Original article

Predictors of physical and emotional recovery 6 and 12 months after surgery

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Background: A proportion of patients do not recover fully from surgery or they develop chronic postsurgical pain. The aim of this study was to examine the incidence and predictors of unfavourable long-term outcome after surgery using a prospective cohort design.

Methods: Some 401 patients undergoing various elective surgical procedures filled in the RAND 36-item Health Survey 1·0 health-related quality-of-life questionnaire before operation and at 6 and 12 months of follow-up to assess changes in pain, physical functioning, mental health and vitality. Preoperative psychological assessment was obtained.

Results: Most patients showed improvement in the various aspects of health-related quality of life after surgery, but a considerable proportion (14–24 per cent) still showed deterioration at 6 and 12 months. Multivariable linear regression analysis identified acute postoperative pain, duration of the operation and preoperative physical condition as the most important predictors of long-term pain and physical functioning. Preoperative surgical fear also had a small but significant contribution. The main predictors of mental health and vitality were physical condition before surgery, surgical fear and optimism.

Conclusion: Up to a quarter of patients experienced suboptimal recovery after surgery. Both somatic and psychological factors were associated with the long-term outcome. Optimal recovery could be promoted by effective interventions on malleable factors.

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Introduction

Most surgical patients show rapid and adequate recovery and are able to resume normal activities within days or weeks after surgery. However, a minority of patients do not fully recover to their presurgical state, or even experience a deterioration of their physical and/or emotional condition that may persist for years after the intervention[1,2]. One of the adverse long-term consequences of surgery is chronic postsurgical pain[3,4]. Recent studies on the incidence of chronic postsurgical pain have indicated that an alarmingly high number of patients experience persistent pain after surgery, although the estimates vary from study to study and depend on the specific type of intervention[3,5]. Persistent pain may also have a severe impact on physical functioning and quality of life[1,6].

Recent reviews have summarized several risk factors for the development of chronic postoperative pain. These included female sex, presence of preoperative pain, intraoperative nerve damage and a high level of acute postoperative pain[3,5]. Recently it has been acknowledged that psychosocial variables may also contribute to the persistence of postoperative pain[2,5,7], as well as to suboptimal long-term functional and self-perceived recovery[2]. However, the number of high-quality studies on predictors of surgical recovery and chronic postsurgical pain is still limited. Adequately designed studies entail comprehensive preoperative assessment not only of potential predictors but also of the physical and emotional condition of the patient at that time. Too often pain, functional status and quality of life are assessed only at follow-up. In order to draw conclusions about recovery and/or the development of new complaints, the pre-existing condition of the patient has to be taken into account.

This study was designed to identify demographic, intervention-related, somatic and psychological variables

associated with suboptimal physical and emotional recovery after surgery. Changes in pain, physical functioning, mental health and vitality from the presurgical period to 6 and 12 months after surgery were examined in patients undergoing diverse surgical procedures. Previously the authors have presented data on patients' retrospective reports of increased pain and functional disability at 6 months after the intervention[8]. The present article provides a more comprehensive analysis of the prevalence and predictors of unfavourable surgical outcome across various health-related quality-of-life domains by using repeated assessments of the outcome variables. This repeated assessment allowed a prospective determination of the worsening of pain and other aspects of health-related quality of life compared with the preoperative state, and the persistence of an unfavourable outcome from 6 to 12 months postsurgery.

Methods

The study was approved by the ethics committee of University Hospital Maastricht, The Netherlands. Consecutive patients scheduled to undergo elective surgery in the departments of general surgery, plastic surgery, ear, nose and throat surgery, faciomaxillary surgery, neurosurgery and thoracic surgery were enrolled between February and August 2003 in the University Hospital Maastricht (1975 patients). Exclusion criteria were age less than 18 years, limitations of self-expression, visual dysfunction and insufficient knowledge of Dutch. Eligible patients received a letter at their home address describing the purpose and methods of the study. Informed consent for preoperative and acute postoperative assessment was obtained from 1663 patients (82·4 per cent). A total of 173 patients were excluded from participation for the following reasons: complications during surgery (14), need for extended postoperative ventilatory support in the intensive care unit (50), research too demanding (32), missing data (33) or logistical reasons (for example, no research assistant available; 44 patients). Of the 1490 remaining patients, 1003 gave informed consent to participate in the follow-up study. Six-month follow-up questionnaires were completed by 838 patients (83·5 per cent). A further 213 patients were excluded because they had repeated operations (124) or because of adverse events in the follow-up period that

Table 1 Characteristics of patients included in the study and those who were excluded or dropped out

	Patients included ($n = 401$)	Patients not included ($n = 1089$)	Effect size‡	*P*
Age (years)*	54(14)	56(16)	0·14	0·005§
Sex ratio (M : F)	185 : 216	517 : 572	0·01	0·682¶
Education†			0·07	0·041¶
Elementary	112 (29·4)	280 (35·0)		
Mid-level	142 (37·3)	305 (38·2)		
Higher	127 (33·3)	214 (26·8)		
ASA grade			0·16	< 0·001¶
I	189 (47·1)	349 (32·0)		
II	172 (43·6)	512 (47·0)		
III	40 (10·0)	228 (20·9)		
Hospital stay (days)*	5·6(4·4)	7·2(9·5)	0·17	< 0·001§
Operating time (min)*	100(67)	108(85)	0·09	0·048§
Anaesthetic technique			0·09	0·003¶
General	289 (72·1)	735 (67·5)		
General + locoregional	33 (8·2)	163 (15·0)		
Locoregional	79 (19·7)	191 (17·5)		
Preop. pain intensity (0–100)*	14·0(21·2)	14·7(22·2)	0·03	0·612§
Preop. SF-36 pain (0–100)*	62·4(30·2)	62·1(31·6)	< 0·001	0·864§
Preop. SF-36 physical functioning (0–100)*	64·4(29·7)	61·8(30·6)	0·07	0·152§
Preop. SF-36 mental health (0–100)*	69·1(17·5)	65·0(10·1)	0·19	< 0·001§
Preop. SF-36 vitality (0–100)*	58·2(20·2)	54·8(21·5)	0·14	0·008§
Pain catastrophizing (0–52)*	15·6(12·0)	16·9(13·0)	0·09	0·101§
Optimism (0–32)*	20·1(4·9)	19·2(4·9)	0·15	0·004§
Surgical fear*				
Total (0–100)	24·4(17·6)	26·3(19·0)	0·09	0·084§
Short term (0–40)	13·1(9·3)	13·4(9·7)	0·02	0·633§
Long term (0–60)	11·3(10·1)	13·0(11·5)	0·13	0·008§
Pain intensity on day 4 (0–100)*	13·7(18·1)	17·0(20·6)	0·14	0·005§

Values in parentheses are percentages unless indicated otherwise; *values are mean(s.d.). †Information not available for all patients. ‡Cohen's *d* or Cramer's φ as appropriate. ASA, American Society of Anesthesiologists; SF-36, RAND 36-item Health Survey 1·0. §*t* test; ¶χ^2 test.

could affect health (89). This left 625 patients for the 6-month follow-up, of whom 619 (99·0 per cent) agreed to participate in the 12-month follow-up. After exclusion of 72 patients with malignancy, a total of 547 questionnaires were sent out, 452 of which were returned (response rate 82·6 per cent). A further 51 patients were excluded because they had another operation or an adverse event during the second follow-up period, leaving a maximum of 401 participants for analysis. Characteristics of the patients included in the final study, as well as of patients who were excluded or dropped out, are shown in *Table 1*. *Table 2* gives an overview of the types of operation that were performed in this patient sample.

Predictor variables

The predictor variables examined could be separated into demographic (age, sex), intervention-related (type of intervention, anatomical region), somatic (American Society of Anesthesiologists (ASA) grade, type of anaesthesia, duration of operation, acute postoperative pain) and psychological (pain catastrophizing, optimism and surgical fear) variables.

Operations were categorized independently by five experienced anaesthetists into three groups (minor, intermediate and major) based on the anticipated level of postoperative pain and in accordance with Rawal's stepwise approach of acute pain treatment[9]. Examples of this classification can be found in *Table 2*. The different anatomical regions involved in the operations were: head/neck, upper extremities, thorax, upper abdomen, lower abdomen, upper and lower abdomen, lower extremities, back, and multiple sites. Medical co-morbidity was assessed by an anaesthesist and categorized according to the ASA grading system (I–V). Only patients with ASA grade I–III were included in the study. Type of anaesthesia was coded as general, locoregional, or general plus locoregional. Duration of surgery was dichotomized as fewer than 3 h or 3 h or more. On days 1–4 after surgery pain intensity was scored in a pain diary at 09·00, 12·00 and 21·00 hours. Mean pain intensity on day 4 was used as the measure of acute postoperative pain.

Questionnaires were used to perform psychological assessment before operation. Pain catastrophizing, defined as an exaggerated negative interpretation of the meaning of pain, was measured by the Pain Catastrophizing Scale (PCS)[10]. The PCS has 13 items that are scored on a five-point scale. A total score is obtained by summing all items. Dispositional optimism was measured by the Life

Table 2 Overview of 401 operative procedures included in the study

	No. of patients	Most prevalent operation(s)*
Eye surgery	22	
Minor	22	Vitreous body (7), lens + vitreous body (6), eyeball (3)
Ear, nose and throat	70	
Minor	56	Nasal sinus operation (13), tympanoplasty (12)
Intermediate	14	Jaw surgery (6), laryngectomy (4)
Gynaecological	46	
Minor	16	Vaginal–urological procedure (7), curettage (2), cervix operation (2)
Intermediate	29	Abdominal (16) and vaginal (4) hysterectomy, adnexectomy (4)
Major	1	Extensive gynaecological surgery
Other abdominal operations	90	
Minor	46	TUR prostate (8), TUR bladder (5), urethra (4)
Intermediate	17	Peritoneum (7), colorectal surgery (3), prostatectomy (2)
Major	27	Major bowel surgery (8), hepatectomy (2), abdominal surgery (2)
Thorax	2	
Major	2	Chest wall excision (2)
Orthopaedic	133	
Intermediate	95	Total hip prosthesis (45), discectomy (16), patella surgery (7)
Major	38	Total knee replacement (19), shoulder operation (7)
Plastic surgery	15	
Minor	7	Plastic skin operations (7)
Intermediate	8	Plastic breast surgery (8)
Vascular surgery	23	
Minor	10	Peripheral vascular operations (10)
Intermediate	9	Carotid endarterectomy (9)
Major	4	Aorta (4)

Minor, intermediate and major procedures refer to the expected level of postoperative pain and analgesic requirement. *Given as examples of the specific types of operation in a particular category. TUR, transurethral resection.

Orientation Test (LOT)[11]. The LOT consists of eight items measuring a generalized positive outcome expectancy for the future. Four items are phrased positively and four items negatively. A total optimism score is obtained by summing the eight items after reversing the scores of the negatively phrased items. The psychometric properties of the PCS and the LOT are well established[10,11]; in the present study, values for Cronbach's α of 0·94 and 0·70 respectively were obtained. Surgical anxiety was measured by a ten-item tailormade questionnaire. Each item referred to a specific potential consequence of the operation and was scored on an 11-point scale (from no fear to most extreme fear). Item selection was based on previous studies examining specific fears in surgical patients[12,13]. An initial list of 12 items was pilot tested in 12 patients and, on the basis of feedback from patients and research assistants administering the questionnaire, subsequently adapted to the present ten-item version. Factor analysis of this ten-item version indicated two subscales: fear of immediate consequences of the operation (4 items: operation, pain, anaesthesia, unpleasant side-effects; Cronbach's $\alpha = 0{\cdot}83$) and fear of longer-term consequences (6 items: deterioration of health, operation not successful, being in a hospital, concerns about family, inadequate recovery, long time to rehabilitate; Cronbach's $\alpha = 0{\cdot}82$). The two factors were used as separate predictors in the analyses.

Outcome variables

The RAND 36-item Health Survey 1·0 (SF-36; RAND Corporation, Santa Monica, California, USA)[13] was used to assess various aspects of health-related quality of life. The RAND SF-36 yields scores for eight different domains: bodily pain, physical functioning, physical role functioning, vitality, mental health, social role functioning, emotional role functioning and general health. Analyses were restricted to the four subscales deemed to be most important in the present context: bodily pain and physical functioning as indicators of physical recovery, and mental health and vitality as indicators of emotional recovery. Global perceived recovery was measured with the one-item Global Surgical Recovery (GSR) index[14] ('If 100% recovery is back to the usual health you had before you got sick and had surgery, what percent of recovery are you at now?'). All outcomes were continues variables, ranging from 0 (worst) to 100 (optimal).

Procedure

The SF-36, PCS and LOT were sent to patients 1–3 weeks before treatment. Patients were requested to bring the completed questionnaires to the hospital on the day of admission, when the surgical anxiety questionnaire was filled out. After the operation, research assistants visited the patient at least once a day to provide help with the pain diary if necessary. Patients who were discharged from hospital within 4 days took their pain diary home and returned it to the research team in a prepaid envelope. Patients who had not returned their diaries within 14 days after surgery were contacted by telephone to remind them. The diary included an informed consent form that asked the patient for permission to be included in the 6-month follow-up study.

At 6 and 12 months, participants were sent the SF-36 as well as a questionnaire containing the GSR and some questions on new operations and other significant events affecting health. The 6-month follow-up package also included an informed consent form for the 12-month follow-up assessment. Patients could return the questionnaires and consent form by means of a prestamped envelope. After 2 weeks a postal reminder was sent to those who had not responded.

Statistical analysis

Preoperative patient characteristics, intervention-related factors and postoperative pain on day 4 for patients included in the final analysis were compared with those of patients who were excluded or dropped out during the study. Independent-samples *t* tests were used for continuous data, and χ^2 tests for nominal data. Effect sizes are expressed as Cohen's *d* and Cramer's φ respectively.

Repeated-measures ANOVA was used to analyse changes in SF-36 scores for pain, physical functioning, mental health and vitality scores between baseline and the 6- and 12-month follow-up, comparing 6 months *versus* baseline and 12 months *versus* 6 months. The number of patients showing an improvement of 10 per cent or more on the relevant SF-36 domains, a deterioration of 10 per cent or more, or who remained stable (change of less than 10 per cent from baseline in either direction) was calculated.

To test the association of the predictor variables with each of the outcome variables (pain, physical functioning, mental health, vitality and global perceived recovery), five multivariable multiple linear regression analyses were performed. Multivariable refers to the fact that there is more than one dependent variable (assessment at 6 and 12 months) and multiple refers to the fact that there is more than one predictor variable in the regression analysis. Predictor variables were entered blockwise. In the first block demographic and intervention-related variables

(sex, age, type of operation, anatomical region) were entered, and for analysis of the SF-36 subscales the respective preoperative subscale scores were also entered. The variables of this block always remained in the model, independent of statistical significance. The second block entered the somatic predictors (ASA grade, duration of operation, type of anaesthesia and acute postoperative pain). In the final block the psychological predictors (pain catastrophizing, the two surgical anxiety subscales and optimism) were entered. The variables in blocks two and three were included in the final model only when $P < 0{\cdot}100$. The strength of the association of each of the predictor variables with the multivariable outcome, controlled for all other predictors in the model, is indicated by the η2 parameter. The η2 parameter is equivalent to explained variance across the 6- and 12-month outcome variables by the predictor variables.

The multivariable analyses were followed by univariable multiple regression analyses in which the 6- and 12-month outcomes were regressed separately on the same set of predictor variables. The standardized β coefficient indicates the strength of the associations between the predictor variables and each of the two follow-up assessments separately. Again, the coefficient of each individual predictor was controlled for the influence of all other predictors in the model. Owing to missing data in predictor and/or outcome variables, between 356 and 378 patients were available for the various analyses. Analyses were performed with the general linear model procedure of the statistical package SPSS® version 15.0 (SPSS, Chicago, Illinois, USA). $P < 0{\cdot}050$ was considered statistically significant.

Results

Drop-out analyses

There were several differences between patients who remained in the study and those who were excluded or who dropped out (*Table 1*). Patients remaining in the study were significantly younger and better educated, had a lower ASA grade, had a shorter hospital stay, more often had only general anaesthesia, and a higher SF-36 score for baseline mental health and vitality, and optimism, and a lower score for fear of the long-term consequences of surgery. They also reported significantly less postoperative pain 4 days after the operation. However, *Table 1* also shows that the absolute differences between the groups were small. Because significance is dependent on group size, effect sizes were also calculated (Cohen's *d* for continuous variables and Cremer's φ for nominal variables) to determine the meaningfulness of the differences. Cohen's *d* of 0·8 or above is usually considered a large effect, 0·5–0·7 as a medium effect and 0·2–0·4 as a small effect. The interpretation of Cremer's φ is comparable to the correlation coefficient and signifies the strength of association between two variables. As can be seen in *Table 1*, all effect sizes were below 0·2, indicating that the differences between patients included in the study and those who were excluded or dropped out were very small.

Pain

Baseline and follow-up SF-36 scores for the pain subscale were available for 377 participants; the mean(s.d.) score increased from 62·5(30·3) before surgery to 74·1(25·6) at 6 months and 75·1(26·6) at 12 months after operation, higher scores denoting better quality of life and thus less pain. The improvement from baseline to 6 months was significant ($P < 0{\cdot}001$), but at 12 months there was no further improvement ($P = 0{\cdot}262$). Most patients showed improved (201, 53·3 per cent) or stable (111, 29·4 per cent) pain scores at 12 months' follow-up *versus* preoperative scores, although 65 patients (17·2 per cent) reported greater pain.

The most prominent multivariable predictor of the SF-36 pain score at 6 and 12 months was the preoperative SF-36 pain score (*Table 3*). Demographic and intervention-related variables did not contribute to the 6- and 12-month pain scores. However, the duration of the operation and pain intensity at 4 days postsurgery were significantly and independently related to higher pain scores at follow-up. In addition, ASA grade was predictive of outcome, with grades II and III being associated with more pain at 6 and 12 months than ASA grade I. The final model (*Table 3*) shows that results for the 6- and 12-month assessments were very similar.

Physical functioning

Baseline and follow-up scores for the SF-36 physical functioning subscale were available for 367 participants; the mean(s.d.) score increased from 64·8(29·5) before operation to 72·7(26·1) at 6 months and 73·8(26·2) at 12 months postsurgery. Only the increase from baseline to 6 months' follow-up was significant ($P < 0{\cdot}001$), remaining stable thereafter ($P = 0{\cdot}141$). Most patients had better (156, 42·5 per cent) or similar (158, 43·1 per cent) functional abilities at the 12-month follow-up compared with preoperative abilities, but 53 patients (14·4 per cent) reported that their functional abilities had reduced.

Again, as expected, physical functioning at baseline was the strongest predictor of follow-up functioning (*Table 3*).

Table 3 Results of multivariable and univariable multiple linear regression analysis for the RAND 36-item Health Survey 1·0 pain and physical functioning subscale scores at 6 and 12 months of follow-up

	SF-36 pain score ($n = 366$)			SF-36 physical functioning ($n = 356$)			Global perceived recovery ($n = 359$)		
		β			β			β	
	η2#	6 months	12 months	η2#	6 months	12 months	η2#	6 months	12 months
Preop. score	0·149**	0·346**	0·410**	0·405**	0·652**	0·675**			
Sex	0·001	0·022	0·004	0·007	0·036	0·060	0·010	0·071	0·095¶
Age	0·001	−0·014	0·008	0·002	−0·005	−0·026	0·002	−0·043	−0·040
Type of operation†									
Intermediate	0·002	−0·003	−0·041	0·005	0·055	0·012	0·001	−0·041	−0·034
Major	0·002	−0·054	0·050	0·010	0·060	−0·023	0·002	0·037	−0·008
Body region‡									
Upper extremities	0·005	−0·064	−0·037	0·007	−0·063	−0·057	0·016¶	−0·074	−0·127¶
Thorax, non-cardiac	0·016	−0·104*	−0·068	0·006	−0·046	−0·024	0·003	−0·030	0·014
Upper abdomen	0·001	−0·020	< 0·001	0·001	−0·018	−0·027	0·003	0·048	0·052
Lower abdomen	0·002	0·044	0·022	0·007	−0·022	−0·067	0·017¶	0·139*	0·062
Upper + lower abdomen	0·007	0·045	0·098	0·005	−0·016	0·040	0·001	0·019	0·043
Lower extremities	0·001	0·032	−0·025	0·005	−0·057	−0·002	0·011*	−0·135¶	−0·097
Back	0·007	0·087	−0·066	0·009	0·033	0·082	0·003	−0·062	−0·043
Multiple sites	0·012	0·074	−0·084	0·005	−0·045	−0·041	0·018*	−0·110*	−0·102*
ASA grade§									
II	0·018*	−0·076	−0·121*	0·026*	−0·105**	−0·109**	—	—	—
III	0·033**	−0·132**	−0·173**	0·066**	−0·166**	−0·202**	—	—	—
Duration of surgery	0·018*	−0·102*	−0·116*	0·016¶	−0·089*	−0·074¶	0·041**	−0·191**	−0·159**
Pain intensity on day 4	0·064**	−0·230*	−0·113*	0·028**	−0·105**	−0·034	0·051**	−0·220**	−0·186**
Long-term fear	—	—	—	0·015¶	−0·065¶	−0·086*	—	—	—
Pain catastrophizing	—	—	—	—	—	—	0·061**	−0·187**	−0·236**

Results of final models, in which the coefficient for each independent variable is controlled for all other independent variables. #Multivariable effect size, signifying the amount of explained variance across the two follow-up assessments. Reference category: †minor; ‡head/neck; §American Society of Anesthesiologists (ASA) grade I. SF-36, RAND 36-item Health Survey 1·0. **$P < 0·010$, *$P < 0·050$, ¶$P < 0·100$ (significance of η2 parameter tested by multivariable multiple linear regression analyses, and that of β coefficient by univariable multiple linear regression analyses).

Other significant multivariable predictors were ASA grade and acute postoperative pain intensity. ASA grades II and III, and a higher level of acute postoperative pain were related to poorer physical functioning at follow-up. For acute postoperative pain, the association was significant only at 6 months. There was a trend towards significance for a multivariable association of physical functioning at follow-up with duration of surgery and fear of the long-term consequences of surgery. Duration of surgery reached significance only at 6 months' follow-up, and fear of the long-term consequences of surgery only at 12 months' follow-up (*Table 3*).

Mental health

Baseline and follow-up scores for the SF-36 mental health subscale were available for 377 participants; mean(s.d.) scores were 69·0(17·6) at baseline, 74·4(17·6) at 6 months, and 73·8(18·7) at 12 months postsurgery. The increase from baseline to the 6-month follow-up was significant ($P < 0·001$) and the score remained stable thereafter ($P = 0·361$). Some 128 patients (34·0 per cent) were in better, 190 (50·4 per cent) in similar and 59 (15·6 per cent) in poorer mental health at 12-month follow-up compared with baseline. Again, in addition to baseline mental health, ASA grade was predictive of mental health at follow-up (*Table 4*). Moreover, a high level of dispositional optimism before the operation predicted better mental health at follow-up, although this was significant only at 12 months (*Table 4*).

Vitality

Baseline and follow-up scores for the SF-36 vitality subscale were available for 381 participants; the mean(s.d.) score increased from 58·0(20·2) at baseline to 61·4(20·8) and 62·8(20·2) at 6 and 12 months after operation. The increase from baseline to 6 months was significant ($P = 0·001$), but that from 6 to 12 months was not ($P = 0·059$). Vitality increased in 148 patients (38·8 per cent), remained the same in 141 (37·0 per cent) and decreased in 92 (24·1 per cent) from baseline to the 12-month follow-up. In addition to baseline vitality, several predictors were significant (*Table 4*). Patients undergoing surgery classified

Table 4 Results of multivariable and univariable linear regression analysis for the RAND 36-item Health Survey 1·0 mental health and vitality subscale scores at 6 and 12 months of follow-up

	SF-36 mental health ($n = 373$)			SF-36 vitality ($n = 378$)		
		β			β	
	η2#	6 months	12 months	η2#	6 months	12 months
Preop. score	0·242**	0·547**	0·441**	0·202**	0·458**	0·392**
Sex	0·006	−0·058	−0·062	0·016¶	−0·066	−0·113*
Age	0·001	−0·016	0·012	0·005	0·056	0·054
Type of operation†						
Intermediate	0·009	0·086	0·105	0·024*	0·175**	0·110¶
Major	0·002	−0·001	0·045	0·001	0·035	0·001
Body region‡						
Upper extremities	0·003	−0·040	0·009	0·001	−0·018	0·004
Thorax, non-cardiac	0·010	−0·084	0·032	< 0·001	−0·009	−0·001
Upper abdomen	< 0·001	−0·009	−0·006	0·016¶	−0·116*	−0·073
Lower abdomen	< 0·001	0·002	−0·004	0·001	0·008	−0·016
Upper + lower abdomen	0·005	0·081	0·071	0·004	0·024	0·072
Lower extremities	0·001	0·029	0·002	0·003	−0·062	−0·028
Back	0·010	−0·071	−0·109	0·002	−0·046	−0·030
Multiple sites	0·011	−0·082	−0·057	0·012	−0·076¶	−0·082
ASA grade§						
II	0·019*	−0·092*	−0·124*	0·022*	−0·053	−0·131**
III	0·025*	−0·129**	−0·136**	0·031**	−0·113*	−0·165**
Duration of surgery	—	—	—	—	—	—
Pain intensity on day 4	—	—	—	—	—	—
Pain catastrophizing	—	—	—	—	—	—
Long-term fear	—	—	—	0·028**	−0·144**	−0·086*
Optimism	0·017*	0·045	0·131*	0·025*	0·083¶	0·146**

Results of final models, in which the coefficient for each independent variable is controlled for all other independent variables. #Multivariable effect size, signifying the amount of explained variance across the two follow-up assessments. Reference category: †minor; ‡head/neck; §American Society of Anesthesiologists (ASA) grade I. SF-36, RAND 36-item Health Survey 1·0. **$P < 0·010$, *$P < 0·050$, ¶$P < 0·100$ (significance of η2 parameter tested by multivariable multiple linear regression analyses, and that of β coefficient by univariable multiple linear regression analyses).

as intermediate with respect to expected postoperative pain reported a higher gain in vitality at follow-up than patients undergoing operations classified as minor. Patients with higher ASA grades reported less gain in vitality. Two psychological predictors reached significance and had an independent contribution to vitality at follow-up: long-term fear was associated with less vitality, and optimism with more vitality. Fear had a somewhat stronger association with vitality at 6 months and optimism at 12 months. Additional univariable associations included less vitality at 6 months after upper abdominal operations (compared with head and neck surgery) and less vitality at 12 months in women.

Global perceived surgical recovery

GSR scores were available for 388 patients. Mean(s.d.) GSR scores increased slightly but significantly, from 79·3(24·6) at 6 months to 82·2(24·7) at 12 months ($P = 0·002$). If (near) optimal recovery is defined as a GSR score of 90 per cent or more, only 39·2 per cent of patients showed optimal recovery at 6 months and 46·9 per cent at 12 months. Moreover, 16·5 and 14·9 per cent of patients perceived their recovery as 50 per cent or less at 6 and 12 months respectively. Perceived recovery showed the strongest association with preoperative to postoperative changes in pain and physical functioning. Correlation of GSR at 6 months with the change in the SF-36 pain score at 6 months was $r = 0·61$, and correlation with change in physical functioning was $r = 0·53$. At 12 months these correlations were $r = 0·59$ and $r = 0·51$ respectively. Changes in mental health and vitality had lower associations with perceived recovery ($r = 0·36$–$0·46$).

Perceived recovery at follow-up was less favourable for patients who underwent surgery of the lower extremities and at multiple sites, compared with that in patients having head and neck surgery (*Table 3*). Only at the 12-month follow-up was this the case for upper extremity operations. There was a significant positive association between lower abdomen operations and perceived recovery only at the 6-month follow-up. In addition, duration

of operation and acute postoperative pain on day 4 were significantly and negatively associated with global perceived recovery. When entered simultaneously, the only psychological predictor remaining in the final model was pain catastrophizing. Higher pain catastrophizing before operation was related to lower perceived recovery (*Table 3*). When pain catastrophizing was substituted by long-term surgical fear in the final model, this also proved to be a significant predictor of perceived recovery at 6 and 12 months ($\beta = -0{\cdot}108$ at 6 months and $\beta = -0{\cdot}098$ at 12 months), as did optimism (in a positive direction; $\beta = 0{\cdot}120$ at 6 months and $\beta = 0{\cdot}105$ at 12 months).

Discussion

At 6 and 12 months after surgical intervention, the majority of patients reported improvements in all aspects of health-related quality of life. Nevertheless a considerable proportion reported a deterioration of their physical and emotional condition. At 12 months after surgery, approximately 15 per cent of patients reported more pain, less physical ability and more emotional problems, and 24 per cent reported having less vitality than before the operation. The most important predictors of long-term outcome were medical co-morbidity of patients as reflected in the ASA grade, acute postoperative pain and duration of surgery. The latter two predictors were associated mainly with physical recovery (pain, physical functioning and perceived recovery), and not so much with emotional recovery (mental health, vitality). Several psychological factors also had small but statistically significant associations with long-term outcomes. A higher level of preoperative fear of the long-term consequences of surgery was negatively associated with physical functioning at 12 months' follow-up, and with vitality and perceived recovery at 6 and 12 months. Optimism was also associated with long-term outcome. Patients scoring higher on dispositional optimism were in better mental health and had more vitality 12 months after surgery, even when controlled for baseline mental health and vitality.

Most changes in health-related quality of life occurred during the first 6 months after surgery, after which patients' condition appeared to remain stable. Clinically this implies that, in monitoring recovery after surgery, particular attention should be paid to the patient's condition during the initial months. An initially poor recovery may have lasting consequences. It is also important to note that a similar set of predictors was found for the 6- and 12-month outcomes, with slight variation in the magnitude of the associations, attesting to the robustness of the findings.

The strongest predictor of pain intensity at follow-up was acute postoperative pain, consistent with previous studies of chronic postsurgical pain[3,5,15]. It remains to be determined whether the impact of acute postoperative pain on pain persistence is a direct causal influence, for instance by central sensitization and/or the formation of a pain memory[16], or whether both acute and persistent postoperative pain are influenced by similar risk factors, perhaps including genetic factors. Future studies assessing the long-term effects of effective acute pain management and/or studies that measure central sensitization more directly are necessary to clarify this issue[17]. Higher levels of acute postoperative pain were also associated with poorer long-term physical functioning and global perceived recovery. This association may be secondary to the inception of chronic postsurgical pain.

Preoperative ASA grade appeared to be associated with poorer outcome on all domains of quality of life. The lower health-related quality of life at 6 and 12 months for patients with ASA grades II and III was not simply a continuation of a poorer health status of the patient before the operation, because this was controlled for. However, whether their relatively poor health condition at follow-up was caused by the operation or whether it reflected the progression of an already present disease condition cannot be determined from the present data.

Several studies have identified state and trait fear as predictors of acute and chronic postoperative pain[18–23]. In the present authors' previous study[8], which focused on 6-month outcomes, the measure of surgical fear was found to be predictive of chronic postsurgical pain. When a different measure was used in the present study to assess chronic postoperative pain, this finding was not replicated. A significant association between fear of the long-term consequences of the operation and changes in physical functioning and vitality at follow-up was found, however. Interestingly, it was demonstrated recently that a preoperative anxiolytic agent reduced postoperative anxiety and acute postoperative pain[24]. The reduction in postoperative pain was especially prominent in highly anxious patients. Whether preoperative anxiolytic treatment can also reduce unfavourable long-term outcomes should be the topic of future research.

Dispositional optimism was related to changes in emotional recovery at follow-up, but not to physical recovery. This effect became apparent only at the 12-month follow-up assessment. Other studies have reported similar associations between optimism and long-term emotional wellbeing after surgical intervention[25–27]. In addition, one previous study found that optimism was less

strongly related to functional ability than to psychological wellbeing[26].

The strength of the present study was that it enabled a prospective assessment of changes in the various SF-36 domains from the preoperative period to 6 and 12 months after surgery. Although it is possible that part of the change in health-related quality of life at follow-up was caused by factors other than surgical intervention, the authors are confident that most of the variance can indeed be attributed to the effects of surgery. First, all patients were excluded who had a malignancy that might result in a deterioration of the condition, who had indicated that they had another operation during the follow-up period, or who reported some other condition that affected their health. Second, the changes in the various domains of health-related quality of life correlated fairly strongly with perceived recovery of surgery, indicating that patients themselves seemed to attribute their condition to the operation.

This study also had several limitations. First, a heterogeneous patient group was studied, and, although the analyses controlled for several intervention-related variables, this heterogeneity probably had an impact on the outcome variables and may have attenuated some of the associations between preoperative predictors and outcome. The classification of procedures as minor, intermediate or major was based only on anticipated postoperative pain level and acute pain treatment requirements. Other factors, such as complexity of the procedure, were not taken into account, although duration of operation may partly account for that. A second limitation is that many patients were lost from initial inclusion to final follow-up. Even though some of this loss was due to the exclusion of patients with malignancy, further operations and other factors affecting health, this may affect the generalizability of the results. Drop-out analyses indicated that baseline differences between patients who remained in the study and those who were excluded or dropped out were small, but consistently indicated poorer physical and psychological functioning in patients lost to follow-up. This may have led to an underestimation of unfavourable outcome, and thereby less power to identify predictors thereof.

This study demonstrated that suboptimal recovery 6 and 12 months after surgical intervention is relatively frequent and can be partly explained by various somatic and psychological predictors. Of the factors related to poor outcome, acute postoperative pain and presurgical anxiety are potentially malleable. Future study should focus on the possibility to intervene on these variables and to determine whether this promotes optimal recovery.

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