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MINIREVIEWS

Quality of life and functional capacity in patients after cardiac surgery intensive care unit

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Abstract

Coronary heart disease and aortic stenosis are prevalent cardiovascular diseases worldwide, leading to morbidity and mortality. Coronary artery bypass grafting (CABG) and surgical aortic valve replacement (SAVR) have therapeutic benefits, including improved postoperative quality of life (QoL) and enhanced patient functional capacity which are key indicators of cardiac surgery outcome. In this article, we review the latest studies of QoL outcomes and functional capacity in patients who underwent cardiac surgery. Many standardized instruments are used to evaluate QoL and functional conditions. Preoperative health status, age, length of intensive care unit stay, operative risk, type of procedure, and other pre-, intra-, and postoperative factors affect postoperative QoL. Elderly patients experience impaired physical status soon after cardiac surgery, but it improves in the following period. CABG and SAVR are associated with increases of physical and mental health and functional capacity in the immediate postoperative and the long long-term. Cardiac rehabilitation improves patient functional capacity, QoL, and frailty following cardiac surgery.

Key Words: Quality of life; Health-related quality of life; Functional capacity; Cardiac rehabilitation; Cardiac surgery; Coronary artery bypass grafting; Heart valve surgery; Heart valve replacement

Core Tip: Health-related quality of life (QoL) and functional capacity are the main indicators of patient outcome after cardiac surgery. Preoperative health condition, age, length of intensive care unit (ICU) stay, operative risk, type of procedure, perioperative complications and comorbidities are the primary determinants of QoL after ICU discharge. Following heart surgery, the physical status of elderly patients is lower than that of younger patients but improves over time. The results of studies of patient health status and functional ability after cardiac surgery reveal significant short- and long-term improvement of QoL and functional capacity. Cardiac rehabilitation has a central role in the recovery of function.

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INTRODUCTION

Cardiovascular diseases are among the leading causes of morbidity and mortality worldwide[1,2]. They account for 17.9 million deaths annually[3], increase in occurrence with age, and coronary heart disease and aortic stenosis are among the most common[4-6]. However, effective prevention, treatment, and management decrease the incidence and the risk of sudden cardiac death[2]. Surgical intervention by coronary artery bypass grafting (CABG) and surgical aortic valve replacement (SAVR), which are primarily performed in elderly patients[7], increase survival, functional status, and quality of life (QoL)[3,8,9]. The current revision of the European Society of Cardiology/European Association for Cardio-thoracic Surgery (ESC/EACTS) recommendations on managing valvular heart disease include considering the patient's anticipated life expectancy and QoL when planning interventions in elderly patients[10].

Elderly patients undergoing cardiac surgery pose a significant challenge as they have a greater incidence of comorbidities and are at a high risk of readmission, mortality, and development of complications. Patients with cardiac procedures and an ICU stay of at least 5 days had a 1-year overall survival rate of 46.2%, and those who were discharged had a 1-year survival rate of 72.4%[11]. In another study[12], the overall survival rate was 67.8% 10 years after surgery. Patients over 75 years of age had lower survival rates than younger patients (44.6% *vs* 74.6%, $P < 0.001$).

QoL is a subjective perception of an individual's well-being, and is influenced by sociocultural factors. The ability to carry out daily activities, including of physical mobility, independence from others, sufficient energy for self-help, social contacts, emotional stability, absence of pain or other symptoms of discomfort, and adequate sleep and rest, are indicators of a high QoL[3,13]. QoL is an important outcome of cardiac surgery as it helps predict surgical success from the viewpoint of both patients and surgeons and it is affected by preoperative and postoperative factors[14]. Following cardiac surgery, patients frequently experience pain, discomfort, depressive symptoms, frailty, a loss of overall well-being, and an inability to return to their pre-procedure level of functioning. These symptoms may considerably reduce QoL.

Functional capacity is also affected postoperatively because respiratory abnormalities may decrease peripheral muscle strength and physical activity[14]. Patients experience decreased muscle strength and functional capacity[15] as well as pulmonary complications such as pneumonia, atelectasis, and pleural effusion after CABG[16]. Improving functional status is a key objective in addition to increasing survival. Early mobilization after cardiac surgery appears limited, with a significant trend to increase over ICU stay, and is related to decreased duration of mechanical ventilation and ICU length of stay[17]. Enrollment in cardiac rehabilitation (CR) programs improves functional capacity and decreases mortality, complications, length of postoperative stay, and readmission rate[18-21]. The benefits of alternative exercise modalities, such as neuromuscular electrical stimulation, are increased muscle strength and improved muscle function, but have no significant effect on functional capacity[22]. The aim of this review is to provide an overview of the most recent findings on QoL and functional capacity in patients after heart surgery.

ASSESSMENT TOOLS

QoL instruments

Health status instruments aim to provide a comprehensive assessment of health-related QoL (HRQoL) and can be used to compare various patient cohorts, conditions, and subsequent treatments (Figure 1). The 36-Item Short-Form Health Survey (SF-36) is a standardized tool for evaluating QoL[23], and offers valuable insights when used in patients undergoing cardiac surgery[4,8,12,24]. It consists of 36 multiple-choice questions measuring eight different health-related dimensions. The scores of each item in every dimension are recorded and transformed into a scale ranging from 0 (worst health status) to 100 (best health status), with increasing scores representing improved QoL outcomes[25]. The 12-Item Short Form Health Survey (SF-12) is another generic health status measure, two-component summary scales of mental

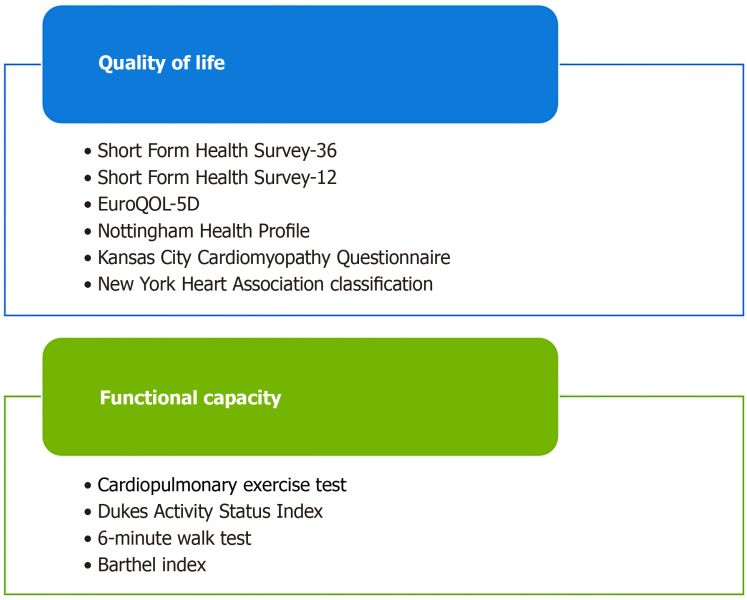

Figure 1 Assessment tools for the evaluation of quality of life and functional capacity.

and physical HRQoL are generated. It includes 12 questions from the original SF-36 health survey, and two-component summary scales of mental and physical HRQoL are generated by scoring, combining, and weighing the standardized responses[26].

The EuroQOL-5D scoring system assesses the cost-benefit or cost-effectiveness of a particular procedure or treatment [4]. It is a descriptive model that characterizes health in terms of five dimensions, namely mobility, self-care, daily activity, pain/discomfort, and anxiety/depression. Each dimension is scored as having no problems, some problems, or extreme problems. The instrument is a self-completed questionnaire that allows respondents to rate their general health on the day of the interview using a vertical visual analog scale with a hash mark system that ranges from 0 to 100, representing the worst and best possible states of health, respectively[27].

The Nottingham Health Profile questionnaire is a generic scale designed to identify indicators of health limitations rather than quantify disease severity. It contains 38 questions grouped into six domains[28]. The Kansas City Cardiomyopathy Questionnaire is a self-administered 23-item questionnaire designed to independently assess a patient's perception of their health status, including heart failure symptoms, impact on physical and social function, and how their heart failure affects their QoL[29].

Functional status assessment

Cardiopulmonary exercise testing (CPET) is considered the gold standard noninvasive assessment of cardiopulmonary disorders, especially heart failure. It evaluates the pulmonary, cardiovascular, muscular, and cellular oxidative responses to exercise. CPET determines maximum exercise capacity by measuring peak oxygen uptake, and has prognostic and diagnostic applicability for cardiorespiratory fitness[30]. It is also an effective means to evaluate the therapeutic benefit of cardiac surgery in patients after CABG[31] or enrollment in CR[21].

The Duke Activity Status Index (DASI) is a self-administered questionnaire used to measure functional capacity[32], and it has been validated in patients with cardiovascular disease[33,34]. A 12-item scale weighs the metabolic costs of daily activities such as personal care, ambulation, household tasks, sexual function, and recreation. The summation of positive responses yields a total score ranging from 0 to 58.2, with higher scores indicating greater functional capacity[32].

The 6-Minute Walk Test evaluates cardiopulmonary functional capacity and is used to determine the effects of therapeutic interventions and prognosis of patients undergoing heart surgery, including CABG and aortic or and mitral valve replacement[15,20,31,34-36]. The test consists of the distance walked as quickly as possible without running for 6 min in a 30-m hallway.

The Barthel mobility index is an ordinal scale that measures the ability to complete activities of daily living. Ten items are scored by summing the points awarded to each daily life skill, such as eating, transferring, grooming, toileting, bathing, dressing, walking, climbing stairs, and incontinence (bladder and bowel). The values range from 0 to 100, with increasing scores indicating improved independence in performing daily activities[11,37,38].

HRQoL

Predictors of QoL

Several studies have investigated the potential risk factors affecting QoL after cardiac surgery. The existing evidence identified 62 preoperative, 5 intra-operative, and 36 postoperative independent predictors of HRQoL shown in Figure 2

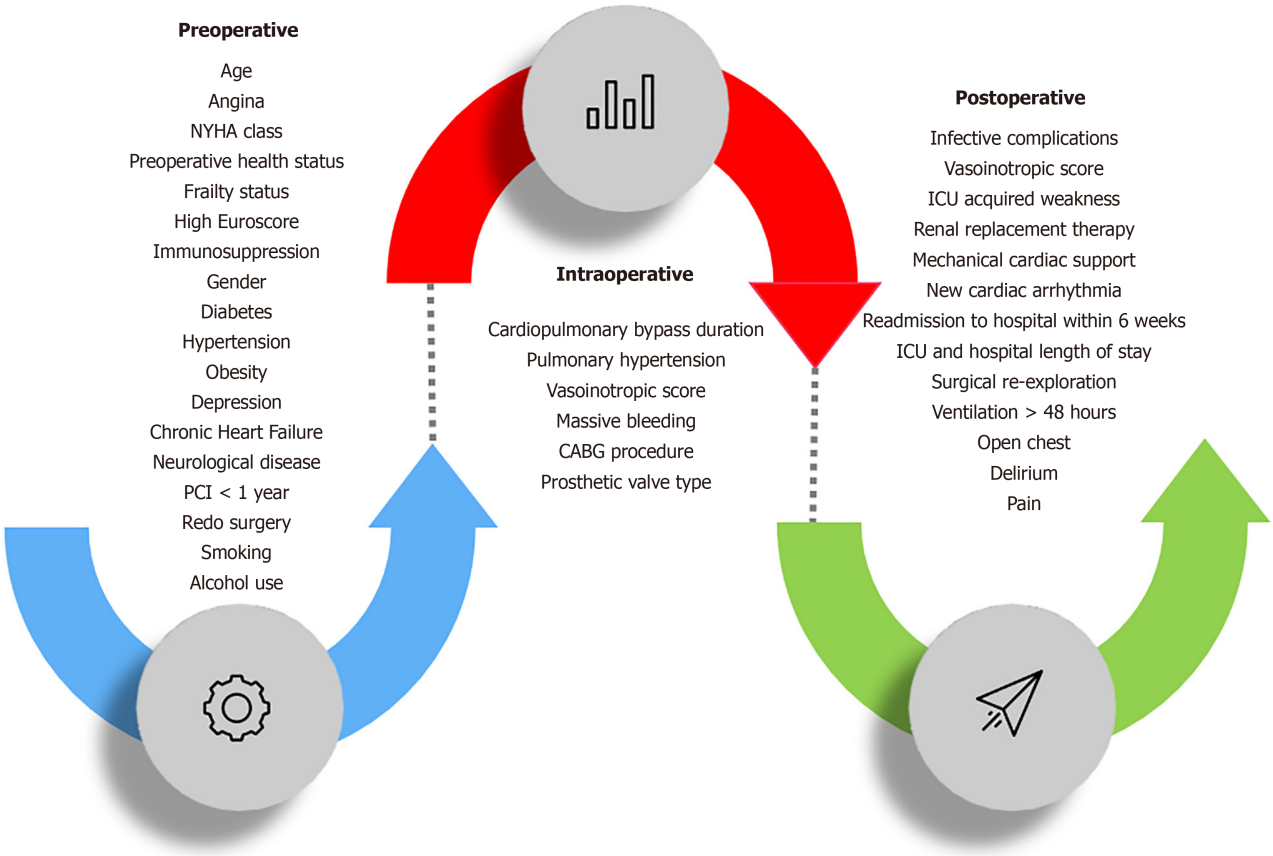

Figure 2 Pre-, intra- and postoperative predictors of health-related quality of life after cardiac surgery. CABG: Coronary artery bypass grafting; ICU: Intensive care unit; NYHA: New York Heart Association; PCI: Percutaneous coronary intervention.

[14]. Alcohol use, body mass index, body weight, depression, preoperative health status, and smoking are potential modifiable predictors of HRQoL outcomes after cardiac surgery[14]. Preoperative health status was identified as a predictor of worsening postoperative HRQoL 1 year after surgery[39]. Low preoperative HRQoL increased the odds of worse physical health after surgery, and improved mental health was associated with better preoperative physical health and worse preoperative mental health[40]. CABG was a predictor of deterioration of mental health, and previous neurological disease was found to be a negative predictor of physical health[39]. Noyez *et al*[41] reported the same correlations between pre- and postoperative QoL, with age and operative risk indicating deterioration of postoperative QoL. On-pump CABG had an effect on QoL similar to that of off-pump procedures 6 months and 18 months after surgery[42, 43] and to that of CR outcomes[44].

Perioperative management with administration of fluid, inotropes, mechanical ventilation strategies, and postoperative secondary preventive care significantly reduces morbidity, mortality, and duration of hospital stay and improves patient QoL[45,46]. In the postoperative period, pain, traumatic memories, and restlessness in the ICU are independent predictors of QoL. Muscle mass shows a trend of decrease in post-cardiac surgery patients and is associated with a prolonged duration of mechanical ventilation and length of ICU stay[47]. Predictors of HRQoL outcome are potentially modifiable[14]. Moreover, the incidence of postoperative delirium and infections is higher in octogenarians after SAVR than in patients younger than 80 years of age. However, there is no difference in operative mortality and long-term survival[7,24].

Recovery time after surgery is an independent predictor of an improvement in HRQoL. Except for the mitral valve, valve replacement predicts improvement of the subscales of physical function and general health. Furthermore, postoperative HRQoL deteriorates with increasing age[8]. The domains of role–physical, body pain, and vitality decrease by a one-third point with every 1 year increase in age. Sex was also a significant predictor, with an average of 13-point less improvement in the role-emotional domain in men than in women[48]. However, Pačarić *et al*[3] found that age, sex, lifestyle, and risk factors did not predict poor QoL in CABG patients after rehabilitation.

QoL and CABG

For elderly patients, functional independence and improved QoL after cardiac surgery may be more important than extending life expectancy. There seems to be a correlation between QoL and patients' age 6 months after CABG[49]. Patients who were 60-69 years of age had the most significant improvement of all QoL domains compared to those < 50, 50-59, and ≥ 70 years of age. Another study found that the trajectories of SF-36 scores revealed that HRQoL and function had improved in the 10 years after cardiac surgery; the improvements of physical and social functioning and role limitations caused by physical problems were smaller in patients older than 75 years of age[12] (Table 1).

Table 1 Characteristics of studies that evaluated patient outcomes after coronary artery bypass grafting and other cardiac surgery

Ref.	Study design	Purpose	Population (*n*)	Male/female; age in yr	Cardiopulmonary bypass time in min/X-clamp time in min	Intervention	Outcomes	Main results
Deschka *et al* [11], 2013	Observational study	To assess survival, functional capacity, and QoL 1 year after cardiac surgery	CABG, HVS, combined procedures, aortic surgery, miscellaneous, emergency procedures (119)	84/35; 72.2 ± 9.3	NA	Barthel mobility index, SF-12 questionnaire	Long-term ICU treatment after cardiac surgery is related to a high in-hospital and follow-up mortality	In-hospital: Mortality was 36.1%, 1-year overall survival was 46.2%, and 1-year survival of the discharged patients was 72.4%. Preoperative Barthel mobility index was 94.7% ± 13.9% *vs* 85.2% ± 23.0% postoperatively. QoL was comparable with the normative population
Peric *et al*[49], 2015	Observational study	To evaluate the changes in QoL 6 months after CABG surgery related to the patients' age	CABG (226)	181/45; 58.3 ± 8.3/61.6 ± 6.1	On pump procedure	NHP questionnaire part 1 before and 6 months after surgery	Improvement of QoL after 6 months in older patients. Age is not an independent predictor of QoL deterioration after CABG	Before CABG elderly patients had worse QoL in sections of PM (r = 0.22, P = 0.001), SI (r = 0.16, P = 0.009) and En (r = 0.23, P = 0.001). After 6 months, patients group < 50 years improved in sections of PM, En, pain, and sleep. Group 60-69 years improved in all sections. Group 50-59 years and ≥ 70 years also improved in all sections except SI and sleep respectively. There was a significant relationship between patient's age and improvement of QoL in sections of PM (r = 0.18, P = 0.008), SI (r = 0.17, P = 0.01) and En (r = 0.21, P = 0.002)
Westerdahl *et al* [51], 2016	Prospective study	To investigate pulmonary function and HRQoL 1 year after cardiac surgery	CABG, HVS, or combined surgery (150)	123/27; 66 ± 9	112 ± 53/84 ± 46	SF-36 questionnaire, pulmonary function measurements	HRQoL improved in comparison to preoperative values. Static and dynamic lung function measurements slightly decreased, levels of pain were low, and saturation of peripheral oxygen was same as preoperatively	HRQoL improved in all 8 aspects of SF-36 (P < 0.001). FVC decreased by 4%-5% compared to preoperative values (P < 0.05). Sternotomy-related pain at rest was 0 (0-7), at deep breath 0 (0-4) and at coughing 0 (0-8)
Gjeilo *et al*[12], 2018	Prospective, observational cohort study	To assess survival, functional status, and HRQoL 10 years after cardiac surgery	Isolated CABG, HVS, CABG with HVS, miscellaneous (274)	228/46; 64.1 ± 9.9	64.0 (range: 16.0-206)/40.0 (5.0-180.0)	SF-36 questionnaire NYHA classification	HRQoL and function improved from before to 10 years after cardiac surgery, also for older patients	Total survival at 10 years was 67.8%. HRQoL improved compared with baseline in 7 of 8 SF-36 subscales. Older patients improved less than younger patients (3 of 8 SF-36 subscales were worse). NYHA classification improved also among older patients (from 59% in NYHA class III/IV at baseline to 30.3% after 10 years, P < 0.013)
Joskowiak *et al* [39], 2022	Prospective cohort study	To assess HRQoL change within 12 months after cardiac surgery and to identify predictors of deterioration in physical and mental health	CABG, AVR, CABG and AVR, aortic surgery, other surgery, redo surgery (164)	123/41; 70 (range: 62-76)	122.9 ± 37.4/81.8 ± 27.6	SF-36 questionnaire upon admission and at 3 months and 12 months after surgery	Gradual improvement of physical and mental health status	PCS score increased from 40.1 (range: 31.9-49.9) before surgery to 46.3 (37.0-52.4) at 3 months and 52.4 (46.4-56.3) at 12 months after surgery. The MCS score increased from 48.8 (38.6-55.3) at baseline to 50.9 (38.9-57.2) at 3 months and 53.1 (42.0-57.8) at 12 months after surgery. Up to 7.9% and 21.2% of patients had poorer PCS and MCS scores respectively at 12 months. Predictors of deterioration in postoperative HRQoL

							are preoperative health status, age < 70 years, CABG and a previous neurological event
Muthukrishnan *et al*[50], 2023	Prospective cohort study	To determine the QoL 3 months after CABG surgery	CABG (200)	184/16; 55 (12.5)	SF-36 questionnaire and STAI scale 2 days before and 3 months after CABG surgery	Improvement in physical health. Preoperative anxiety was a significant predictor of physical health	PCS score was 34.57 ± 9.6 preoperative *vs* 43.53 ± 7 postoperative. MCS score respectively was 54.87 ± 1.19 *vs* 51.65 ± 9.67. Perception of low physical health QoL was due to preoperative anxiety (β = 0.535, t = 8.433, P < 0.001)

AVR: Aortic valve surgery; CABG: Coronary artery by-pass grafting; CAD: Coronary artery disease; En: Energy; FVC: Forced vital capacity; HRQoL: Health-related quality of life; HVS: Heart valve surgery; MCS: Mental component summary; NA: Not available; NYHA: New York Heart Association; PCS: Physical component summary; PM: Physical mobility; QoL: Quality of life; SI: Social isolation; STAI: State-trait anxiety inventory; SF-36: Short-Form Health Survey-36.

Studies of the QoL after CABG have yielded encouraging short-and long-term results. Although preoperative anxiety was a strong predictor of poor HRQoL, patients had greater increases of the level of physical health compared with mental health 3 months after CABG[50]. This is within the range of the findings of another study, where physical and mental component summary scores increased for the majority of patients at 12 months after surgery. However, one-third of patients at 3 months and one-fifth of patients at 1 year did not recover their mental health status[39].

Deschka *et al*[11] assessed survival, functional outcome, and QoL 1 year after discharge from the hospital in patients who had been treated for at least 5 days. The physical and mental health scores in the SF-12 health survey did not differ from a normative sample. HRQoL also significantly increased 1 year after surgery in all eight SF-36 trajectories in 150 patients undergoing CABG, valve surgery, or combined surgery[51]. Long-term positive health status results were also reported by Gjeilo *et al*[12], with improvement of seven of eight SF-36 subscales 10 years after obtaining the baseline values.

QoL and heart valve surgery

QoL after valve surgery has been the focus of interest in many studies. SAVR procedures in octogenarians have low postoperative mortality. However, QoL was found to decrease 30 days after surgery and then improve to or above normal at the 1-year follow-up (Table 2). Additionally, age did not seem to affect physical or mental health during the reported period[24]. Improvement in the QoL of frail patients after 3 months was reported by Kotajarvi *et al*[34], with increases of physical function and physical health of 50% in the DASI and 14% in the SF-12 scores. In the frail compared with non-frail patients, mental health (3.6 points *vs* < 1 point), well-being (21.6 points *vs* 7.1 points), and QoL (25.1 points *vs* 8.7 points) improved significantly in frail compared with non-frail patients.

HRQoL was increased at 6 months after the SAVR procedure except in the bodily pain dimension of SQ-36. The EQ-5D index increased from 0.73 to 0.90, as did the visual analog scale score[25]. At 12 months of follow-up after SAVR and CABG, the results converged, with improvements in QoL within each group[52]. Over 2 years of follow-up the health status of patients with severe aortic stenosis after SAVR also increased considerably[29].

In a study with a follow-up of 5.9 years, there was a noticeable increase across the subscales of the SF-36 except for mental health in patients after heart valve replacement. At 1 year, there was an improvement across all domains except for mental health. At 2 years, health status increased from the preoperative measurement, with mental health being significantly better. However, physical function, role-physical, and role-emotional domains were significantly reduced compared with the 1 year outcomes. After 2 years, all SF-36 trajectories other than mental health showed significant increases compared with the preoperative values[48]. In an observational study of 899 patients, mean physical health

Table 2 Characteristics of the studies reviewed for patients after heart valve surgery

Ref.	Study design	Purpose	Population (*n*)	Male/female (*n*); age in yr	X-clamp time in min	Intervention	Outcomes	Main results
Thomson Mangnall *et al*[48], 2014	Prospective study	To evaluate the HRQoL after heart valve replacement surgery	Rheumatic heart disease (128)	56/72; 26.7 (12.4)	NA	SF-36 questionnaire (preoperatively and 1, 2, and > 2 years postoperatively)	Significant improvement of HRQoL sustained over time	Preoperative HRQoL was impaired but at 1 year postoperative improved across all domains ($P < 0.05$) apart from mental health ($P = 0.081$). At 2 years it remained improved from preoperative measurement, with mental health now significantly better ($P = 0.028$). By > 2 years follow-up all HRQoL domains, except for mental health, were significantly better than preoperative ($P = 0.066$)
Jansen Klomp *et al* [24], 2016	Prospective, observational cohort study	To investigate the influence of age on postoperative outcomes and HRQoL 1 year after SAVR	AS age < 80 (597) and AS age ≥ 80 (163)	363/234 and 85/78; 71 (range: 66-75) and 82 (81-83)	91 (range: 75-111) and 82 (68-107)	SF-36 questionnaire (PCS and MCS score)	Mortality rates were low in group ≥ 80 years and QoL increased towards normal values	In octogenarians, postoperative delirium was 11.0% *vs* 6.2% in < 80 years; $P = 0.034$. Operative mortality was 1.9% *vs* 2.9%; $P = 0.59$. The QoL was impaired 30-days after surgery (PCS = 45.01, $P < 0.001$; MCS = 48.21, $P = 0.04$) but improved towards or above normal values at 1-year follow-up (PCS = 49.92, $P = 0.67$, MCS = 52.55, $P < 0.001$). Age was not associated with a lower PCS ($\beta = 0.08$ per year, $P = 0.34$) or MCS ($\beta = 0.08$ per year, $P = 0.32$) 1 year after surgery
Baron *et al* [29], 2017	Randomized clinical trial	To compare HRQoL among intermediate-risk patients with severe AS treated with either TAVR or SAVR	TAVR (950) and SAVR (883)	1006/827; 81.4 (6.8)	NA	KCCQ, SF-36 questionnaire and EuroQOL-5D at baseline, 1 month, 1 year, and 2 years	Improvement of health status with both TAVR and SAVR at 2 years of follow up	After 2 years of follow up, both TAVR and SAVR showed significant improvements in both disease-specific (16-22 points on the KCCQ-OS scale) and generic health status (3.9-5.1 points on the SF-36 physical summary scale)
Kotajarvi *et al*[34], 2017	Prospective study	To investigate QoL in patients undergoing TAVR or SAVR, and examine the extent to which patient-centered outcomes compare between frail and non-frail patients	AS (103)	61/42; 80.6 ± 7.4	NA	DASI, SF-12 questionnaire and LASA administered before and 3 months after surgery	Frail patients exhibit greater improvement in patients' self-reported outcomes than non-frail patients	Frail patients improved in DASI and SF-12 PCS scores by 50% and 14%, respectively. SF-12 MCS scores improved in frail compared to non-frail participants (3.6 points *vs* < 1 point). Physical well-being and QoL measures also increased in frail compared to non-frail participants (21.6 points *vs* 7.1 points) and (25.1 points *vs* 8.7 points) respectively
Olsson *et al* [25], 2017	Single-center study	To describe patients' self-reported outcomes in terms of physical function, symptoms, dependence, HRQoL, and cognitive function after TAVI and SAVR	TAVI (24) and SAVR (24)	15/9 and 12/12; 81 (range: 60-90) and 80 (61-88)	NA	Katz index of independence in ADL, SF-36 questionnaire, EuroQOL-5D and Mini Mental State Examination on the day before and at 6 months after surgery	No change in cognitive function or dependence and no difference in the size of improvement between groups at 6 months' follow-up	Symptoms reduced, but breathlessness and fatigue remained, especially in the TAVI group. HRQoL was very low in the TAVI group at baseline but increased in all dimensions except social function
Blokzijl *et al* [8], 2021	Observational, multicenter, cohort study	To explore the effect of SAVR on QoL and the variance with age	SAVR (899)	583/316; NA	NA	SF-12 or SF-36 questionnaire at baseline and at 1-year follow-up	Patients after SAVR on average improve in physical and mental QoL	Physical health increased from 55 to 66 and mental health from 60 to 66
Surman *et al*[52], 2022	Prospective study	To report on the prospective outcomes in the areas of depression, QoL, angina, and frailty in SAVR and TAVR patients with AS	TAVR (100), SAVR (100), and CABG (100)	79/21, 80/20, 79/21; 65.94 (11.6), 82.87 (6.9), 65.90 (10.0)	NA		Improvement in PROMs and frailty in all groups by 3 months postoperative regardless of type of surgery	QoL improved within each group over 12 months (P value = 0.0001). Depression between groups (P value = 0.0395) and within each group was significant (P value = 0.0073 for SAVR and 0.0001 for TAVR). Angina was most frequent in TAVR in the QL ($P = 0.0001$) and PL ($P = 0.0007$) domains, and

	improvement was significant in the QL (SAVR P = 0.0010, TAVR P = 0.0001) and PL (SAVR P = 0.0002, TAVR P = 0.0007) domains in both groups. Frailty improved in both groups but was greatest in TAVR (P = 0.00126)

ADL: Activities of daily life; AS: Aortic stenosis; CABG: Coronary artery bypass grafting; DASI: Duke Activity Status Index; HRQoL: Health-related quality of life; KCCQ: Kansas City Cardiomyopathy Questionnaire; LASA: Linear analogue self-assessment; MCS: Mental component score; NA: Not available; PCS: Physical component score; PL: Physical limitation; PROMS: Patient reported outcomes; QL: Quality of life score; QoL: Quality of life; SAVR: Surgical aortic valve replacement; SF-36: Short-Form Health Survey-36; TAVI: Transcatheter aortic valve implantation; TAVR: Transcatheter aortic valve replacement.

evaluated by the SF-36 increased from 55 to 66 and mental health increased from 60 to 66 in 4 years[8].

Functional capacity and cardiac surgery

Patients undergoing cardiac surgery are likely to experience complications such as impaired mobility, worsened functional capacity, and decreased muscle strength. Functional status 1 year after cardiac procedures and long-term intensive care stays were significantly lower than the preoperative scores[11]. Despite that, the findings of recent clinical studies indicate improvement of exercise capacity after CABG or valve replacement[31,53-55]. The DASI score showed a 50% improvement in physical function[34], and a prospective study[12] found that the percentage of New York Heart Association class III/IV patients decreased from 59% to 30.3% 10 years post-cardiac surgery (P < 0.013).

Inspiratory muscle training (IMT) improves exercise capacity, lung function, and inspiratory muscle strength. A recent study reported the beneficial effect of IMT on exercise capacity, respiratory muscle strength, inspiratory muscle endurance, QoL, and laboratory biomarkers in patients after CABG[31]. A study of twice-daily IMT in patients from the third postoperative day until 4 weeks after valve replacement found that inspiratory muscle strength and lung function values were restored to pre-operative values, and functional capacity significantly increased[9]. A similar study found improvements in lung function, inspiratory pressure, and functional capacity 6 months after mitral valve replacement surgery[35]. The results of that study agree with the report by Cordeiro *et al*[56] in which, after cardiac surgery, patients underwent respiratory muscle training, conducted twice daily from the ICU discharge until hospital discharge. However, a recent randomized and controlled pilot trial conducted by the same research group[15] found that IMT did not provide greater benefits than usual care for improving functional capacity in patients after CABG. Nonetheless, the study did show that IMT led to a reduction in pulmonary complications and shortened hospital stays.

CR and cardiac surgery

CR and physical activity after cardiac surgery decrease morbidity and frailty and improve QoL and physical and cognitive disorders. CR after coronary artery revascularization is a Class IA recommendation of the ACC/AHA/SCAI guidelines. The evidence supports exercise rehabilitation to decrease hospitalizations and increase functional capacity, exercise tolerance, and HRQoL[57]. However, many patients remain (49.5%) or become (39.0%) physically inactive after cardiac surgery[58]. A CR program includes a number of interventions such as patient assessment, education regarding medical adherence and cardiovascular risk management, dietary recommendations, psychosocial support, behavior modification, personalized exercise training, and physical activity counseling[57,59]. After cardiac surgery, the patient must resume optimal functioning to carry out daily activities and adopt a healthy lifestyle for a lifetime. Therefore, short- and long-term goals are essential components of CR[60]. The program should be prescribed either before hospital discharge or at the initial outpatient visit[57]. In the acute phase[60], rehabilitation includes early mobilization during hospitalization, within the first 24 h[61]. Mobilization includes active-passive range of motion exercises, changing

position, respiratory physiotherapy, neuromuscular electrical stimulation, and virtual reality training[60-63].

After discharge from the hospital, outpatient care and maintenance incorporates supervised progressive exercise that is center- or home-based and performed either face-to-face or in an alternative model, patient education, and behavior modification[64]. The optimal type of exercise, intensity, and duration are tailored to safety and effectiveness criteria[57]. The appropriate dose of exercise is defined by individual tolerance and clinical efficacy, and cardiopulmonary exercise testing combined with echocardiography are used for clinical assessment and risk stratification[30]. Training sessions vary in intensity (50%-95% of peak heart rate, heart rate reserve, or exercise capacity), modality (cycle ergometer, treadmill walking, circuit training, cross-country skiing, and ball games), and duration (20-80 min per session including warm-up and cool-down exercises)[64]. The costs and effectiveness of home- and center-based CR for QoL improvement are comparable[57].

Patients undergoing transcatheter aortic valve intervention or SAVR benefit similarly from CR[38]. In phase II CR, the QoL of CABG patients was found to be significantly correlated with either peak oxygen uptake or functional aerobic impairment by previous studies[65,66]. An early CR exercise program including active range-of-motion exercises from the day following heart valve surgery until hospital discharge improved physical function[67]. Similarly, 3 weeks of bicycle exercise, walking, and strength training combined with education and psychological support begun before discharge increased functional and emotional status after aortic valve replacement[68].

A 36-session outpatient CR program of physical exercise, lifestyle modification, and pharmacotherapy also benefited patients after CABG. The 12-week program improved QoL and exercise tolerance and mitigated cardiac risk factors in 370 patients with diabetes and 942 without diabetes[69]. A prospective study of the QoL of patients before cardiac surgery, 1 month after surgery, and after CR[3] found that patients had a low QoL before surgery and had low scores in all subscales other than social functioning. One month after surgery, the subscale scores had improved but still indicated an unsatisfactory QoL. One year following surgery, almost all subscales were satisfactory. After rehabilitation, there was a considerable improvement in all trajectories of the SF-36, with the highest increase in score for the change in physical pain and the lowest score in the area of physical role functioning.

CONCLUSION

This overview of recently published studies reveals the significance of QoL and functional capacity as key outcome measures for patients after cardiac surgery. After undergoing cardiac surgery, it is recommended that all patients be assessed with standardized assessment tools such as the EQ-5D, SF-36, and DASI to determine their QoL and functional capacity. Most patients significantly improve their physical and mental status capacity. With increasing age, patients are at higher risk of experiencing a deterioration of postoperative QoL and slow functional recovery. Pre-, intra-, and postoperative risk factors should be identified early, prevented, and treated to improve QoL and functional capacity after cardiac surgery. Evidence of the benefits of rehabilitation on improving cardiorespiratory fitness and cardiovascular function are clear and undeniable. Therefore, systematic efforts to implement national guidelines regarding the management of cardiovascular health, high referrals to CR programs, adherence, and compliance comprise an excellent strategy to increase patient participation.

FOOTNOTES

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