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Relation between Quality of Recovery in Hospital and Quality of Life at 3 Months after Cardiac Surgery

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Background: **Improved quality of life (QoL) is a desirable outcome of cardiac surgery. The aim of the current study was to measure the association between quality of recovery 3 days after surgery and QoL measured 3 months later.**

Methods: **After obtaining ethics committee approval and consent, 120 adult cardiac surgical patients were studied. A 40-item quality of recovery score (QoR-40) was used to measure postoperative health status on days 1–3 and 1 month after surgery. QoL was measured using the short-form health survey (SF-36) at 1 and 3 months after surgery. The effect size (Δmean/SD) was used to define responsiveness, a clinically important difference in health. Associations were measured using correlation and reliability coefficients.**

Results: **There was a significant change in the mean QoR-40 for up to 1 month after surgery ($P < 0.0005$). QoL was improved at 3 months ($P < 0.0005$) but not 1 month ($P = 0.29$) after surgery. There was a moderate correlation between day-3 QoR-40 and 3-month SF-36 ($r = 0.39$; $P < 0.0005$). A poor-quality recovery in hospital predicted a poor QoL at 3 months (adjusted odds ratio, 4.20; 95% confidence interval, 1.41–12.5; $P = 0.01$).**

Conclusions: **The QoR-40 is a valid measure of quality of recovery after surgery and anesthesia. When compared with the SF-36, it is a better measure of early postoperative recovery. A poor-quality recovery on the days after surgery can predict a poor QoL at 3 months after surgery. This may allow earlier and more effective support strategies while patients are still in the hospital (counseling, home assistance, local doctor notification, cardiac rehabilitation).**

EVALUATION of outcome after cardiac surgery has traditionally centered on measurement of complication and mortality rates,[1] yet quality of life (QoL) measures are being increasingly used as important, broader estimates of subsequent health status.[2–4] A patient's immediate postoperative health status is also of interest. We previously developed a 40-item quality of recovery score (QoR-40),[5] designed to measure a patient's health status after surgery and anesthesia. Its psychometric properties were found to be acceptable: (1) convergent validity between QoR-40 and a 100-mm visual analog scale ($r = 0.68$; $P < 0.001$); (2) test–retest reliability (intraclass $r_i = 0.92$; $P < 0.001$); and (3) internal consistency (Cronbach $\alpha = 0.93$; $P < 0.001$).

The aim of the current study was to measure, in cardiac surgical patients, the association between quality of recovery in the days after surgery with QoL measured up to 3 months postoperatively. A secondary aim was to further evaluate the QoR-40 in cardiac surgical practice.

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Methods

After obtaining ethics committee approval and informed consent, 120 adult cardiac surgical patients were studied. Patients were excluded if they had poor English comprehension, dementia or current psychiatric disturbance, a known history of drug dependence, or an unstable clinical condition that, in the opinion of the investigators, was a current threat to life.

Patient demographic and perioperative data were collected. These included ventricular function, surgical risk status (using the Tu score[1]), type of surgery, cross-clamp time, hemodynamic function, duration of mechanical ventilation, and length of stay.

Postoperative Complications

Postoperative complications were defined as follows:

1. Respiratory: postoperative mechanical ventilation for more than 24 h or pneumonia, defined as pulmonary infiltrate with positive microbial cultures;
2. Cardiac: arrhythmia requiring treatment with antiarrhythmic medication or electrical cardioversion reversion; radiologic evidence of pulmonary edema; or myocardial infarction, defined by new Q waves on electrocardiogram or creatine kinase-MB isoenzyme concentration greater than twice normal;
3. Renal: acute renal failure, defined by serum creatinine concentration greater than 200 μM;
4. Neurologic: stroke, defined as a new central neurologic deficit;
5. Sepsis: wound infection requiring excision of tissue or antibiotic therapy, or positive microbial culture (other than pneumonia).

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Health Status Instruments

The short-form health survey (SF-36)[6] is a 36-item health status questionnaire measuring eight dimensions of QoL: physical functioning (10 items), role limitations caused by physical problems (4 items), bodily pain (2 items), social functioning (2 items), mental health (5 items), role limitations caused by emotional problems (3 items), vitality–energy/fatigue (4 items), and general health perception (5 items). There is also a single item about perceptions of health changes over the previous 12 months, which provides a useful measure to assess physical and mental constructs of health. Each dimension has a possible score of 0 (poor health) to 100 (excellent health). The SF-36 has been evaluated in US[6] and Australian[7] populations, and we and other investigators have used it to assess QoL after cardiac surgery.[8–10] It is a widely accepted measure of health-related QoL.

The QoR-40[5] is a 40-item quality of recovery score measuring five dimensions: physical comfort (12 items), emotional state (9 items), physical independence (5 items), psychological support (7 items), pain (7 items) (see Web Enhancement). Each item is rated on a five-point Likert scale (for positive items: 1 = none of the time, 5 = all of the time; for negative items, the scoring was reversed). The QoR-40 has a possible score of 40 (extremely poor quality of recovery) to 200 (excellent quality of recovery). It was specifically designed to measure a patient's health status after surgery and anesthesia and has been proposed as a measure of outcome in clinical trials.[5]

Aspects of preoperative baseline health status were measured using the QoR-40 and SF-36. The QoR-40 was repeated on postoperative days 1, 2, and 3 (where day of surgery = day 0), and the QoR-40 and SF-36 were repeated at 1 and 3 months after surgery. In the hospital, patients were briefly interviewed and asked to complete their questionnaires, which were collected by one of the investigators when completed. Patients unable to complete the questionnaires independently were asked for verbal responses to each item by one of the investigators. After discharge from the hospital, patients were contacted by telephone in the days preceding a mailing. They were then contacted again to ensure they had received the questionnaires, were able to complete all sections, and were then reminded to return their forms in a supplied self-addressed envelope. Incomplete or outstanding forms were followed up with a further telephone call.

Duration of stay in the intensive care unit was from the time of admission after surgery until discharge to the cardiac surgical ward. Duration of stay in hospital was defined from the time of surgery until hospital discharge and was rounded up to the nearest day.

Statistical Analysis

Demographic and perioperative data are presented as mean (SD), median (interquartile range) or number (%). Selected data are presented as mean (95% or 99% confidence intervals).

Associations between each of the dimensions of the QoR-40 and SF-36 are presented as a correlation matrix. Associations were measured using Pearson correlation coefficients (r). The primary comparison was the association between the QoR-40 on postoperative day 3 and the sum of the dimensions of the SF-36 (global SF-36) at 3 months. Construct validity of the QoR-40 was assessed by its relation with aspects of postoperative recovery (duration of mechanical ventilation, complications, length of stay) and with an interdimension matrix. Univariate odds ratios were also calculated to describe the association between postoperative complications and a poor quality of recovery at 1 month. Internal consistency was assessed by Cronbach α.[3,11]

Responsiveness is the ability to detect a meaningful change in health status[3,12] and can be measured using the standardized response mean, calculated as the mean change divided by its SD.[3,12] We used the preoperative interview to determine baseline health status for the QoR-40 and SF-36 and compared these with the QoR-40 at day 3 and SF-36 at 1 month, respectively. Standardized response means of 0.2, 0.5, and 0.8 correspond to small, medium, and large changes in health status.[13] Changes over time were analyzed using general linear models.

For each dimension of the QoR-40 and SF-36, impairment was defined if an individual score was less than 1 SD below the group mean. A poor quality of recovery and poor QoL were defined by impairment in two or more dimensions or impairment of the global QoR-40 and SF-36, respectively. Univariate predictors of a poor QoL at 3 months were identified using Mann–Whitney U or chi-square tests; significant ($P < 0.1$) factors were used in logistic regression analyses. Separate multiple logistic regression models were developed to determine associations with QoL separately for preoperative factors, and with intraoperative and postoperative factors. A similar approach was used for identifying predictors of quality of recovery on day 3. Logistic regression was used to calculate adjusted odds ratios to describe the association between a poor quality of recovery and a poor QoL. Receiver operating characteristic curves were also analyzed for the poor QoL–diagnostic properties of the QoR-40.

All statistical analyses were performed using SPSS for Windows V9.0 (SPSS Ltd., Chicago, IL). A P value less than 0.05 was considered significant; no correction was made for multiple comparisons.

Results

We recruited 120 cardiac surgical patients (table 1); a further five patients declined participation. All patients were available for interview on postoperative day 3, and

Table 1. Patient and Perioperative Characteristics

Variable	
Age (yr) [mean (SD)]	63 (9.7)
Male/Female (%M)	93/27 (78)
Weight (kg) [mean (SD)]	81 (15)
Type of surgery [n (%)]	
CABG	95 (79)
Valve	17 (14)
Combined and other	8 (7)
Preoperative medications [n (%)]	
Nitrates	62 (52)
β Blockers	67 (56)
Ca^{2+} antagonists	43 (36)
Intravenous heparin ± nitrates	10 (8.3)
Tu Score (1) [median (IQR)]	2 (1–4)
Baseline QoR-40 [mean (SD)]	181 (14)
Cross-clamp time (min) [mean (SD)]	64 (25)
Duration of surgery (h) [mean (SD)]	4.3 (1.1)
Time to tracheal extubation (h) [median (IQR)]	7.2 (5.2–10.7)
Duration of ICU stay (h) [median (IQR)]	23 (11–40)
Duration of hospital stay (days) [median (IQR)]	6.4 (5.2–9.2)
Prebypass hemodynamic data [mean (SD)]	
Heart rate (beats/min)	63 (12)
Mean BP (mmHg)	72 (10)
PCWP (mmHg)	11 (4)
Cardiac index ($l \cdot min^{-1} \cdot m^{-2}$)	2.22 (0.49)
ICU admission hemodynamic data [mean (SD)]	
Heart rate (beats/min)	86 (11)
Mean BP (mmHg)	77 (13)
PCWP (mmHg)	12 (3)
Cardiac index ($l \cdot min^{-1} \cdot m^{-2}$)	2.97 (0.71)
Postoperative complications [n (%)]	
Respiratory	7 (5.8)
Cardiac	45 (38)
Stroke	3 (2.5)
Sepsis	33 (28)
Acute renal failure	3 (2.5)
Any major complication	69 (58)

CABG = coronary artery bypass graft; IQR = interquartile range; QoR-40 = 40-item quality-of-recovery score; ICU = intensive care unit; BP = blood pressure; PCWP = pulmonary capillary wedge pressure.

108 were available at 3 months after surgery (missing data: 1 underwent esophagectomy, 3 refused further participation, 8 patients were lost to follow-up). Overall, 69 patients (58%) had one or more postoperative complications (table 1); there were no deaths. Hemodynamic data are presented in table 1.

When compared with preoperative values, there was a significant change in the mean QoR-40 for up to 1 month after surgery ($P < 0.0005$) and for QoL at 3 months ($P < 0.0005$) but not 1 month ($P = 0.29$) after surgery (fig. 1). Relative to age norms,[6,7] cardiac surgical patients had low ratings across all SF-36 dimensions preoperatively, yet they had regained or exceeded age norms at 3 months after surgery.

There was a moderate correlation between the day-3 QoR-40 and the 3-month SF-36 ($r = 0.39$; $P < 0.0005$). A significant correlation was preserved even after accounting (by exclusion) for similar dimensions. Stepwise linear regression identified the preoperative QoR-40 and day-3 QoR-40 ($R = 0.52$; $P < 0.0005$), but not the

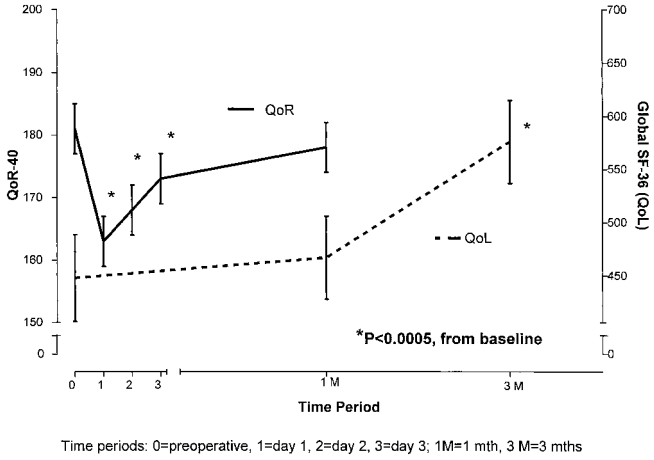

Fig. 1. Mean (99% confidence interval) change in perioperative health status. The 40-item quality of recovery score (QoR-40) measures quality of recovery, and the short-form health survey (SF-36) measures quality of life (QoL).

preoperative SF-36 ($P = 0.37$), as significant predictors. Perioperative factors associated with a low QoR-40 on day 3 included longer duration of surgery ($P = 0.016$), respiratory complications ($P = 0.039$), and increased length of stay in hospital ($P = 0.032$). Postoperative complications were associated with a poor quality of recovery at 1 month (table 2).

The QoR-40 and SF-36 demonstrated good internal consistency. For QoR-40, preoperative $\alpha = 0.81$, day-1 $\alpha = 0.64$, day-2 $\alpha = 0.66$, day-3 $\alpha = 0.75$, 1-month $\alpha = 0.82$, and 3-month $\alpha = 0.81$ (all $P < 0.0005$). For SF-36, preoperative $\alpha = 0.84$, 1-month $\alpha = 0.87$, and 3-month $\alpha = 0.90$ (all $P < 0.0005$). The QoR-40 had excellent responsiveness in the days after surgery, and the SF-36 at 3 months postoperatively (table 3). Physical function was identified *a priori* as a particularly relevant indicator and had high responsiveness (table 3).

The interdimension correlations of the QoR-40 and SF-36 are presented in tables 4 and 5.

Perioperative predictors of a poor QoL at 3 months are presented in table 5. Univariate analysis did not identify any preoperative factors, including the Tu risk score.[1] Multivariate logistic regression identified the QoR-40 as the only significant predictor ($P < 0.003$). Patients with a poor QoL at 3 months had lower mean QoR-40 on day

Table 2. Association Between a Poor Quality of Recovery at 1 Month and Postoperative Complications

Complication	Univariate OR (95% CI)	*P* Value*
Respiratory	7.94 (1.23–51.2)	0.012
Cardiovascular	1.88 (0.71–5.0)	0.21
Sepsis	2.12 (0.77–5.85)	0.14
Stroke	2.37 (0.20–27.5)	0.48
Acute renal failure	10.1 (0.87–118)	0.025
Any major complication	7.72 (1.49–19.8)	0.005

* Chi-square test.

OR = odds ratio; CI = confidence interval.

Table 3. Mean (SD) Change in Perioperative Health Status

Instrument (Maximum Score)	Preoperative	Postoperative								
		Day 1	SRM	Day 2	SRM	Day 3	SRM	1 Month	SRM	3 Months	SRM
QoR-40 dimensions											
Physical comfort (60)	54 (5.0)	49 (6.4)		49 (5.6)		51 (5.8)		53 (6.2)		54 (5.4)	
Emotional state (45)	38 (5.2)	38 (6.1)		38 (6.1)		38 (5.8)		38 (5.9)		39 (5.7)	
Physical independence (25)	23 (3.0)	12 (4.1)	−2.13	15 (4.7)	−1.36	18 (4.8)	−0.90	23 (2.5)	−0.07	24 (2.2)	+0.30
Psychological support (35)	34 (2.2)	33 (4.5)		33 (4.1)		33 (4.1)		33 (3.8)		33 (2.6)	
Pain (35)	33 (2.6)	31 (3.1)		31 (2.9)		32 (3.0)		32 (3.0)		32 (3.2)	
Global QoR-40 (200)	181 (14)	163 (16)	−0.94	167 (16)	−0.77	172 (17)	−0.47	178 (17)	−0.18	182 (15)	+0.05
SF-36 dimensions											
Physical function (100)	51 (26)	—		—		—		56 (22)	+0.20	72 (25)	+0.73
Role—physical (100)	28 (38)	—		—		—		25 (36)		51 (43)	
Bodily pain (100)	62 (25)	—		—		—		61 (22)		74 (24)	
General health perceptions (100)	62 (20)	—		—		—		69 (21)		72 (21)	
Vitality (100)	48 (24)	—		—		—		55 (21)		66 (21)	
Social function (100)	63 (32)	—		—		—		67 (29)		81 (25)	
Role—emotional (100)	55 (44)	—		—		—		52 (44)		73 (40)	
Mental health (100)	73 (17)	—		—		—		75 (18)		81 (18)	
Global SF-36 (800)	442 (159)	—		—		—		460 (152)	+0.10	569 (166)	+0.66

The 40-item quality-of-recovery score (QoR-40) measures quality of recovery, and the 36-item short form (SF-36) measures quality of life. The standardized response mean (SRM) is referenced to the change from baseline health status.

SRM = Δ mean score/SD.

3: 166 (95% confidence interval, 161–171) *versus* 176 (95% confidence interval, 172–180) ($P = 0.004$; fig. 2). A poor-quality recovery was associated with a poor QoL (table 6). The positive and negative predictive values were 62 and 70%, respectively. The area under the receiver operating characteristic curves for the day-3 QoR-40 and 1-month QoR-40 were 0.67 and 0.80, respectively.

Discussion

Our study demonstrates that the QoR-40 was significantly correlated with the SF-36, an extensively validated measure of health status.[6–10] Lower QoR-40 scores were associated with longer duration of surgery, postoperative complications, and increased length of stay in hospital. The QoR-40 was reliable (internal consistency) and able to measure meaningful changes in health (responsiveness) in patients recovering from cardiac surgery. The QoR-40 was identified by regression analyses and risk estimates as a highly significant predictor of a poor QoL.

We found that cardiac surgery is associated with marked improvement in functional status and ability of patients to overcome physical and emotional problems associated with coronary artery or valvular heart disease. However, not all patients benefit from surgery, and the most reliable predictor of a poor QoL was a poor quality of recovery after surgery. The QoR-40 can quantify re-

Table 4. Interdimension Correlations for the Postoperative Day 3 QoR-40 (Internal Consistency, $\alpha = 0.75$) and the 3-Month SF-36 (Internal Consistency, $\alpha = 0.90$)

	QoR-40	1	2	3	4	5
QoR-40 dimensions						
1. Emotional state	0.81	—				
2. Physical comfort	0.83	0.68	—			
3. Psychological support	0.63	0.29	0.32	—		
4. Physical independence	0.70	0.36	0.37	0.58	—	
5. Pain	0.50	0.38	0.42	0.05	0.16	—

	Global SF-36	1	2	3	4	5	6	7	8
SF-36 dimensions									
1. Physical functioning	0.67	—							
2. Role—physical	0.81	0.45	—						
3. Bodily pain	0.71	0.54	0.51	—					
4. General health	0.77	0.46	0.49	0.58	—				
5. Vitality	0.85	0.56	0.63	0.53	0.69	—			
6. Social functioning	0.80	0.54	0.59	0.58	0.59	0.66	—		
7. Role—emotional	0.77	0.35	0.56	0.36	0.50	0.60	0.50	—	
8. Mental health	0.67	0.30	0.40	0.31	0.59	0.60	0.49	0.59	—

Table 5. Univariate Predictors of Poor Quality of Life at 3 Months

	P Value
Preoperative factors	
Age	0.25
Gender	0.30
Marital status	0.66
Type of surgery	0.94
Number of grafts	0.67
Tu score (1)	0.34
Prebypass cardiac index	0.71
Intraoperative and postoperative factors	
Cross-clamp time	0.73
Duration of surgery	0.72
Postoperative cardiac index	0.071
Time to tracheal extubation	0.72
Duration of ICU stay	0.19
Duration of hospital stay	0.14
Day 3 QoR-40	0.003
Emotional state	0.015
Physical comfort	0.023
Psychological support	0.070
Physical independence	0.024
Pain	0.073
Postoperative complications	
Respiratory	0.015
Cardiovascular	1.00
Stroke	0.045
Sepsis	0.49
Acute renal failure	1.0

ICU = intensive care unit; QoR-40 = 40-item quality-of-recovery score.

covery after cardiac surgery, represented by an increase in QoR-40 for up to 1 month after surgery. Thus, the QoR-40 describes aspects of the recovery process after surgery, but at 1 month there is yet to be a significant improvement in QoL. This was demonstrated at 3 months by an increase in most dimensions of the SF-36.

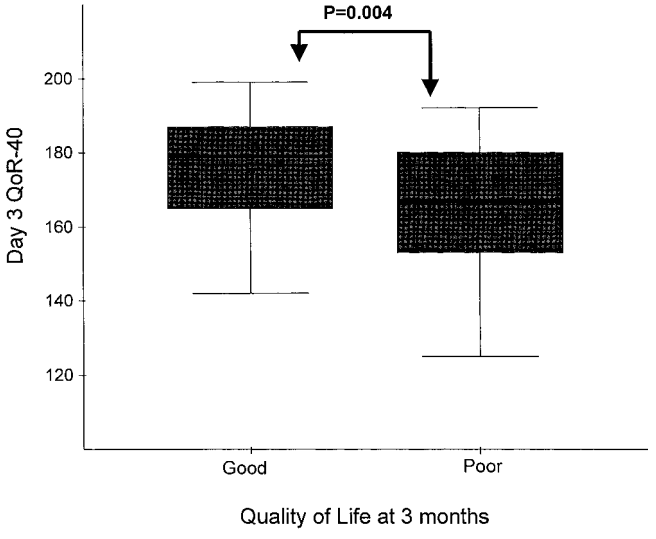

Fig. 2. Box plots of the day-3 40-item quality of recovery score (QoR-40) in patients who have a good or poor quality of life at 3 months after cardiac surgery. The box represents the interquartile range, the horizontal line the median, and whiskers the 10th and 90th percentiles.

Table 6. Association between Quality of Recovery (QoR) and a Poor Quality of Life at 3 Months after Surgery (Incidence 36%)

	Incidence	Univariate OR (95% CI)	Adjusted OR (95% CI)
Poor QoR (day 3)	20%	3.81 (1.41–10.3) $P = 0.01$	4.20 (1.41–12.5) $P = 0.01$
Poor QoR (1 month)	18%	48.7 (6.11–389) $P < 0.0005$	77.6 (8.86–679) $P = 0.0001$

Risk estimates (odds ratios [OR]) were adjusted for age and postoperative cardiac index using logistic regression.

CI = confidence interval.

Postoperative complications may impair a good-quality recovery, demonstrated by an association between QoR-40 and an increased length of stay in intensive care unit and hospital. Our results support construct validity, predictive ability, and responsiveness of the QoR-40.

Quality-of-life measures are intended to represent most, if not all, aspects of a patient's health status and have gained importance in clinical research.[4,14,15] QoL should be rated from the patient's perspective and include subjective items that are relevant to them. Any dimension may be nominated by an individual patient as most important for them, and efforts can then be made to specifically address that aspect of care. QoL, measured by the SF-36, is associated with quality of recovery, measured by the QoR-40. This supports the notion that a poor-quality recovery after surgery can predict a poor QoL at 3 months after surgery. The day-3 QoR-40 performed slightly better than the preoperative QoR-40 or SF-36. The day-3 QoR-40 may therefore be used to identify patients with a poor QoL earlier and lead to initiation of supportive strategies while they are still in the hospital (patient and family counseling, home assistance, local doctor notification, and arrangement for additional cardiac rehabilitation).

The resultant psychometric indices of QoR-40 in this study would have been lessened by effective clinical care aimed at maintaining dimensions of perioperative health status. Thus, unwell patients would have continued to receive support and had their comfort optimized, and this may explain the reduced correlations with the dimensions of pain and psychological support observed in this study. Our previous study[5] found higher indices in a heterogeneous surgical population experiencing greater extremes of comfort and mobility.

Health status instruments can be used for discrimination, prediction, or evaluation.[3] It is the intended purpose of the instrument that determines how it should be evaluated, and it is advisable that a specific instrument be selected for a specific purpose.[3,14,15] Predictive indices are intended to identify patients whose health status changes. Evaluative indices are used to measure a change in health status, and so their responsiveness is an essential characteristic.

We have shown that the QoR-40 is responsive, particularly in the dimension of physical function, perhaps the most relevant aspect of recovery after cardiac surgery. It was expected that there would be minimal changes in other dimensions, given the continued level of support patients received throughout their recovery; this was also noted with some dimensions of the SF-36.

Cardiac surgery improves QoL in those with significant cardiac disease,[8–10,15] but it should be recognized that this is not the case for approximately 20% of patients.[8,14] Some of this has been attributed to neurocognitive deficits associated with cardiac surgery,[16] and this can impact on QoL.[10] Participation in a cardiac rehabilitation program has proven benefits[17,18] and can improve QoL.[10] Our study could not identify any preoperative or postoperative factors associated with QoL at 3 months, other than the QoR-40. Similarly, cardiologist clinical judgment scales[9] and exercise testing[15] cannot identify patients who have a poor QoL. Interestingly, and consistent with our study, psychological factors may be the most useful predictors of QoL after cardiac surgery.[14]

Limitations of the Study

We combined the dimension scores of the SF-36 as a global measure of QoL. We recognize that this approach has not been validated; it was used only to provide an overall estimate of QoL. The QoR-40 and SF-36 contain similar items and dimensions that will assist their correlation. Indeed, because they represent similar psychosocial aspects, they should be correlated. However, multivariate regression identified that the day-3 QoR-40, and not the preoperative SF-36, had the strongest predictive ability. When we removed same dimensions, we found that a correlation persisted, indicating true predictive ability. The QoR-40,[5] in contrast to the SF-36,[6] was developed to measure early postoperative health status and is therefore more appropriate to use in the days after cardiac surgery. Twelve patients were not available at the 3-month interview; therefore, their results may differ from the remaining cohort. Our study was exposed to several sources of bias, which we dealt with by maximizing recruitment and follow-up rates (90%), and by using interviewers who were not directly involved in the clinical care of the participants. The many comparisons in this study may lead to false conclusion of significance; therefore, borderline results should be interpreted with care. Serious complications (*e.g.*, stroke) can be expected to have a potent effect on QoL, but these are generally uncommon events. Our study did not have sufficient power to derive precise estimates of such factors. Other complications were transient and may not, of themselves, have had any direct effect on QoL (*e.g.*, mechanical ventilation > 24 h). However, they may be a marker of other factors that do and so are correlated with poor QoL. The important finding in our study was that the QoR-40 was a more reliable predictor of poor QoL.

This study has provided further validation of the QoR-40. We found that QoL is improved at 3 months after cardiac surgery. At 1 month, most patients had recovered from surgery but had not yet regained their QoL. A poor QoL can be predicted by a poor quality of recovery in the days after surgery. This may allow earlier and more effective interventions that could improve the outcome of patients undergoing cardiac surgery.

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