger of poor operative outcome. Long-term symptomatic and functional recovery are excellent.
Vicchio and colleagues ³¹ (2007)	To examine resulting life expectancy and HRQOL with bileaflet mechanical prostheses with a centralized management of anticoagulation in patients aged > 70 y Results: (SF-36) NYHA III/IV 90.6% (preoperative), NR% (postoperative) SF-36 scores were significantly higher than those of the age- and sex-matched general Italian population in all domains: PF 64.4; RP 88.5; BP 96.3; GH 64.5; VT 63.4; SF 79.5; RE 92.6; MH 68.9 (<i>P</i> < .001 in all domains).	70 (73 ± 3.3)	AVR 77.2% AVR + CABG 15.2% Other 7.6%	Age- and sex-matched population	4.38 ± 2.85 y	Septuagenarian patients receiving mechanical valve prostheses did not experience increased rates of anticoagulation-related complications and perceived a satisfactory HRQOL.

Vicchio and colleagues ⁵³ (2008)	To evaluate LV mass regression, survival, and HRQOL in elderly patients after AVR with small-sized bileaflet prostheses Results: (SF-36) Scores obtained in the SF-36 test were similar in the 2 groups and significantly higher than those of the general Italian population matched for age and gender ($P < .001$ in all domains). Quantitative results NR.	70 (NR)	AVR (79.6%) AVR + CABG (20.4%)	Age-matched general population	3.9 ± 2.7 y	The implantation of 19-mm bileaflet mechanical prostheses in the elderly allowed LV mass regression and a good perceived HRQOL.
Vicchio and colleagues ¹⁴ (2008)	To determine whether changes in prognosis and HRQOL after AVR in octogenarians differ depending on the choice of mechanical or tissue valves Results: (SF-36) NYHA III/IV 70% (preoperative), NR% (postoperative) Mean scores on each SF-36 scale were satisfactory and comparable in the 2 groups. SF-36 scores were significantly higher than those in the general Italian population matched for age and sex on 7 of 8 domains: PF (60-70 vs 40-50); RP (80-90 vs 40-50); BP (90-100 vs 40-50); GH (60-70 vs 40-50); SF (70-80 vs 50-60); RE (80-90 vs 50-60); ME (60-70 vs 40-50). Only VT did not show a statistical difference. Quantitative results NR.	80 (82.3 ± 2.3)	AVR 78%-83.7% AVR + CABG 16.3%-22%	Age-matched general population	3.4 ± 2.8 y	Considering the similar rates of early mortality, the very low rates of valve-related complications in the follow-up with both types of valve substitutes, and the similar perceived HRQOL, mechanical prostheses and tissue valves can both yield satisfactory results in octogenarians.
Maillet and colleagues ⁸ (2009)	To evaluate the immediate and mid-term survival and, most of all, the frailty of patients aged >80 y after an AVR for severe aortic stenosis Results: (NYHA) NYHA III/IV 82.1% (preoperative), 26.8% (postoperative) Some 67.9% of patients had a general self-rated health as excellent or good, and 32.1% reported poor or very poor. Some 76.8% of patients had a self-rated HRQOL that was excellent, very good, or good, and 23.2% reported poor or very poor. Some 66.1% of patients considered that their health had improved since the operation, and 60.7% of patients would undergo another AVR. Three important geriatric parameters were studied: gait problems or falls, ADL, and mood disorders. Some 26.8% of patients experienced a fall at least once during the last year, and 66.1% declared to have gait problems. Only 26.7% needed help for some of their ADLs, and 0% needed help with all ADLs. Only 8.9% were too dependent to live alone, and 17.8% thought that their autonomy was worse than before intervention. Half of the population admitted to having sad ideas, and 33.9% had loss of interest or pleasure. Self-rated HRQOL was significantly associated with all geriatric parameters and cardiac symptoms ($P < .001$).	80 (83.7 ± 3.3)	AVR 58.3% AVR + CABG 41.7%	N/A	723 ± 404 d	AVR for severe aortic stenosis can be achieved with an acceptable postoperative morbidity and mortality rate in octogenarians. There is a good mid-term survival and relief of cardiac symptoms, but this selected elderly population remains frail as assessed by the high rate of geriatric symptoms. Further studies in octogenarians should evaluate the impact of a specific geriatric management on HRQOL and frailty after cardiac surgery.

(continued)

TABLE 3. Continued

Author (year)	Objective	Defined as elderly (mean age, y)	Procedures	Comparison group on generic QOL	Follow-up interval	Conclusions
Aoyagi and colleagues ¹⁸ (2010)	To evaluate surgical outcomes in octogenarian patients undergoing valve surgery Results: (NYHA) NYHA III/IV 81.7% (preoperative), 0.0% (postoperative) Some 97.6% of late survivors reported that their activity level was equal to or better than the preoperative level; 29.3% were capable of doing heavy activity (lifting heavy objects); 48.7% were able to do moderate activity (cleaning); 19.5% were able to do light activity (ADLs); and 2.4% were bedridden. All long-term survivors reported their decision to undergo valve surgery after the age of 80 y was a good choice.	80 (82.3 ± 1.9)	AVR 41.7% AVR + CABG 15% MVR 3.3% Other 40%	N/A	3.4 ± 3.1 y	Valve surgery can be performed in octogenarian patients with acceptable mortality, good long-term results, and good HRQOL. Early referral to surgery is important to obtain a better postoperative outcome.
Ferrari and colleagues ¹⁵ (2010)	To identify predictive risk factors for operative results and to analyze the long-term survival outcome in octogenarians operated for primary isolated AVR Results: (NYHA) NYHA III/IV 48% (preoperative), 0.0% (postoperative) At follow-up, patients were doing well and, in the course of the interview, confirmed a fulfilling HRQOL comparable to the standard HRQOL of nonoperated octogenarians. Quantitative results NR.	80 (82 ± 2.2)	AVR 100%	N/A	6.5 ± NR y	Conventional primary, isolated AVR can be safely performed in octogenarians with acceptable mortality, good long-term survival, and good QOL. In the era of catheter-based aortic valve implantation, open surgery for AVR remains the standard of care for healthy octogenarians, and patients aged >80 y with mid or low operative risk should not be denied the benefit of surgery.
Folkmann and colleagues ²¹ (2010)	To identify HRQOL in octogenarians 1 y after AVR with or without CABG Results: (Own questions) NYHA III/IV NR% (preoperative), NR% (postoperative) Some 42% experienced a minimal restriction in their ADLs; 74% experienced less severe symptoms; 18% had the same intensity, only 8% experienced more severe symptoms after surgery; 5% of patients experienced angina or dyspnea daily, and 52% had no symptoms. The remaining 43% of patients experienced angina ~2 or 3 times per week. Angina did not impair HRQOL in 57% of patients. A further 41% reported mild impairment of their HRQOL, and 2% reported severe restriction of their HRQOL secondary to heart disease. Some 100% of survivors did not regret undergoing surgery.	80 (82.9 ± 2.5)	AVR 46.1% AVR + CABG 53.9%	N/A	1 y	AVR without CABG is associated with a good outcome. The marked improvement in HRQOL after 1 y supports the decision to operate on patients aged >80 y.
Spaziano and colleagues ³⁰ (2010)	To evaluate both long-term functional status and HRQOL after valvular replacement surgery in octogenarians Results: (SF-12, MLHFQ, NYHA) NYHA III/IV 67.1% (preoperative), 5% (postoperative). NYHA functional class improved from 2.7 to 1.4 after surgery. Men showed results similar to those of the age-matched general Canadian population on the PCS and MCS of the SF-12v2. Women were similar to the general population on the PCS, but their scores were significantly lower on the MCS. Women discharged to a convalescence resource had significantly better HRQOL scores than those discharged to home with regard to PCS, the total score of the MLHFQ, and the physical dimension score of the MLHFQ.	80 (80-89)	AVR 36.8% AVR + CABG 48.7% Other 14.5%	Age- and gender-matched general population Male vs female	2.0 ± 1.1 y	Patients aged >80 y benefit from heart valve replacement surgery in terms of both HRQOL and functional status. Women may be at increased risk of a decline in their emotional well-being and may benefit more from convalescence than from discharge to home.

Markou and colleagues ²⁴ (2011)	To investigate changes of HRQOL at 1 y post-CABG and post-AVR in patients aged ≥ 70 y Results: (EuroQOL) NYHA III/IV % (preoperative), % (postoperative) At 1 y postoperatively, the EQ-5D index of the CABG group shows a significant increase, whereas that of the AVR group does not; however, the EQ-VAS registration shows a significant increase for both the CABG group and AVR group. The AVR group improved on pain and discomfort item. The CABG group improved in mobility, pain and discomfort, and anxiety. PDF document unable to be sourced.	70	AVR 40.4% CABG 51.6%	Preoperative vs postoperative of same patients			In elderly patients, HRQOL strongly increases after CABG and AVR; however, the improvement of functional and social HRQOL is less for patients undergoing AVR compared with CABG.
Nikolaidis and colleagues ²⁶ (2011)	To analyze the early and long-term mortality, morbidity, and HRQOL in patients aged ≥ 80 y who underwent AVR alone or combined with CABG Results: (NYHA) NYHA III/IV 56% (preoperative), 12% (postoperative) The majority of the patients were asymptomatic, whereas 13% were experiencing angina. Some 82% had independent personal care; 88.3% had positive feelings about life; and 82% were happy with their decision to undertake the operation.	80 (82.9 $\pm$ 2.3)	AVR 45.5% AVR + CABG 51.6% Other 2.9%	N/A	39.3 $\pm$ 29 mo		AVR can be undertaken with excellent results in octogenarians, and the current risk is significantly lower than what is predicted with conventional risk-scoring systems. Patients of advanced age should not necessarily be excluded from being candidates for AVR.
Oliveira and colleagues ²⁸ (2012)	To review the long-term survival, autonomy, and HRQOL of elderly patients undergoing AVR Results: (Barthel's Index) Some 89.6% of patients were autonomous (BI score ≥ 85), whereas a dependent status (BI score ≤ 60) was observed in 5.2%; 93.5% of patients confirmed having had an improvement in their HRQOL with AVR, and the remaining recognized that they had no additional benefit regarding their QOL.	75 (78.5 $\pm$ 2.5)	AVR AVR + CABG AVR + MVR Other	N/A	47.2 $\pm$ 23.4 mo		At follow-up, most patients achieved improvement of HRQOL and remained autonomous. These results stress that excellent long-term outcomes with AVR can be achieved in appropriately selected elderly patients.

(continued)

TABLE 3. Continued

Author (year)	Objective	Defined as elderly (mean age, y)	Procedures	Comparison group on generic QOL	Follow-up interval	Conclusions
Reynolds and colleagues ⁵⁴ (2012)	To compare health status and HRQOL outcomes for patients with severe aortic stenosis and high surgical risk treated with transcatheter or surgical AVR Results: (SF-12, EQ-5D, KCCQ) NYHA III/IV NR% (preoperative), NR% (postoperative) There are great, highly statistically significant, and clinically meaningful HRQOL improvements at 6 and 12 mo. TF cohort: There are significant benefits for KCCQ summary ($P < .001$), KCCQ physical limitation ($P < .001$), KCCQ total symptoms ($P < .001$), KCCQ QOL ($P < .001$), KCCQ social limitations ($P < .001$), SF-12 physical ($P < .001$), SF-12 mental ($P = .001$), and EQ-5D utility ($P < .001$) scores up to 12 mo. TA cohort: There are significant benefits for KCCQ summary ($P < .001$), KCCQ physical limitation ($P = .008$), KCCQ total symptoms ($P < .001$), KCCQ QOL ($P < .001$), KCCQ social limitations ($P < .001$), SF-12 physical ($P = .008$), and SF-12 mental ($P = .02$) scores up to 12 mo. Please refer to original article for detailed quantitative results.	80 TF (84.6 $\pm$ 6.5) TA (83.2 $\pm$ 5.9)	AVR 100%	Transfemoral transcatheter AVR Transapical transcatheter AVR	0, 1, 6, 12 mo	Both transcatheter and surgical AVR groups experienced substantial improvements at 1 y. This is despite patients being in the highest 5% of surgical risk according to the Society of Thoracic Surgeon Series. Transfemoral transcatheter AVR may be associated with a short- term advantage compared with surgery.
Vicchio and colleagues ³² (2012)	To evaluate the impact on survival and HRQOL of CABG associated with AVR in septuagenarians and octogenarians Results: (SF-36) NYHA III/IV A: 74% B: 74.5% (preoperative), NR% (postoperative) Elderly patients achieved SF-36 scores higher than the general age- and sex-matched Italian population matched population in all domains ($P < .001$): (group A/group B vs general population): PF (66.8/66.6 vs 47.4), RP (86.4/85.8 vs 47.2), BP (93.2/92.7 vs 48.7), GH (64.5/65.2 vs 42.2), VT (62.4/61.8 vs 44.2), SF (80.8/81.3 vs 59.5), RE (90.7/91.2 vs 52.2), and MH (69.8/70.6 vs 53.3).	70 (74.2 $\pm$ 3.6)	AVR 78.1% AVR + CABG 21.9%	Age- and sex-matched general population	4.2 y	Associated CABG determines a significant increase of hospital mortality in the elderly undergoing AVR. Survivors did not show differences in long-term outcome and HRQOL according to the presence of associated CABG.

QOL, Quality of life; HRQOL, health-related quality of life; AVR, aortic valve replacement; CABG, coronary artery bypass grafting; MVR, mitral valve replacement; NYHA, New York Heart Association; SF-36, Medical Outcomes Survey Short Form 36; SF-12, Medical Outcomes Survey Short Form 12; BP, bodily pain; GH, general health; SF, social functioning; RE, role emotional; MH, mental health; VT, vitality; LV, left ventricular; NHP, Nottingham Health Profile; PF, physical functioning; RP, role physical; NR, not recorded; N/A, not applicable; ADL, activities of daily living; MLHFQ, Minnesota Living with Heart Failure Questionnaire; PCS, physical component summary score; MCS, mental component summary score; BI, Barthel's Index; TF, transfemoral cohort; TA, transapical cohort; KCCQ, Kansas City Cardiomyopathy Questionnaire.

TABLE 4. Early mortality in elderly patients after aortic valve replacement

Study	Year	Overall early mortality	Isolated AVR	AVR + CABG
Studies included in this review				
Sundt and colleagues ¹²	2000	11%	8.6%	14.1%
Chiappini and colleagues ¹⁹	2004	8.5%	—	—
Lam and Hendry ²³	2004	8.6%	6.7%	10.7%
Salazar and colleagues ²⁹	2004	14.5%	—	9.1%
Ennker and colleagues ²⁰	2006	6.6%	—	—
Kolh and colleagues ²²	2007	13%	9%	24%
Vicchio and colleagues ³¹	2007	11.8%	—	—
Vicchio and colleagues ⁵³	2008	8.8%	—	—
Vicchio and colleagues ¹⁴	2008	8.8%	8.5%	10%
Maillet and colleagues ⁸	2009	16.7%	10.2%	25.7%
Aoyagi and colleagues ¹⁸	2010	13.3%	—	—
Ferrari and colleagues ¹⁵	2010	5.6%	—	—
Folkmann and colleagues ²¹	2010	7.8%	6.8%	8.8%
Spaziano and colleagues ³⁰	2010	5.6%	—	—
Markou and colleagues ²⁴	2011	—	—	—
Nikolaidis and colleagues ²⁶	2011	4.9%	4.3%	5.4%
Oliveira ²⁸	2012	2.7%	—	—
Reynolds and colleagues ⁵⁴	2012	—	—	—
Vicchio and colleagues ³²	2012	—	7.8%	15.2%
Meta-analysis				
Vasques and colleagues ²	2012	—	6.7%	—

AVR, Aortic valve replacement; CABG, coronary artery bypass grafting.

Vasques and colleagues² recently performed a meta-analysis of 13,216 patients that showed a low overall pooled postoperative mortality of 6.7% in octogenarians undergoing isolated AVR, especially in contemporary series (5.8% for studies published from 2000 to 2006 and 7.5% for studies published from 1982 to 1999). Given low levels of early mortality and excellent long-term survival,^{2,10,13,57} as well as excellent HRQOL, delay or exclusion from surgical intervention based solely on age may deny patients from receiving best practice care. The risk of surgery is better judged by the presence of significant comorbidities, such as renal failure, stroke, and use of an intra-aortic balloon pump.¹³ 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. Some of the important factors are physical and mental ability to withstand the stress of surgery and motivation to improve postoperative lifestyle and participate in rehabilitation.¹⁹

Transcatheter aortic valve implantation has been evaluated for HRQOL benefits, especially in high-risk surgical patients.⁵⁸⁻⁶⁰ Reynolds and colleagues⁵⁴ compared the transcatheter approach with conventional surgical AVR in the highest risk surgical patients according to the Society of Thoracic Surgeons Series. Both transcatheter implantation and surgical AVR led to highly statistically significant and clinically meaningful HRQOL benefits. However, data remain

limited, and more time is required before this procedure becomes an established treatment modality for elderly patients.

The focus is no longer purely about prolonging life, but rather about improving the HRQOL, which is now 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.¹⁷ Information about expected HRQOL allows these patients to have realistic expectations on physical, functional, emotional, and mental welfare. This review demonstrates that there is increasing evidence showing worthwhile gains in regard to HRQOL after AVR in selected elderly patients.

The patients from the 19 articles reviewed span a wide range of developed nations: United States, Canada, Germany, France, Italy, Switzerland, Sweden, Austria, United Kingdom, Australia, Japan, Mexico, and Portugal. Thus, the results of this systematic review are applicable to all developed countries. Both elderly patients and their families can be more confident about the benefits of undergoing AVR when it is required. Moreover, performing surgery in the elderly seems to be cost-effective.²⁴ Larger prospective trials also will be required to further clarify the findings of this systematic review. Nonetheless, given the increasing evidence demonstrating good HRQOL after AVR and a rapidly increasing elderly population, it is imperative that healthcare providers can now more confidently provide AVR to elderly patients.

Review Limitations

We aimed to minimize reporting bias with a comprehensive search of the literature for all studies that meet our eligibility criteria. Despite using multiple online and hospital databases, as well as directly e-mailing authors, there was incomplete retrieval of identified research for 1 article.²⁴ In addition, publication bias may have occurred given that only published data were assessed.

We acknowledge that the level of evidence of this systematic review cannot exceed the level of evidence of the current literature. However, this systematic review adds substantially to the currently available evidence for elderly patients being considered for AVR and builds on the conclusions of nonsystematic narrative reviews.²⁷

Future Direction

This systematic review revealed a heterogeneous data set that is difficult to compare and interpret. The subjective nature of HRQOL means a consistent method of investigation is required. Our recommendations for future studies on HRQOL after AVR are outlined next.

The most important method of accurately determining HRQOL is by using previously validated, reliable, and reproducible HRQOL instruments, such as the SF-36. The study should have a prospective design with predetermined follow-up time points to minimize bias, show HRQOL progression over time, and allow comparison between studies. Consistent measurements should be performed at baseline; 1 and 6 months; and 1, 2, 3, 4, 5, and 10 years. Telephone interviews are preferable, and repeated attempts at contact to minimize loss to follow-up are advisable. Elderly patients should have their preoperative baseline HRQOL scores compared with postoperative scores at each time point. This review demonstrates the benefit of comparing baseline and postoperative HRQOL scores with an age-matched general population. Because it is unethical to deny patients surgery if they are fit for surgery, it may be possible to compare patients who received surgery and those who 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 less comorbidities, so the effect of age can only be ascertained if patients are matched for comorbidities. Patients also should 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 patients undergoing elective surgery, who are more likely to receive AVR in the first place. Finally, multi-center involvement should be organized to increase patient numbers and minimize bias from single-center studies.

CONCLUSIONS

The main findings of this systematic review are that elderly patients have (1) improvement in cardiac symptoms after AVR, (2) equal or better HRQOL compared with an age-matched general population, (3) equivalent or superior HRQOL compared with younger patients who underwent AVR, and (4) significant functional gains after surgery. We highlight the positive impact of AVR on HRQOL of elderly patients. This systematic review should encourage doctors to evaluate potential patients for AVR surgery on the basis of their comorbidities rather than using age as a precluding factor. This review is complete for the current literature, but we 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.

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