Preoperative Quality of Life as a Predictive Factor of 3-Year Survival After Open Heart Operations

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Background. **The aim of this prospective study was twofold: to determine the evolution of quality of life in heart surgery patients through the first 3 postoperative years using the Nottingham Health Profile questionnaire and to determine whether preoperative quality of life influences 3-year survival.**

Methods. **From January to July 1994, 215 patients underwent elective open heart operation in our department. Patients filled in the Nottingham Health Profile questionnaire five times: preoperatively, postoperatively at month 3, and at each anniversary of their operation for 3 years. The evolution of quality of life scores through time were compared using analysis of covariance with repeated measures. Analysis of 3-year survival prognostic factors was achieved using the Cox proportional hazards model.**

Results. **Quality of life scores varied through time, but not significantly. Multivariate analysis showed two independent risk factors to influence 3-year survival: dyspnea class (III–IV versus I–II, relative risk = 2.80, 95% confidence interval = 1.2 to 6.5) and the energy section of the Nottingham Health Profile questionnaire (relative risk = 1.02 by unit, 95% confidence interval = 1.01 to 1.03).**

Conclusions. **Our study shows quality of life scores to be stable for the first 3 years after operation and the preoperative energy score to be predictive of 3-year survival.**

(Ann Thorac Surg 2000;69:722–7)

In a previous study [1], we compared quality of life (QOL) in patients before and 3 months after open heart operation using the Nottingham Health Profile (NHP) questionnaire. This study concluded that cardiac operations improve QOL in patients. The improvement was similar (1) for patients undergoing coronary artery bypass grafting and those undergoing valve replacement and (2) for patients with no postoperative events and those with nonlethal postoperative complications. The strongest predictive factors of QOL were age and the New York Heart Association (NYHA) functional class. We continued follow-up in these patients by sending them a questionnaire to be filled in at each anniversary of their operation for 3 years. The aim of this prospective study was twofold: to determine the evolution of QOL through the first 3 postoperative years and to determine whether preoperative QOL is predictive of 3-year survival.

Patients and Methods

From January to July 1994, 215 patients underwent elective open heart operation requiring cardiopulmonary bypass in the Department of Thoracic and Cardiovascular Surgery at the University Hospital in Besançon, France. The questionnaire was given to all patients before open heart operation, 3 months afterward, and once a year for 3 years thereafter.

The variables recorded were age, sex, occupation, heart disease, angina pectoris status according to Canadian classification, dyspnea class according to the NYHA classification, comorbid diseases (previous heart operation, chronic obstructive pulmonary disease, renal failure, diabetes mellitus, cerebral or peripheral vascular disease), ejection fraction, left ventricular wall motion, surgical procedure, and operative complications.

The Nottingham Health Profile questionnaire was originally written in English [2, 3], before undergoing rigorous translation into French, back translation, and linguistic validation [4]. It contains 38 subjective statements divided into six sections: energy, physical mobility, emotional reaction, pain, sleep, and social isolation. The number of statements in each section varies, from three in the energy section to nine in the emotional reaction section. Within each section an aggregation of responses is made possible by the use of item weights determined in a general population sample. Bucquet and colleagues [4], using the Thurstone method of paired comparisons [5], paired each item with each one in the same section and presented the groups of pairs for judgment, or perception of relative severity, to a population sample. Ultimately, they transformed the observed frequencies of relative severity into weights totaling 100 per section.

Accepted for publication July 27, 1999.

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Published by Elsevier Science Inc

0003-4975/00/$20.00
PII S0003-4975(99)01329-6

Statistical Analysis

The answer to each question was binary (yes–no). The score in each section was obtained by adding the weight of the questions with positive responses. To give an example, the energy section is composed of three questions—(1) I'm tired all the time, (2) Everything is an effort, (3) I soon run out of energy—each of which has a weight (39.20, 36.80, 24.00, respectively). A patient who answered no to the first question, yes to the second, and yes to the third would have a score of 60.80 ($[0 \times 39.20] + [1 \times 36.80] + [1 \times 24.00]$) in the energy section. Scores range from 0 to 100; the higher the score, the higher the level of dysfunction or distress.

EVOLUTION OF QUALITY OF LIFE SCORES THROUGH TIME. Postoperative scores (at 3 months, 1, 2, and 3 years) in each section explored by the NHP questionnaire were compared using analysis of covariance with repeated measures (BMDP 5V; BMDP Statistical Software, Los Angeles, CA).

PREOPERATIVE DATA AND SURVIVAL. Analysis of 3-year survival prognostic factors was achieved using the Cox proportional hazards model both in uni- and multivariate analysis. Variables with a p value less than or equal to 0.20 in univariate analysis were included in the multivariate model. Patients who died during the postoperative course (in-hospital mortality) were not included in this analysis. The method of Moreau and associates [6] was used to confirm the hypothesis of proportional hazards. Quantitative data were grouped as follows: age ($\leq$ 70, $>$ 70), ejection fraction ($<$ 0.30, $\geq$ 0.30), angina class (I–II, III–IV), NYHA functional class (I–II, III–IV), comorbid disease (none, others), postoperative events (none, others). Occupational status was omitted from these analyses, as the large number of categories made interpretation difficult. QOL scores in each section were kept as quantitative variables. All statistical analyses were performed with BMDP statistical software (BMDP, Los Angeles, CA). Values of QOL scores are expressed as mean ± standard error of the mean.

Results

Characteristics of Study Population

Six patients did not fill in the questionnaire. Four did not speak French, and two refused, resulting in 209 completed preoperative questionnaires (Table 1).

The mean age was 65 ± 10 years and the sex ratio (M/F) was 3:1. Eighty-one patients (39%) were less than 65 years of age, 39 (18%) were aged between 65 to 70 years, 59 (29%) from 70 to 75 years, and 30 (14%) were more than 75 years.

The occupations or former occupations of the patients were classified in seven sections according to the official record classification of the Institut National de la Statistique et des Etudes Economiques, the French Institute of Statistics and Economic Studies. Nurses, schoolteachers, civil servants, clergymen, technicians, and foremen were classified as helping professions. More than half of the patients were white-collar or blue-collar workers. Twenty-five patients, mostly women, had never held a job. Half of the patients suffered from coronary artery disease and 40% from heart valve disease. The predominant heart valve disease was calcified aortic stenosis in 62

Table 1. Characteristics of the Study Population

Variable	No. of Patients	% of Patients
Age (y)		
≤ 70	120	57
> 70	89	43
Sex		
Male	156	75
Female	53	25
Occupational categories		
Managers	10	5
Small business owners	32	15
Helping professions	21	10
Farmers	11	5
White collar workers	56	27
Blue collar workers	54	26
Nonworkers	25	12
Heart disease		
CAD	110	53
HVD	84	40
CAD + HVD	15	7
Preoperative status		
Angina		
None	78	37
I–II	100	48
III–IV	31	15
NYHA functional class		
I–II	176	84
III–IV	33	16
Ejection fraction		
≥ 0.30	198	95
< 0.30	11	5
SWM		
Normal	157	75
Abnormal	52	25
Comorbid diseases		
None	159	76
Diabetes mellitus	25	12
CPVD	21	10
Renal failure	2	1
COPD	2	1
Prior heart operation	11	5
Postoperative events		
No events	184	88
LCO	4	2
Reoperation for bleeding	3	1.5
PE	4	2
MV >24 h	5	2
SWI	1	0.5

CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; CPVD = cerebral or peripheral vascular disease; HVD = heart valve disease; LCO = low cardiac output; MV = mechanical ventilation; NYHA = New York Heart Association; PE = pericardial effusion; SWI = sternal wound infection; SWM = segmental wall motion.

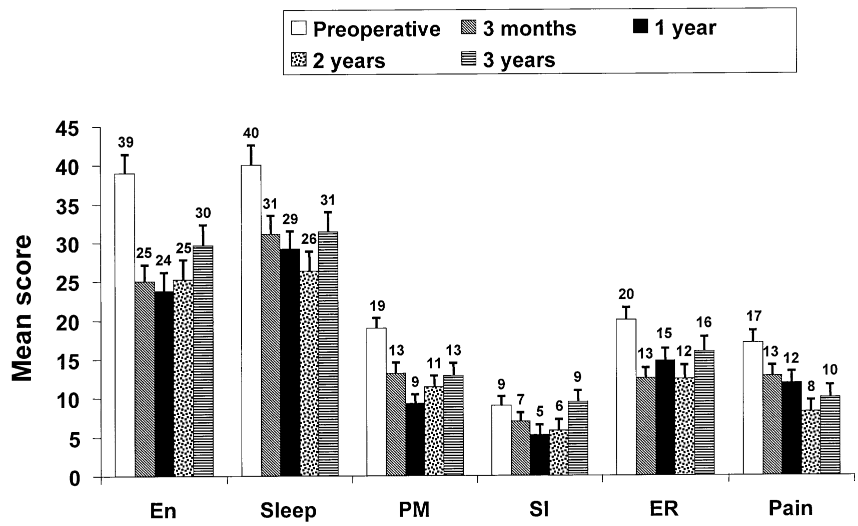

*Fig 1. Mean scores for each section of quality of life before and after operation. Comparison of the scores before and after operation shows an improvement in quality of life in all sections explored by the Nottingham Health Profile. Postoperative quality of life scores do not vary significantly through time. (*En = *Energy;* ER = *emotional reaction;* PM = *physical mobility;* SI = *social isolation.)*

patients (30%); 17 patients (8%) had a double-valve disease. The postoperative course was uneventful in 184 patients. In-hospital mortality was 3.7%. Twenty-two patients died during the follow-up.

Evolution of Quality of Life Scores Through Time

Figure 1 shows the evolution of the scores in each section through time. QOL scores varied through time, roughly but not significantly following a U-shaped curve ($p >$ 0.20). The initial disease (coronary artery disease or calcified aortic stenosis) did not influence the stability of the results (data not shown).

Factors Influencing 3-Year Survival

Table 2 shows the relative risks of all preoperative data in univariate analysis. Among the seven variables retained in the multivariate model, two independent risk factors appeared statistically significant: dyspnea class (III–IV versus I–II, relative risk = 2.80, 95% confidence interval = 1.20 to 6.50) and energy section of the NHP (relative risk = 1.02 per unit, 95% confidence interval = 1.01 to 1.03). As the relative risk of energy section in patients in dyspnea class I–II was nearly the same as that of those in dyspnea class III–IV, we can assume that there was no interaction between these two variables.

Comment

Most studies on QOL in cardiac surgery show an improvement in QOL brought about by operation [7–11]. Caine and colleagues [7], in a study using the NHP questionnaire and involving 100 male patients aged less than 60 years, showed a clear improvement in patients' QOL 3 months and 1 year after CABG. This improvement compared favorably with those from a normal male population. Guadagnoli and associates [8] showed that patients more than 65 years of age reported functional benefits similar to those reported by patients less than 65 years, and that the factors associated with better functioning did not vary by age group. MacDonald and colleagues [9], with a cutoff point at 75 years of age, also showed an improvement in QOL in older patients, but found a higher proportion of complications leading to death and disability than in younger patients. Nielsen and associates [10], in a case-control study using the NHP questionnaire, focused on patients whose cardiac operation was complicated by multiple organ failure. They showed that 1 year after discharge, the NHP score was higher for the "multiple organ failure" group than for the control group in three of the six dimensions of health (energy, physical mobility, and emotional reactions). Our previous study [1], which compared QOL before and 3 months after cardiac operation confirmed the results of the above cited studies, showed an improvement in all sections explored by the NHP. This improvement may reflect either the effects of the operation or those of factors linked to the operation. Our patients underwent a rehabilitation program that lasted from 3 to 6 weeks. During rehabilitation, patients exercised, followed a healthy diet and refrained from smoking. Active rehabilitation most probably improved QOL evaluated soon after rehabilitation even if the patients had resumed their former habits. After 3 years, the role of rehabilitation in patient improvement most likely had decreased and the role of operation increased whether or not patients modified their lifestyle.

Stability of the Quality of Life Scores Through Time

The stability of results during the first 3 years after operation is an important issue in our study. It is equivalent for patients with coronary artery disease and patients with aortic valve stenosis. Soderlind and colleagues [11], in a study concerning QOL after complicated open heart operations, also found stability in results 1 and 2 years after operation. A 3-year follow-up is probably not sufficient to assess the stability of results. A longer follow-up would, in all probability, show a deterioration in the quality of life. This would be due partially to aging and partially to deterioration of the surgical results, such as graft occlusion or valve-related complications. The

Table 2. Influence of Preoperative Data on 3-Year Survival: Univariate and Multivariate Analysis

	Univariate Analysis		Multivariate Model	
Variable	RR	95% CI	RR	95% CI
Age				
≤ 70	1			
> 70	1.02	0.97–1.07		
Sex				
Male	1			
Female	1.06	0.4–2.7		
Heart disease				
CAD	1			
VR	1.12	0.9–1.3[a]	1.09	0.9–1.3
Angina class				
I, II	1			
III, IV	1.85	0.1–2.6		
NYHA functional class				
I, II	1			
III, IV	3.4	1.4–8.1[a]	2.80	1.2–6.5[b]
Ejection fraction				
≥ 0.30	1			
< 0.30	1.24	0.2–9.2		
Segmental wall motion				
Normal	1			
Abnormal	1.63	0.5–4.8		
Comorbid diseases				
No	1			
Yes	1.25	0.5–3.1		
Postoperative events				
No	1			
Yes	1.42	0.4–4.8		
Energy	1.02 per unit	1.01–1.04[a]	1.02 per unit	1.01–1.03[b]
Sleep	1.01 per unit	0.99–1.02[a]	1.00 per unit	0.98–1.02
Physical mobility	1.03 per unit	1.01–1.05[a]	1.01 per unit	0.98–1.04
Social isolation	1.00 per unit	0.97–1.02		
Emotional reaction	1.01 per unit	0.99–1.03[a]	0.99 per unit	0.97–1.01
Pain	1.01 per unit	0.99–1.03[a]	0.98 per unit	0.96–1.01

[a] Selected for multivariate analysis ($p \leq 0.20$). [b] Statistically significant variables of the model.

CI = confidence interval; RR = relative risk.

expected scores, based on reference scores for a standard population [12] applied to the sex and age distribution in our series, worsen during follow-up as the population ages. The expected scores in the energy section increase an average of 1 point per year during the first 3 years.

Persistence of Sleep Disturbance

The comparison of our patients' scores to those of the general population shows that postoperative scores are similar to expected scores in all sections except the sleep section. The persistence of sleep disturbance 3 years after operation is worrying. It is understandable how fear of operation, metabolic or neurologic disturbances induced by cardiopulmonary bypass would cause sleep disturbance 3 months after operation. This might be thought to diminish in time. Our study shows that these disturbances remain up to 3 years after operation in healthy patients. This may stem from (1) the fear of death engendered by cardiac operation and echoed by everyday reminders such as medication, doctor's appointments, and scars or (2) cerebral lesions induced by cardiopulmonary bypass, perhaps coming from bubbles or microthrombi, which can disturb sleep and perhaps other functions not explored by the NHP, such as memory or cognitive function.

Energy Score as a Predictive Factor of 3-Year Survival

The NHP questionnaire is a generic scale that was not originally designed for patients undergoing cardiac operations. Thus, it was an adjunct to traditional clinical measures. It was not intended to be a measure of disease but an indicator of limitations on health [13]. Preoperative energy score as a predictive factor of 3-year survival is an unexpected but important result of this study. When comparing preoperative to 3-month scores, the improve-

Table 3. Relative Risks of Death According to the Answers to Energy Section Answers

I'm tired all the time	Everything is an effort	I soon run out of energy	RR	95% CI
No	No	No	1.0	
Yes	No	No	2.1	1.2–3.7
No	Yes	No	2.0	1.2–3.4
No	No	Yes	1.6	1.1–2.2
Yes	Yes	No	4.4	1.5–13
Yes	No	Yes	3.4	1.4–8.3
No	Yes	Yes	3.2	1.4–7.7
Yes	Yes	Yes	7.0	1.7–28

CI = confidence interval; RR = relative risk.

ment in energy score was equivalent in both patients who were going to die and the others (approximately 30%). However, the baseline value was significantly lower in patients alive after 3 years of follow-up (35 ± 2.5) than in patients who were to die within 3 years of follow-up (62 ± 6.8).

The relative risk of 1.02 per unit of energy score means that a difference of 10 points between 2 patients increases 3-year death risk by $(1.02)^{10} = 1.22$. In concrete terms, when compared to patients who answered no to all three questions in the energy section, patients who answered yes to the first question (I'm tired all the time) and no at the other two had a relative risk—according to the weight of question 1—of 2.1, 95% confidence interval = 1.2 to 3.7. Patients who answered yes to the second question (Everything is an effort) and no to the other two had a relative risk of 2.0, 95% confidence interval = 1.2 to 3.4, and patients who answered yes to the third question (I soon run out of energy) and no to the other two had a relative risk of 1.6, 95% confidence interval = 1.1 to 2.2. Table 3 gives all the possible answers and their corresponding relative risk.

The fact that energy score is an independent risk factor means that the patient's perception of how he or she feels—a completely subjective parameter—would seem to be a better indicator of survival than objective medical data. This important finding needs to be confirmed before recommending that the energy section of the NHP questionnaire be used in cardiac surgery risk scores.

New York Heart Association Functional Class as a Predictive Factor of 3-Year Survival

Our previous study [1] showed that "preoperative NYHA functional class did not influence preoperative energy score, but was an important independent predictor of variations in energy score." Our current study showed the improvement in energy score to be equivalent in patients who were going to die and in the others (approximately 30%), but with a significantly higher baseline value in patients deceased after 3 years. Although the baseline value in energy score influences survival, NYHA functional class influences survival, whatever the baseline value, by restricting improvement.

Links Between Sections of the Nottingham Health Profile in Patients Undergoing Cardiac Operations

In univariate analysis, the energy and physical mobility sections were significantly different in patients who were going to die and the others. Stepwise regression shows that once the energy section is included in the model, the physical mobility section loses its significance. This shows the close correlation between these two aspects of QOL in patients undergoing open heart operations.

In conclusion, our study brings to light some important points: (1) the stability of QOL scores during the first 3 years after operation, (2) the predictive value of preoperative energy score on 3-year survival, (3) the presence of sleep disturbance 3 years after operation, and (4) the refraining role of NYHA functional class on the dynamics of recovery. Even if the NHP questionnaire was not designed for cardiac surgery, the influence of the energy score on 3-year survival shows that its use is suitable in cardiac surgery. This important finding needs to be confirmed before recommending the use of this section of the NHP questionnaire in cardiac surgery risk scores.

This study was supported by grants from Programme Hospitalier de la Recherche Clinique, Ministère de la Santé Publique, Paris. We are grateful to Nancy Richardson-Peuteuil for her editorial assistance.

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INVITED COMMENTARY

This manuscript challenges clinicians and outcome analysts by integrating subjective quality of life (QOL) variables into outcome analysis. Preoperative QOL scores are used as incremental risk variables and postoperative ones are used as outcome variables.

This study is somewhat limited by the small sample size, the limited number of lethal events and the absence of complex transformations of patient variables. I might also disagree with the statement that the patient's subjective perception of "how he feels" would be a better predictor for survival versus objective medical data.

Clinical symptoms are subjective transformations of pathophysiological dysfunctions, therefore the relation between subjective and objective variables needs to be strong but not "one to one." Subjective variables will enrich the patient's description. The science of outcome analysis has demonstrated the prime importance of the availability of the original non-transformed variables (subjective or objective) and the identification of the appropriate transformation in the search of the optimal relation with the studied event.

Clinicians weathered by the crude realities of medicine have not always appreciated the subtleties of the "quality of life" scoring systems. This study has shown unequivicably that QOL scores will have to be included in new longitudinal datasets of cardiac surgery and cardiological patients.

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Published by Elsevier Science Inc

0003-4975/00/$20.00
PII S0003-4975(99)01329-6