RELIEVING THE STRAIN OF HEART PAIN

Psychological problems in patients undergoing coronary artery bypass graft surgery

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Psychological problems in patients undergoing coronary artery bypass graft surgery

Het verlichten van spanningen bij hartepijn

Psychologische problemen bij patienten die een coronaire bypass-operatie ondergaan

Proefschrift

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aan de Erasmus Universiteit Rotterdam
op gezag van de rector magnificus

Prof.dr P.W.C. Akkermans M.A.

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The patient must allow a group of relative strangers to break open his chest, stop his heart's functioning while various maneuvers are performed on and around it, and restart the heart; endure a prolonged convalescence marked by pain, restriction of activities, enforced passivity, sensory over- and understimulation, and the ongoing risk of sudden disaster ... . It is clear that navigating these waters would be a tremendous task for even the most "adjusted" person.

(Goldman & Kimball, 1985)

Voor mijn ouders

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CHAPTER 1

INTRODUCTION

Coronary artery bypass graft surgery (CABG) and percutaneous transluminal coronary angioplasty (PTCA) have become common interventional methods to treat patients with significant coronary artery disease [1]. Both methods are successful in their aim to relieve angina and thereby to increase life expectancy. CABG, however, involves revascularisation of the myocardium in an open-heart procedure with extracorporeal circulation.

The practice of cardiac surgery is constantly changing and so is the clinical profile of the patient presented for CABG. Improvements in surgical techniques and anaesthetic management have substantially reduced mortality rates [2] and extended the indications for surgery to the elderly population (above 65 years of age) [3]. With the rapid progress that has been made in the field of heart surgery, there has been an increasing interest in the impact of surgery on everyday life (i.e., the quality of life) and, more specifically, in psychological outcome of CABG [4-9]. It has become obvious that the physical results can be excellent, while there is little or no psychological improvement [10]. Studies have demonstrated that despite successful CABG, a considerable number of patients (about 20% to 25%) show psychological problems afterwards, in particular anxiety and depression [7, 8, 11-13].

Undergoing CABG implies a stressful experience for most patients and their families. Increased feelings of anxiety and depression have been reported, both pre- and postoperatively [10-18]. Most of the reported concerns are related to the illness itself, the surgical procedure (e.g., anaesthesia, losing self-control, death), the early period after surgery (e.g., pain, surgical failure, complications, dependency) and the future postoperative situation (e.g., problems in family and career) [19]. The following case reports, collected by semi-structural interviews, are presented to illustrate the diversity of concerns in four arbitrary patients, one week after CABG in the hospital.

Case A

An 80 year-old man suffered from severe angina. Although his wife disagreed, he decided to undergo CABG. He didn't feel anxious, neither before nor after surgery: '*There is nothing to be afraid of*'. Actually, for several years he felt quite depressed and had lost interest in his surroundings and even in life itself. He was only concerned

about his wife and leaving her behind if he would die during surgery, especially because she was ill too. Postoperatively, he felt somewhat relieved as the angina pain was gone.

Case B

A 49 year-old woman was very calm in the period prior to surgery. She was not anxious about the surgical procedure. She had undergone several types of surgery (e.g. lumbar surgery and mastectomy) and had faith in medical techniques. Despite a lot of bad luck in her life (e.g., many operations and a divorce), she never felt depressed. Postoperatively, her main concern was her career as a veterinary surgeon and the chance of being written off professionally. As heart disease was a major problem in her family, she was familiar with its consequences. It was hard for her to accept that a life without heart disease had finished.

Case C

A 55 year-old man was scheduled for repeat surgery. His first CABG had been performed twelve years ago. At that time he was very anxious, both pre- and postoperatively. Preoperatively, he was very concerned about dying during surgery. Postoperatively, he was worrying whether the result of the operation would be successful. Until one year after surgery, he experienced strong feelings of anxiety and disability. Regarding the repeat surgery, his main concern before the operation was again the fear of dying: '*Although the mortality rate is only 2%, there is still a chance of being among those two percent*'. Fortunately, this time he was able to reduce his fears by concentrating on his work and other aspects of everyday life. Postoperatively, he worried about having a pacemaker. However, this appeared to be necessary for only two days. As soon as the pacemaker was removed, he felt relieved and quite hopeful about his recovery.

Case D

A 76 year-old man reported no fears in the preoperative period. Friends of his, who had undergone CABG before, told him that there was no need to worry. After CABG, he became restless and confused and showed signs of an organic brain syndrome, including trouble with memory and attention. He was thought to have a postcardiotomy delirium and was treated by a psychiatrist with Haldol. He was very anxious and he worried about his forgetfulness. After a few days he was doing much better, but still he felt sad. He cried easily and longed to go home.

These case reports demonstrate that patients undergoing CABG may have a wide variety of concerns, with some patients reporting more problems (e.g., anxiety and depression) than others. The extent of psychological problems rather than the underlying concerns emphasizes the need for research on psychological outcome following CABG. In particular, those patients reporting high rates of psychological problems should be identified in an early phase and offered additional support.

In recent years, several attempts have been made to study preoperative predictors of recovery from CABG [11, 12, 15, 20-22]. The function of these prospective studies was to identify patients who are at risk of having postoperative problems. If we understand the factors leading to either good or poor outcome, it becomes possible to develop and test interventions to assist those patients who are in need of additional support [17]. Eventually, these interventions may contribute to an optimal success rate for all patients undergoing CABG.

The aim of this thesis was to examine psychological outcome in patients undergoing CABG, using a prospective approach. Psychological outcome was defined in terms of psychological problems often reported in patients undergoing CABG, based on both our own clinical observations and findings from literature. The most reported psychological problems, both pre- and postoperatively, are feelings of anxiety and depression [9, 10, 16, 19, 23, 24]. Although somatic in nature, feelings of disability [10, 23], vague somatic complaints [11, 15, 19] and fatigue [25, 26, 27] have frequently been recognized in relation to psychological outcome after CABG. It is assumed that these problems, weeks or months after surgery, are associated with feelings of anxiety and depression rather than being a manifestation of the actual somatic status [15, 16, 19, 25].

With respect to the prospective approach, a review of recent prospective studies on recovery from CABG is presented in the next chapter (chapter 2). These studies were mainly based on outcome in terms of quality of life. In line with the aim of this thesis, we particularly concentrated on psychological outcome. Directed by the findings in Chapter 2, four specific aims are described in Chapter 3. These specific objectives were examined in separate studies, which

are described respectively in Chapter 4, 5, 6 and 7. Finally, an overall discussion of the results, methodological issues and suggestions for future research and clinical practice are presented in Chapter 8.

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CHAPTER 2

PREDICTION OF QUALITY OF LIFE AFTER CORONARY ARTERY BYPASS GRAFT SURGERY: A REVIEW AND EVALUATION OF MULTIPLE RECENT STUDIES

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Abstract

The present review evaluated recent prospective studies predicting quality of life after coronary artery bypass graft surgery (CABG). Seventeen prospective studies, appearing in the MEDLINE and PsycLIT data bases between 1986 and 1996, were reviewed regarding objectives, methodological issues, results and clinical relevance. All studies reported that psychological factors had predictive value. In particular, preoperative anxiety and depression predicted postoperative psychological maladjustment; social support, preoperative feelings of control, denial and optimism contributed to psychological adjustment. In conclusion, many specific psychological outcomes seemed to be best predicted by preoperative assessment of functions in that specific area, especially in the case of anxiety and depression. Furthermore, personality factors including denial, optimism, control and the need for support appeared to be predictors of psychological outcome. Appropriate identification of predictive factors might improve the development of individually-tailored interventions for patients at risk of postoperative psychological problems.

Introduction

Coronary artery bypass grafting (CABG) is an established treatment procedure for patients suffering intractable angina and life-threatening ischemic heart disease [1]. Despite its undoubted benefits, CABG has a significant in-hospital mortality rate [2, 3] and immediate symptomatic improvement is apparent only in about 80% of cases [2]. Recurrence of anginal symptoms [2, 4], myocardial infarction (MI) and cardiac death [2] are likely within the ten years after CABG. In many instances, however, the angina pectoris is very mild and can be managed by medication, with only some patients requiring additional invasive treatment such as angioplasty or reoperation [4].

Many factors influence mortality and morbidity, including age at the time of surgery, left ventricular function, ventricular dysrhythmias, time of intervention and type and number of grafts [2, 5, 6]. Mortality also seems to be related to body surface area, the presence of comorbid disease and repeat surgery [3]. Advances in

surgical techniques and anaesthetic management have already substantially reduced mortality rates. However, extracorporeal circulation still carries a risk for impaired cerebral functioning [7].

Although mortality associated with cardiac complications is decreasing, the incidence of cerebral complications is substantial [8, 9]. Neuropsychological dysfunction is quite common early after surgery and can persist in the late postoperative period [10-19]. The incidence ranges from 33% to 83% of patients in the early postoperative period and up to 35% of patients for one year postoperatively [9]. Older patients especially seem to have an increased risk of developing postoperative psychiatric complications [20, 21] and cognitive decline [9].

The outcome of CABG usually has been seen only in terms of mortality and morbidity. The outcome of treatment has been measured by survival rates, test results, return to work figures, and clinical judgement. Recently, however, the emphasis has been more towards assessing outcome in terms of patients' perceptions of changes in their state of health over time and how this affects their lives; in other words, assessing the health-related quality of life [22]. Health-related quality of life refers to the impact of health conditions on function. In addition to the physical consequences of medical or surgical interventions, psychosocial factors are taken into account.

Health-related quality of life

There is no universal agreement as to what quality of life means or how it can be measured [23, 24]. Most researchers agree that quality of life is a multidimensional construct [25], but there is no agreement on which dimensions should be assessed. It seems, however, that health-related quality of life is a reflection of the way that patients perceive and react to their health status and to non-medical aspects of their lives (i.e. jobs, family and friends) [24]. Major domains with regard to health-related quality of life assessment are physical functioning, emotional status, cognitive performance, social functioning, general perceptions of health and well-being and disease-specific symptoms [23]. Employment status is also sometimes included.

Most health-related quality of life measures are designed for use with any disease. The reason for this approach is that it seeks to determine the impact of the disease on general function, supposing that all diseases have a general effect on

the quality of life. In contrast to this more general approach, there are quality of life measures for specific diseases, such as cardiovascular disease. The rationale underlying this disease-specific approach is clinical and assumes that each medical condition or treatment has very specific outcomes [25, 26]. To assess health-related quality of life, both general or generic and disease-specific measures are required, each with its own advantages and disadvantages [25-28].

Quality of life measures have gained increasing attention as outcome variables in studies of cardiovascular disease in addition to the objective measures of cardiovascular status [25]. One main goal of CABG is to relieve angina and thereby to improve physical activity. This, in turn, has consequences for work, leisure, social and sexual activities and for mood. Successful surgery enables most patients to resume a much fuller way of everyday life [29-35]. Improvements in physical (i.e., fewer activity restrictions), social (i.e., social participation and pursuit of hobbies) and sexual functioning (i.e., increased energy and desire and decreased pain and worry) [36] as well as vocational status [34] are noted six months after CABG. Decreased anxiety, depression, fatigue and sleep problems are reported within six months after surgery [37]. One year postoperatively, relief of angina, increased performance of everyday activities and improvements in mental state, leisure activity, satisfaction and family life were reported by the majority of patients [33]. Improvements in general health status, one year postoperatively, seemed to compare favourably with those from a normal male population [22].

For some patients, however, outcome for quality of life can be disappointing despite successful surgery [33, 38-43]. For instance, 20% of male patients presented somatic complaints and showed a lack of confidence about physical activity at one year after surgery, which seemed to be an expression of anxiety rather than of being somatic in origin [33]. Despite a general improvement in psychological functioning, 22% of patients reported feelings of depression and 18% were still anxious, one year post-operatively [32]. Also cognitive dysfunctions [18, 19] and delirium [20, 21, 44] may occur in the postoperative period.

For the patient, cardiac surgery may be experienced as a life-threatening procedure [45]. Some (20% to 25%) patients fail to adapt to this procedure and increased anxiety and depression have been noted postoperatively [32, 33, 38]. Therefore, there is a need to evaluate the patient's perception of the stressfulness

surrounding the surgical procedure and to understand the possible effects of this perception on outcome [46].

In recent years, there has been an increasing proliferation of interest in long-term psychological adaptation and in different aspects of quality of life following CABG [32, 33, 47-50]. Return to work often has been studied in regard to outcome after CABG [51-53] but there is still a lack of prospective research studying predictors of other aspects of quality of life, such as psychological outcome. Patients at risk of postoperative psychological problems might be identified before surgery. Identification of predictive factors may improve the development of interventions for those at risk [41].

This review evaluated evidence with regard to the possibility of identifying factors, which predict outcome after CABG. The focus was on the prediction of outcome in terms of health-related quality of life, emphasizing psychological outcome. In this article, we reviewed prospective studies appearing in the MEDLINE and PsycLIT data bases using the keywords coronary artery bypass surgery (CABG), cardiac surgery, prediction, recovery, psychological, psychosocial, quality of life, and preoperative factors. All of the studies were conducted after 1986. Intervention and experimental studies were excluded as the focus was on the natural course of convalescence after CABG. Furthermore, since we focused on those studies in which outcome is defined in terms of quality of life or at least a psychological domain, studies on outcome only associated with employment or cognitive functioning were not reviewed in this article.

First, the objectives of selected studies are presented. Next, the studies are discussed regarding a number of methodological issues [54], including patient selection, experimental design, selection of instruments and statistical analysis. Finally, the results regarding prediction of outcome are presented and their clinical relevance is discussed.

Methods

Objectives

Regarding the objectives of predictive studies, a distinction was made between broad-based and focused studies. The broad-based studies had a more exploratory character and related outcome to a series of preoperative psychological factors to

identify predictors of outcome. The focused studies, on the other hand, tested several hypotheses relating outcome to one or two psychological factors.

Broad-based studies (n = 9) The main objectives in these studies were to assess the situation before and after surgery to evaluate outcome and to detect and isolate factors that could predict this outcome. Outcome was related to a series of the same factors measured before surgery, such as quality of life [22, 55, 56] and psychosocial outcome [40, 42]. Sometimes a factor analysis was used to reduce the variables to select dependent psychological variables and possible psychological predictors [38, 57]. Bryant and Mayou [41] selected independent variables, including preoperative measures of medical, psychological and social functioning and demographic factors, to predict social outcome, return to work and psychiatric state. Jenkins et al. [58] selected 39 variables, including demographic descriptors, medical data, preoperative daily activities, social relations and questions on general contentment and optimism, to predict outcome in terms of symptoms of illness. Subsequently, this outcome was based on nine variables including clinical, behavioral and psychological measures.

Focused studies (n = 8) These studies examined the association between outcome after CABG and one or two specific psychological factors. Relationships between social support and outcome were examined in three studies. Kulik and Mahler [59] studied the relationships between in-hospital spouse support and general spouse support with a variety of psychological, behavioral and physical measures of recovery during the period of hospitalization after CABG. In a more recent study, they [60] examined the separate and combined effects that postoperative emotional support and preoperative marital status might play in longer-term adjustments. A third study relating social support to long-term recovery included the influence of support to the spouse [30]. The hypothesis that higher levels of perceived ability of social support was related to more positive emotional and functional outcomes in patients recovering from CABG and in their spouses was tested. A second goal in this study was to explore the relationship between support to the spouse and patient outcome.

Mahler and Kulik [61] examined two personality characteristics that have, in recent years, been linked to a more active role in the health care process: preoper-

ative perceived feelings of control over recovery and the patient's desire for health care involvement. The association between these factors and their relationship with the early postoperative outcome was explored. Two types of health care involvement preferences were distinguished: the desire for behavioral involvement in health care and the desire for information about health care. Later, Mahler and Kulik [62] examined how these patients' preferences for information and behavioral involvement, respectively, predicted social and emotional recovery and the use of medical services during the year following CABG.

Two prospective studies examined the predictive value of dispositional optimism. Scheier et al. [63] evaluated the role of optimism on coping efforts and the physical and emotional recovery of patients during hospitalization and at six months after CABG. Fitzgerald et al. [29] examined dispositional optimism and personal control appraisals as personality resources which might influence the quality of life at eight months after CABG. They selected three adaptational outcomes to capture the quality of life construct: angina pain, negative affect and life satisfaction.

Finally, the relationships between preoperative denial and immediate postoperative outcome (i.e., anxiety) and long-term recovery (i.e., anxiety, depression and psychosocial adjustment) were studied [64].

Selection of patients

The basis for patient selection, including sample size, type of surgery, age and gender, varied widely across the studies (Table 1). First, the number of patients varied between 45 [40] and 463 [58] in the broad-based studies and between 49 [29] and 155 [30] in the focused studies. Second, in all studies the type of surgery was nonemergency CABG and in three studies was combined with cardiac valve surgery [42, 55, 58]. Often the studies were limited to patients who were having CABG performed for the first time [29, 38, 56, 58, 60-63]. One study included five patients undergoing a second CABG [41]. Differences between a first and repeat surgery should be reported because repeat surgery may be both a medical risk [4] and an important factor with respect to psychological adjustment to outcome. Unfortunately, nearly half the studies did not mention whether it was a first or repeat surgery. Third, possible upper age limits should consider patients with increasing age since improvement in surgical techniques has extended the

indications for surgery to the older population [54]. Half the studies, however, had an upper age limit, varying from 58 to 70 years. Finally, selection of patients should include both men and women because the number of women undergoing CABG is increasing. Eight studies included male patients only [22, 41, 57, 59-63].

Table 1. Selection of patients

Reference	N	Type of surgery	Limits of age (yr)	Gender
Broad-based studies				
Boudrez et al.[38]	330	first CABG	no limit	284♂ 46♀
Bryant and Mayou [41]	79	first/second CABG	<65	79♂
Caine et al. [22]	100	CABG[a]	<60	100♂
Chocron et al. [55]	209	CABG/valve[a]	no limit	156♂ 53♀
Jenkins et al. [58]	463	first CABG/valve	25-69	382♂ 81♀
Kos-Munson et al. [56]	92	first CABG	<64	77♂ 15♀
Langosch and Schmoll-Flockerzie [57]	75	CABG[a]	no limit	75♂
Magni et al. [42]	99	CABG/valve[a]	>21	69♂ 30♀
Strauss et al. [40]	45	CABG[a]		38♂ 7♀
Focused studies				
Fitzgerald et al. [29]	49	first CABG	<58	41♂ 8♀
Folks et al. [64]	121	CABG[a]	<65	91♂ 30♀
King et al. [30]	155	CABG[a]	no limit	122♂ 33♀
Kulik and Mahler [60]	85	first CABG	35-70	85♂
Kulik and Mahler [59]	72	CABG[a]	no limit	72♂
Mahler and Kulik [62]	83	first CABG	no limit	83♂
Mahler and Kulik [61]	75	first CABG	no limit	75♂
Scheier et al. [63]	51	first CABG	<58	51♂

CABG = coronary artery bypass graft surgery; [a] The authors did not mention whether it was a first or repeat surgery

Two studies explicitly excluded patients with a major psychiatric disorder [29, 64] and two studies included spouses or family members in addition to the patient population [30, 42]. Most studies took into account the percentage of refusals and dropouts. Reasons frequently given were death, major postoperative complications, too busy, too tired, and relocation. Because patients do not drop

out randomly, reporting data only on patients who complete follow-up may give an inaccurate picture of the results [54]. Only one study checked on potential differences between the patients who returned for follow-up and those who refused [30].

Study design

Prospective studies usually evaluate patients prior to surgery and at one or more follow-up intervals. In order to assess the recovery process, the timing of follow-up measures is recommended to be both during hospitalization and in the late postoperative period. A preoperative baseline assessment of the variables representing outcome is necessary to determine improvement or deterioration. This assessment takes place preferably more than one day before surgery to exclude the possible effects of anticipatory anxiety that may affect baseline responses [29].

In all studies, patients were assessed at several points in time, starting prior to surgery. The first measurements were mostly obtained on admission or during the day before surgery. Fitzgerald et al. [29] and Magni et al. [42] started their study one month and seven days before surgery, respectively. Kos-Munson et al. [56] started their study following coronary angiography. This early point of assessment was chosen in order to obtain baseline data as close to the onset of recognized cardiac illness as possible. Two additional preoperative meetings took place in order to administer several tests.

The number of postoperative assessments varied between one and three. The time elapsed since surgery varied between as early as two or three days [40, 57] to 27 months [40]. Only three studies assessed in-hospital recovery [57, 59, 61], whereas 11 studies only assessed long-term outcome [22, 29, 30, 38, 41, 42, 55, 56, 58, 60, 62]. No more than three studies estimated outcome both in hospital and after discharge [40, 63, 64].

As far as the independent and dependent variables are concerned, all the studies assessed psychological variables. These variables were from a single concept such as anxiety or depression to an umbrella concept such as quality of life or functional status. To represent physical recovery, many studies included physical markers of outcome [22, 40-42, 55, 58, 59-63]. These physical markers frequently included postoperative complications, ambulation during hospitalization and surgical pain. Objective endpoints such as, for instance, exercise stress ECGs, were

missing in all the studies. In most studies, preoperative [22, 38, 41, 55, 58, 59, 61, 62] and perioperative medical variables [29, 40, 42, 58, 60, 63] were collected to determine which variables might need to be taken into account as covariates in statistical analyses. Preoperative variables mostly included angina level or New York Heart Association (NYHA) functional class, comorbid diseases and risk-factors (e.g., smoking status and alcohol use). Several items derived from surgical records (e.g. total time of anaesthesia, cross-clamp time, pump time and number of grafts) were included as perioperative variables. Sociodemographic variables (e.g., age, gender and education) were described in all the studies. Most studies controlled for the possible effects of these background factors when predicting outcome [29, 40, 41, 55, 56, 58-62, 64]. Only one study used a control group to compare the general health state of patients at one year after CABG with a normal male population [22].

Selection of instruments

Selection of instruments is guided by several considerations: reliability and validity of measures, brevity, availability of normative data and use in prior studies [54].

The test batteries varied across the studies. Three types of instruments were applied to assess psychological factors: interviews, self-report questionnaires and Likert or visual analogue scales (VAS). Medical data were collected by studying medical records. Two studies conducted a semi-structured interview as the basis for interviewer ratings [41, 61]. All studies used at least some standardized self-report inventories (e.g., Profile of Mood States and the State-Trait Anxiety Inventory) or questionnaires in which psychometric qualities were indicated in the text or could be found with the aid of literature references.

A comprehensive quality of life assessment is recommended to cover both a generic and a specific measure [25-28]. Generic measures capture a wide variety of dysfunctions associated with almost any disease [25]. These instruments lack the range, sensitivity and flexibility to deal with the particular problems of specific illnesses [26, 27], but allow comparison with other research findings or other diseases [27]. Disease-specific instruments are considered to give useful additional information about a patient's response to a treatment and allow discrimination between treatments [27]. The combination of both generic and specific measures was applied by Caine et al. [22]. Sometimes a generic measure was combined with

a more domain-specific measure such as emotional state [30, 51, 56]. Chocron et al. [55] administered only one generic measure, although many others assessed exclusively domain-specific variables to get an impression of the quality of life [29, 38, 40, 41, 58, 60, 62].

Statistical analyses

One main end point of prospective studies is the change from preoperative baseline to postoperative condition. Another main goal is to examine what factors are associated with this change or with postoperative outcome.

Three major steps could be distinguished in the several data analyses. First, non-parametric tests [22, 55], *t*-tests [29, 38, 42, 57] or analysis of variance (ANOVA) [30, 60] were used to compare measures before and after surgery. The second step represented the calculation of statistical significance of each predictor variable independently. Chi-square tests [22, 38, 41], analysis of covariance (ANCOVA) [55], ANOVA [58, 59] or correlations [29, 30, 42, 56, 61, 64] were used to analyze whether the preoperative variables were associated with outcome. Factor analysis reduced preoperative data in two studies [38, 57]. Finally, the third step determined whether significant predictors made independent contributions to predict recovery even after other preoperative factors were taken into account. A hierarchical strategy of multiple regression analysis was used in most studies [29, 38, 41, 42, 56-58, 60-63]. Caine et al. [22] used discriminant analysis to investigate prediction of outcome. Strauss et al. [40] differentiated three subgroups within the follow-up sample, using a hierarchical cluster analysis. These subgroups were then compared using either one or two factorial analysis of covariance (ANCOVA), with one group factor, one repeated measurement factor and one covariate. Finally, factors influencing categorical outcome data (i.e., improved or worsened status of patients) were determined by logistic regression in the study of Chocron et al. [55].

Results

Broad-based studies

All studies reported preoperative predictors of outcome (Table 2). Boudrez et al. [38] reported that despite improvement of psychological status, 10% to 20% of

Table 2. **Prediction of outcome after cardiac surgery: broad-based studies**

Reference	N	Outcome	Preoperative predictors
Boudrez et al. [38][a b]	330	psychoneuroticism and anxiety *4 months after CABG*	high score for cardiovascular tendency and gastrointestinal susceptibility
Bryant and Mayou [41]	79	adequate social adjustment	low score for anxiety and depression; higher age and social class
		return to work	preoperative employment; nonmanual jobs
		adequate psychological status *1 year after CABG*	low score for anxiety and depression
Caine et al. [22]	100	return to work and home activities *1 year after CABG*	preoperative employment; short wait before operation; absence of dyspnea; low mobility score
Chocron et al. [55][b]	209	less improved or worsened quality of life *3 months after cardiac surgery*	age over 70 years; NYHA class III/IV
Jenkins et al. [58][a b]	463	freedom from cardiac symptoms *6 months after cardiac surgery*	low score for dyspnea, sleep problems, lifetime cigarette use, preoperative hospitalization for cardiac treatment, anxiety; high score for social support
Kos-Munson et al. [56][a b]	106	satisfactory rehabilitation *1 year after CABG*	low score for depression; high score for income
Langosch and Schmoll-Flockerzie [57]	75	psychopathology *at discharge*	low score for social desirability; high score for concern about well-being
Magni et al. [42][b]	99	anxiety and depression *1 year after surgery*	high score for irritability, anxiety, depression; general hypochondriasis
Strauss et al. [40][b]	45	anxiety and depression and low life satisfaction *21 to 27 months after CABG*	high score for anxiety and depression; fatalistic attitude

CABG = coronary artery bypass surgery; NYHA = New York Heart Association; [a] first surgery; [b] male and female patients

patients still exhibit dysfunctional psychological states (especially anxiety) postoperatively. Predictive power could partly be observed in two preoperative psychosomatic variables including cardiovascular tendency and gastrointestinal susceptibility of the Millon Behavioral Health Inventory (MBHI). Cardiovascular tendency referred to patients evidencing a strong psychological component

associated with cardiovascular symptoms; gastrointestinal susceptibility referred to patients evidencing a strong psychological component associated with gastrointestinal disorders [65]. Much of the variance of the outcome score (i.e., the postoperative psychological status) was, however, explained by postoperative variables such as performance of activities without cardiac pain including cycling, sex and activities in cold temperature.

Bryant and Mayou [41] reported that the outcome in each aspect of function was most closely associated with preoperative functioning in that area. For instance, having psychological symptoms before surgery (mainly anxiety and depression), younger age and lower social class appeared to be predictors of inadequate social adjustment.

Caine et al. [22] identified four significant factors in a discriminant analysis; for instance, preoperative employment had a positive effect on return to work and home activities by one year after surgery.

An average of 80% of patients were improved by both CABG and valve surgery in the study of Chocron et al. [55]. The improvement was also similar for patients with no postoperative events as opposed to those with nonfatal postoperative complications. The strongest predictors of quality of life were age (i.e., over 70 years) and NYHA classification (i.e., III or IV). Female gender predicted postoperative worsening in the social isolation section of quality of life.

The preoperative predictors provided by Jenkins et al. [58] contributed independently in a multiple regression equation which accounted for 21% of the variance of the symptoms illness score. Three of these predictors (i.e., dyspnea, sleep problems and anxiety) were closely related to factors of the symptoms of illness outcome measure. Type of surgery (CABG versus valve surgery) had a nonsignificant relation to the illness symptoms score.

Kos-Munson et al. [56] showed that preoperative depression and income were significantly predictive of rehabilitation. These predictors shared 28.9% and 6% respectively, of the variance with the outcome measure.

The results of Langosch and Schmoll-Flockerzie [57] demonstrated that patients who were apprehensive about their health and felt less bound by social rules were prone to higher psychopathology in the early postoperative period. These factors predicted 24% of the variance of outcome. Anxiety was the main

symptom before and after surgery in this study, although the content of anxiety was not the same in both periods.

Psychological maladjustment before surgery characterized by high anxiety and depression, predicted high anxiety and depression scores after surgery in the study by Magni et al. [42]. Ischemic heart disease rather than valvular cardiac disease also seemed to be linked to a worsened psychosocial outcome. Difficult postoperative adjustment was present in about 25% of the patients.

Finally, Strauss et al. [40] differentiated a risk group (i.e., 24% of the total sample) showing psychosocial problems (i.e., high anxiety and depression and low life satisfaction) approximately two years following CABG. This study demonstrated an increased impairment within the risk group even prior to surgery, especially emotional problems (high levels of anxiety and depression) and a more fatalistic attitude.

Focused studies

The results could be divided in accordance with their specific predictors (Table 3). Social support, as indexed by the frequency of hospital visits by the spouse, was positively associated with outcome during hospitalization [59]. High emotional support was predictive of a reduction in anxiety and depression for up to 13 months after CABG [60]. King et al. [30] examined the effect of five types of social support (i.e., information and advice, material support such as financial assistance and services or goods, esteem support, emotional closeness support and group-belonging support) on recovery one year after surgery. For both patients and their spouses, the set of five support variables was consistently related to emotional and functional outcome, accounting for 38% of the variance. When the differential influence of five types of support was examined, only esteem support accounted consistently for unique shares of the relationship between social support and outcome. Esteem support, which involves the feedback being respected by others, was associated most strongly with emotional outcome. Finally, support perceived by the spouse was related to positive patient outcomes as well as to the spouses' own feelings of well-being after controlling for support to the patient.

Table 3. Prediction of outcome after cardiac surgery: focused studies

Reference	N	Outcome	Predictors
Kulik and Mahler [59]	72	less pain medication and faster speed of recovery *during hospitalization*	high spouse support during hospitalization
Kulik and Mahler [60][a]	85	low level of anxiety and depression; better perceived quality of life; compliance with ambulation; not smoking *up to 13 months after CABG*	high emotional support after surgery
King et al. [30][b]	155	better emotional and functional outcome *up to 1 year after CABG*	high patient and spouse perceptions of esteem support before and after surgery
Mahler and Kulik [61][a]	75	less pain and more negative psychological reactions	desire for information
		greater pain behaviour; more ambulation; shorter stay	desire for behavioral involvement
		shorter stay *during hospitalization*	perceived feelings of control
Mahler and Kulik [62][a]	83	less ambulation dysfunction; fewer social interaction problems; less emotional upset	desire for behavioral involvement
		more social interaction and emotional problems *4 months after CABG*	desire for information
Scheier et al. [63][a]	51	faster rate of physical recovery *during hospitalization* and of return to normal life activities *after discharge*; better quality of life *6 months after CABG*	dispositional optimism
Fitzgerald et al. [29][a,b]	49	enhanced life satisfaction angina pain *8 months after CABG*	specific expectancies specific control appraisals
Folks et al. [64][b]	121	less anxiety *4 days after CABG*; less anxiety and depression; better psychosocial adjustment *6 months after CABG*	preoperative denial

CABG = coronary artery bypass graft surgery; [a] first surgery; [b] male and female patients

Mahler and Kulik [61, 62] studied the patients' role in the health care system. The results of both studies suggested that desires for behavioral involvement and information could moderate adjustment to surgery in different ways for up to four months after CABG. Information-seeking patients tended to experience more emotional and social interaction difficulties, whereas only patients with a desire for behavioral involvement with their treatment fared better from a social-emotional standpoint. The authors [62] attributed desire for information involvement to a basic desire to reduce uncertainty and arousal. Moreover, it has been suggested that information seekers monitor sensations more closely, which may increase emotional distress and uncertainty [66]. On the other hand, the desire for behavioral involvement with treatment may reflect a basic desire to exert some direct control over the situation. The results indicated that patients' desires for information and for behavioral involvement with treatment were independent orientations to health care involvement; they were differentially related to outcomes with no significant interaction effect.

The relationship between dispositional optimism and recovery after CABG was reported in two studies [29, 63]. Dispositional optimism was an important predictor of surgical outcome and coping efforts [63]. For instance, dispositional optimism had a strong effect on the patient's quality of life at six months after CABG, ranging from satisfaction with home, family and health to satisfaction in a sexual relationship and in recreational activities. Optimism correlated positively with problem-specific coping and negatively with denial. In addition to dispositional optimism, specific expectancies (i.e., expectations regarding experiences during the immediate postoperative period and normalization of life functions) played a significant role in certain aspects of the recovery process. Fitzgerald et al. [29] also showed that dispositional optimism predicted quality of life (i.e., angina, negative affect and life satisfaction) eight months after CABG. However, this was not the case when beliefs of control (i.e., belief in general control and perceived control over the course of illness) and specific expectancies (i.e., expectations regarding activity level, sexual functioning and overall capacity) were also included in the prediction. Like Scheier et al. [63], no association between specific expectancies and dispositional optimism was found.

Finally, the relationship between preoperative denial and symptoms of postoperative anxiety, depression and psychosocial adjustment was examined [64].

A significant inverse relationship between preoperative denial and anxiety was shown four days after surgery. The results revealed that the state of denial at higher levels preoperatively might be a predictor of improved outcome in measures of anxiety, depression and psychosocial adjustment, especially in the immediate postoperative period up to six months after surgery.

Clinical relevance

Although all studies reported statistically significant predictors of outcome, relatively little attention was given to the clinical relevance of these predictors. The results, however, may have implications for the identification of those who are at risk of later psychological difficulties.

The available results confirmed that there was a considerable number of patients (about 20% to 25%) showing psychological problems following CABG [38, 40, 42]. For instance, 25% of all patients exhibited high anxiety scores four months after CABG [38]. Postoperatively, the risk group identified by Strauss et al. [40] was characterized by a high level of anxiety and depression, life dissatisfaction, a tendency to give up and problems in work-related rehabilitation. At one year after surgery, 25% of all patients in the study of Magni et al. [42] reported persistent or new psychological distress (i.e., high scores on depression and anxiety scales).

Analysis of the psychological predictors of problematic adjustment showed that these predictors can be relatively stable personality factors, which are not accessible to modification without specifically directed intervention [42]. If this is true, it will be difficult to design or select an intervention to improve patients' psychological outcomes. For instance, providing the extra care that is needed to help pessimistic patients will be a difficult task [63].

On the other hand, preoperative counselling and psychological guidance after surgery may help to reduce anxiety and depression. Interventions designed to prepare patients for surgery are usually aimed at decreasing patients' fear and distress through the provision of information or psychological treatments or both [67, 68]. All patients require routine information before surgery, but it is probable that more could be done, both to counter unrealistic expectations and to give extra individual counselling for patients at risk of psychological difficulties after

surgery [58]. It has been shown that preoperative preparation can reduce patients' psychological distress by providing information about perioperative events and training in specific behaviours or skills to facilitate recovery (i.e., deep-breathing, coughing and leg exercises and techniques for turning in bed) [69]. Rehabilitation could concentrate on individually planned care to identify and to treat psychological problems [58, 61]. For instance, patients could profit from individually-tailored interventions at the time of hospital discharge such as an increased motivation to take responsibility for their personal care and recovery. Patients with a strong desire for information might benefit from interventions explaining possible physical sensations and clarifying questions by regular follow-up sessions [62].

In conclusion, the reviewed studies identified predictors of psychological outcome. This may provide an opportunity to find a remedy for the 20% to 25% of patients experiencing psychological problems, even after successful CABG.

Summary and recommendations

The main goal of CABG is to relieve angina and to prolong life-expectancy. Another important end point is improvement of health-related quality of life. Health-related quality of life measures are currently needed to evaluate the impact of disease and the effects of medical interventions [70]. The multidimensional complexity of quality of life makes such analysis difficult. Prospective studies may isolate factors that can identify patients at risk of a poor health-related quality of life, postoperatively. It is, however, essential to be aware of the effect that the predictors of outcome are different for the various dimensions of quality of life after CABG.

In the preceding sections, 17 studies were reviewed with respect to several methodological issues. Two types of predictive studies were distinguished. Both the broad-based and focused studies used a prospective, longitudinal design with patients who were contacted before and after surgery. The results of both types of studies give an encouraging representation of the possibility of prediction of outcome after CABG.

Regarding the broad-based studies, it seems that many specific outcomes were best predicted by premorbid measures of functions in that area. In particular, high preoperative anxiety and depression scores were reported in predicting high levels

of anxiety and depression after surgery (Table 2). The question arises whether the premorbid psychological status predicts or confounds the recovery process after CABG [23]. The answer to this question depends on the purpose of the study. Preoperative variables may be predictors if one is studying patients' individual differences in adaptation to surgery. Preoperative variables will be confounders where individual differences need to be excluded in determining the sole effect of surgery on outcome.

If we take the focused studies, the results can be grouped by type of predictor. Support was favourably associated with adjustment to CABG [30, 59, 60]. Hospital support affected the patient's emotional status and facilitated coping behaviour [59] and perception of esteem support appeared to be the most important type of support related to feelings of well-being and long-term recovery [30]. Perceived feelings of control and desire for involvement in health care predicted different health outcomes independently [61, 62]. Perceived feelings of control were described as a belief, whereas desire for health care involvement seemed to reflect a preferred style of coping in health care situations [61]. A desire for information was generally associated with asking questions during medical examinations, whereas a desire for behavioral involvement was associated with attempts to self-diagnose, delays in seeking treatment and less use of medical facilities. A desire for involvement with health care has important implications for how well patients cope with CABG [62]. Dispositional optimism, as a personality resource, played an important role in responses to recovery from CABG [29, 63] in the choice of coping strategy [63] and was associated with perceived control over the course of illness [29]. Finally, preoperative denial seemed to be both adaptive [64] and maladaptive [63] in exerting positive effects. Denial may convey either benefit or risk, depending on the situation and temporal factors [64]. It served, for instance, as an adaptive mechanism in the early postoperative period [64], although it seemed to be maladaptive in the late postoperative period [63].

It is possible that some underlying factors cause a relationship between the various predictors and outcomes [29, 30]. Determining how these predictors operate is the key to understanding the different relationships. A given variable is considered to function as a mediator to the extent that it accounts for the relationship between a predictor and an outcome measure [61]. Only three studies examined possible mediators [61, 62, 63]. For instance, Mahler and Kulik [61]

suggested that ambulation may mediate the relationship between perceived control and hospital release.

Despite the fact that the number of women undergoing CABG is increasing, nearly half the selected studies excluded women. The physical outcome of cardiac surgery may not be as beneficial for women as it is for men, which raises the question of whether gender differences also exist in psychological functioning after surgery [71]. Only five out of nine studies that included both males and females reported gender differences or at least the female gender was included in the statistical analyses [38, 42, 55, 56, 58]. With regard to gender differences on outcome variables, significant gender effects were reported with women showing poorer rehabilitative results [56] or more illness symptoms [55]. Gender, however, was not identified as a significant predictor. Remarkable presurgical differences between male and female patients were noted by Boudrez et al. [38] but completely disappeared four months after surgery. Future studies need to examine in greater detail the gender differences regarding psychological outcome, in particular the risk of depression in female cardiac surgery patients [71, 72].

All studies were primarily interested in preoperative predictions but prediction based on early convalescence, for instance on mental state, could be expected to improve the accuracy of predictions of late postoperative outcome [41]. Few studies reported post-surgical predictors, including social support during follow-up [30, 59, 60] and the performance of activities without cardiac pain [38]. It seems appropriate to identify those patients with unfavourable reactions, both preoperatively and postoperatively, in order to improve clinical interventions to increase health-related quality of life.

To understand the surgical effects on quality of life, future studies should consider whether the various measures are attributed by the patient to be health-related. A variety of dimensions, such as social functioning or work, may be both related and unrelated to the cardiac disease, depending on the perception of the individual patient. It is therefore essential to be aware of the significance of individual opinions and the wide range of individual responses to cardiovascular disorders [26].

So far, little attention has been given to the way in which the various dimensions of quality of life might affect one another. Such knowledge could provide more insights into the concept and its clinical relevance [73]. As far as

prediction studies are concerned, there is also a need to know how the several factors before and after surgery relate to one another and what these relationships mean. An alternative statistical approach to predict outcome is to interpret relationships in terms of a structural model in which the represented variables are considered to influence each other, with paths being drawn between the variables showing the direction of influence. This procedure can be implemented by means of the LISREL approach [73, 74]. Structural modelling can contribute to the understanding of the possible relationships concerning the recovery process and might also suggest where clinical interventions would be most effective to improve the outcome after CABG.

Because of the heterogeneity of methodological factors in the selected studies, it is difficult to draw general conclusions regarding prediction of outcome. First, the number of patients varied and different inclusion criteria were used. Second, patients were assessed at different points in time. Third, many different variables as well as instruments, both standardized and non-standardized, were used to assess and predict outcome. Finally, medical factors may influence the effect of psychological predictors of outcome. Most studies gave limited information on these variables and therefore the interpretation of results is complex.

Nevertheless, outcome after CABG is a multidimensional phenomenon and seems explained only partially by medical factors. The results of both broad-based studies and focused studies suggest that various psychological factors contribute to the recovery process. The preoperative psychological condition, in particular anxiety and depression and personality aspects (i.e., avoidance, feelings of control, optimism and the need for support), can to a certain extent be responsible for psychological outcome after surgery.

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CHAPTER 3

AIMS OF THE STUDIES

Introduction

The evaluation of recent prospective research (chapter 2) revealed two major findings with respect to our aim posed in Chapter 1. First, the results indicate that many specific psychological outcomes were best predicted by their preoperative assessments, especially in the case of anxiety and depression. Second, personality factors appeared to be relevant predictors of psychological outcome. Thus, in order to identify patients at risk of postoperative anxiety, depression, feelings of disability, somatic complaints and fatigue, both the preoperative assessments and personality factors should be taken into account.

As prospective studies were primarily interested in relationships between pre- and postoperative variables, little attention was given to relationships between variables at the same points in time. Although their results were of clinical relevance (chapter 2), insight into the overall structure of relationships, both over time and at the same points in time, may contribute to the understanding of underlying processes of the various factors involved and thereby provide a useful framework for development of clinical interventions. Therefore, the aim of the present follow-up study was to improve the understanding of psychological processes in patients undergoing CABG. For this purpose, we attempted to identify the structure of intrarelationships (i.e., relationships within the same variable over time) and interrelationships (i.e., relationships between different variables, both over time and at the same points in time) of anxiety, depression, feelings of disability, somatic complaints and fatigue, in relation to personality factors. In addition, background factors including gender, age and medical factors were involved to adjust for modifying effects [1].

A related issue was then to consider the timing of pre- and postoperative assessments. To exclude possible effects of admission to the hospital, the preoperative assessment or baseline assessment should take place days before admission [2]. So the baseline assessment was planned about two weeks before surgery, following standard preoperative medical testing at the cardiology outpatient clinic. To estimate the effects of hospitalization and the impending surgery, we chose to reassess anxiety on the day of admission (i.e., one day prior to surgery). Postoperative assessments are recommended to be timed

during early convalescence (i.e., during hospitalization) and the late postoperative period (chapter 2). As the surgical procedure may be responsible for feelings of disability, somatic complaints and fatigue during early convalescence, their postoperative assessment was planned only in the late postoperative period. Anxiety and depression, on the other hand, were assessed in both the early and late postoperative period.

To explore structural relationships, structural equation modelling (SEM) has recently emerged as an accepted method [3]. SEM deals with identifying, specifying and testing models for structural relationships between substantively meaningful variables [4]. The rationale behind this approach is that it combines the techniques of multiple regression and path analysis, so allowing relationships between many variables to be tested simultaneously. In general, SEM is used to test important theories developed within a substantive domain. If properly and carefully used, SEM can also play an important role in theory building. Using the model generating approach [4, 5], SEM permits to develop a structural model which can be considered as a first step towards building a theory. So far, theories regarding psychological processes in patients undergoing CABG are not expressed with sufficient precision for one to argue that a particular theoretical perspective implies that a particular structural model should describe the observed data. It was anticipated that the use of the model generating variant of SEM would improve the understanding of psychological processes in patients undergoing CABG.

Specific aims

To extend recent prospective research, our ambition was to enhance the understanding of psychological processes in patients undergoing CABG. If we learn to understand these processes, several clinical implications may become apparent with respect to identification and treatment of those patients with or at risk of psychological problems (e.g., anxiety, depression, feelings of disability, somatic complaints and fatigue). To achieve our aim, the following steps were made.

First, because outcome measures seem to be best predicted by their preoperative assessments, the baseline assessment of patients in the present study

was examined in detail (chapter 4). The focus was on internal (i.e., groups within the study sample) and external (i.e., control subjects) reference groups regarding preoperative demographic, medical and, in particular, psychological factors. In addition, the participation bias regarding follow-up assessments was analyzed by comparing baseline results of participants completing all assessments and those lost to follow-up.

Second, the course of anxiety and depression, starting at baseline until the late postoperative period, was examined to identify variations in both mean level and inter-individual differences over time (chapter 5). Additionally, we investigated whether these variations were modified by gender and age, after controlling for medical factors.

The third step continued on anxiety and depression over time and focused on the underlying processes and on the extent to which these processes were affected by personality and background factors. The structure of intra- and interrelationships of anxiety and depression in relation to personality and background factors was explored (chapter 6).

Finally, the last step proceeded with the exploration of structural relationships by developing a structural model based on anxiety, depression, feelings of disability, somatic complaints and fatigue, at baseline and in the late postoperative period, in relation to personality and background factors (chapter 7). We were specifically interested in the extent to which feelings of disability, somatic complaints and fatigue were psychologically determined.

The above steps were based on one study sample consisting of 270 patients at baseline and 217 at follow-up.

In sum, the specific aims were:

(1) to examine the demographic, medical and psychological factors in patients scheduled for CABG, to gain insight into the baseline assessment of the follow-up study (chapter 4);
(2) to examine variations in anxiety and depression over time (chapter 5);
(3) to explore the structure of intra- and interrelationships of anxiety and depression in relation to personality and background factors (chapter 6);

(4) to explore the structure of intra- and interrelationships of anxiety, depression, feelings of disability, somatic complaints and fatigue in relation to personality and background factors (chapter 7).

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CHAPTER 4

GENERAL RESULTS IN PATIENTS SCHEDULED FOR CORONARY ARTERY BYPASS GRAFT SURGERY: BASELINE CHARACTERISTICS

Introduction

Patients scheduled for CABG find themselves in a situation characterized by a multitude of concerns [1-5]. Among their concerns are those related to the surgical procedure, loss of control, postoperative pain and death [6]. Moreover, patients may be afraid of suffering a heart attack or of dying while waiting for surgery [7, 8].

Waiting for surgery has been reported to be a main source of concern and a period of intense psychological anticipation [3, 9], especially since waiting lists are often lengthy and the exact date of surgery is uncertain. Unfortunately, little work has focused on this period before surgery. Psychological outcome following CABG, on the other hand, has been well studied [10-14]. In addition, several attempts have been made to study predictors of psychological outcome to identify patients at risk of postoperative psychological problems [15-22]. The results indicated that many specific psychological outcomes were best predicted by their preoperative assessments [23]. This finding emphasizes again a need to focus on preoperative psychological factors in patients undergoing CABG. The waiting period should not be regarded as lost time but as an opportunity for interventional procedures for those patients in need of additional support, already prior to surgery [24]. Postoperative psychological problems might then be reduced or even prevented.

To gain more insight into the preoperative situation, the present study examined demographic, medical and, in particular, psychological factors in patients scheduled for CABG. These data represent the baseline assessment of the follow-up study as described in this thesis. The focus was on both internal (i.e., groups within the study sample) and external (i.e., control subjects) reference groups. Regarding the internal reference groups, we investigated differences between men and women within the study sample, because gender differences, both medically and psychologically, have frequently been reported [1, 13, 19, 25-30]. Finally, regarding the entire follow-up study (chapter 5, 6 and 7), the participation bias was analyzed by comparing the baseline results of participants completing all assessments and those lost to follow-up.

Methods

Selection of patients

The study was conducted at the departments of cardiopulmonary surgery of a regional (RH) and a university hospital (UH), were all operations were carried out by the same team. Patients awaiting elective CABG were eligible for inclusion in the study. Patients with concomitant surgical procedures were excluded; additional exclusion criteria were insufficient command of the Dutch language, and a history of psychiatric illness.

A total of 307 consecutive patients were included in the study. Following elimination of patients due to procedural problems (n=13), unwillingness to participate (n=23) and inconclusive data (n=1), 270 patients (192 RH and 78 UH patients) completed baseline assessment, including 221 men and 49 women (mean age 61.0, range 28-80, sd 8.9 years).

During follow-up, 53 patients were lost: 8 patients died before the last follow-up, 29 patients missed a measurement and 16 patients did not respond to their last follow-up.

Procedure

All selected patients underwent standard preoperative medical testing at the cardiology outpatient clinic about two weeks before surgery. During this preoperative visit, a rough indication was given about the date of surgery. Following their visit to the cardiologist, patients were informed about the study. After informed consent was obtained, patients were requested to fill out a demographic inventory and six psychological questionnaires and to return them in an enclosed pre-paid envelope within one week. Medical data were collected from medical records.

Demographic assessment

Demographic variables, including gender, age, marital status, education and employment status were obtained by a demographic inventory.

Medical assessment

Based on earlier findings [15, 18, 21, 22, 31, 32], a number of preoperative medical variables were assessed, including left ventricular ejection fraction (LVEF), the New York Heart Association (NYHA) class (I indicates no angina; IV indicates angina at rest), previous myocardial infarction (MI), previous CABG, history of diabetes, and time on the waiting list (i.e., time of wait from decision on surgery until preoperative medical testing).

Psychological assessment

Psychological variables were assessed with the following relevant questionnaires [3, 17, 19, 33].

To assess anxiety, the Dutch State version of the State Trait Anxiety Inventory (STAI) was used [34], with scores ranging from 20 to 80, and higher scores reflecting greater anxiety. Reliability and validity of the STAI are adequate [34].

The Hospital Anxiety and Depression scale (HAD) [35] was used to assess depression. The relevant subscale is specifically designed to screen physically ill patients and does not include somatic symptoms for the assessment of depression. The depression scale consists of 7 items, with depression scores ranging from 0 to 21, and higher scores indicating more intensity. Scores over 8 indicate that patients are likely to be depressed. Reliability and validity are adequate for the Dutch population [36].

The disability subscale of the Heart Patients Psychological Questionnaire (HPPQ) [37] was used to assess feelings of disability, with scores ranging from 12 to 36, and higher scores indicating more intensity. Reliability and validity are adequate for the Dutch population [37].

Somatic complaints were measured by means of the Psychosomatic Stress Questionnaire (PSQ) [38]. This questionnaire comprises 17 (after excluding 4 items associated with heart disease) vague complaints of neurovegetative nature and can be answered by the subject in a positive or negative response mode. Scores range from 0 to 17 and reliability and validity are adequate for the Dutch population [38].

To assess fatigue, the general fatigue scale of the Multidimensional Fatigue Inventory (MFI) [39] was used, with scores ranging from 4 to 20, and higher

scores indicating more intensity. Reliability and validity have been proven for Dutch studies [39].

Finally, the following subscales of the Dutch Personality Questionnaire (DPQ) [40] were used to assess personality: neuroticism (scores range from 0 to 42), self-esteem (scores range from 0 to 38), rigidity (scores range from 0 to 50) and hostility (scores range from 0 to 38). The remaining subscales were omitted to reduce the number of items. Reliability and validity are adequate for the Dutch population [40].

Statistical analyses

Before answering the research objectives, calculated estimates were substituted for missing data on the psychological variables. This was done by regression of the relevant variable on all remaining variables having acceptable values ($p < 0.05$, two-sided).

To differentiate patients for gender and participation bias (i.e., participants and those lost to follow-up), *chi*-squared tests for independent samples were used for categorical data, and *t*-tests for independent samples were applied for continuous data. In addition, the magnitude of the psychological difference between the groups of patients was calculated using Cohen's δ (0.20=low; 0.50=moderate; 0.8>=high)[41].

Furthermore, all demographic, medical and psychological variables were examined by means of a logistic regression analysis to determine the variables, which have a unique contribution to gender and participation bias, both criterion variables. With this multivariate analysis an estimation of the probability of an event (e.g., men or women and participants or those lost to follow-up) can be made. Standardised scores of the variables were used to compare estimated logistic coefficients (β) more easily. First, all demographic variables were entered together into logistic regression analyses for both gender and participation bias. In these analyses the backward elimination procedure was followed with a significance level fixed at 0.05. Next, this procedure was repeated for both medical and psychological variables. In order to check on the need to adjust for effects of type of hospital, type of hospital and each variable separately were entered into logistic regression analyses for both gender and participation bias.

Table 1. Demographic and medical differences between men (n=221) and women (n=49)[1]

	men		women				
variable	n	%	n	%	X^2	df	p^*
age:							
< 55 years	59	26.7	7	14.3	6.42	2	.04
55-65 years	89	40.3	17	34.7			
> 65 years	73	33.0	25	51.0			
marital status:							
partner	198	90.0	34	69.4	12.67[2]	1	.001
education:							
low	91	41.7	34	69.4	13.35	2	.001
middle	80	36.7	12	24.5			
high	47	21.6	3	6.1			
employment:							
employed	63	28.6	3	6.1	104.19	3	.00
retired	93	42.3	10	20.4			
disabled	50	22.7	3	6.1			
unemployed /housekeeping	14	6.4	33	67.4			
LVEF:							
< 0.30	5	2.4	0	0.0	1.13	2	.57
0.30-0.55	55	26.8	12	26.7			
> 0.55	145	70.8	33	73.3			
NYHA class:							
I	3	1.6	0	0.0	3.42	3	.33
II	42	22.0	5	12.2			
III	132	69.1	31	75.6			
IV	14	7.3	5	12.2			
previous MI	124	56.1	31	63.3	.57[2]	1	.45
previous CABG	21	9.5	1	2.0	2.07[2]	1	.15
history of diabetes	22	10.0	13	26.5	8.19[2]	1	.004
waiting time (>8 weeks)[3]:	75	36.6	18	36.7	.00[2]	1	1.00

LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; MI = myocardial infarction; CABG = coronary artery bypass graft surgery; * significant at 0.05 level, two-tailed; [1] due to missing values, for some variables n will not add up to 270; [2] Yates correction; [3] mean time on waiting list = 8.91 (sd±7.20) weeks

Finally, regarding the psychological differences between the study sample and the reference groups, the magnitude of the difference, Cohen's δ, was calculated.

Results

Gender differences in demographic, medical and psychological variables

Table 1 shows the demographic and medical differences between men and women within the study sample. Compared with men, relatively more women were older than 65 years, had no partner, had less education and did the housekeeping. Regarding medical differences, women were more likely to have a history of diabetes than men. In Table 2 the psychological differences can be found. As can be seen there is a significant gender difference for all psychological variables except rigidity and hostility. Excluding self-esteem, women showed higher mean levels than men. The magnitude of the effect was highest for fatigue, feelings of disability and anxiety.

Table 2. Psychological differences between men (n=221) and women (n=49)

	men		women					
variable	M	sd	M	sd	*t*	df	*p**	δ
anxiety	43.6	12.4	50.7	11.8	-3.68	268	.00	-.58
depression	5.1	3.8	7.2	4.7	-3.25	268	.001	-.51
feelings of disability	28.8	5.9	32.2	4.9	-3.82	268	.00	-.60
somatic complaints	5.9	3.9	7.8	3.4	-3.22	268	.001	-.51
fatigue	12.8	4.7	16.0	4.8	-4.33	268	.00	-.68
neuroticism	11.8	8.4	14.9	7.5	-2.41	268	.02	-.38
self-esteem	27.8	6.3	25.5	6.2	2.34	268	.02	.37
rigidity	32.9	8.3	34.7	6.1	-1.46	268	.15	-.23
hostility	20.9	6.7	20.7	6.8	.16	268	.87	.03

* significant at 0.05 level, two-tailed

Logistic regression analyses regarding adjustment for type of hospital revealed no significant effects. Therefore, adjustment for type of hospital was

not applied in further analyses. Using the backward elimination procedure with the criterion variable gender and all demographic variables as the predictor variables, marital status (β=-0.46), education (β=-0.78) and employment (β=-1.55) remained in the model. Regarding the medical variables, diabetes (β=-0.40) remained in the model. Finally, with respect to all psychological variables, only anxiety (β=0.45) and feelings of disability (β=0.68) remained in the model.

Table 3. Psychological characteristics of the study sample (N=270) and reference groups

	study sample		reference group			
variable	M	sd	M	sd	δ	reference group (n)
anxiety	44.9	12.6	36.8	10.9[1]	.73	general population (n=389) [42]
depression	5.5	4.1	3.7	3.3	.55	general population (n=82) [36]
disability	29.4	5.9	28.3	6.6	.17	heart patients (n=1649) [32]
somatic	7.7	4.8	6.7	4.9[2]	.19	medical population (n=676)[3] [42]
fatigue	13.4	4.9	9.9	5.2	.67	general population (n=136) [39]
neuroticism	12.4	8.3	10.8	7.7[1]	.21	general population (n=5686) [40]
self-esteem	27.4	6.3	28.0	5.6	-.11	general population (n=5686) [40]
rigidity	33.2	8.0	30.6	7.3	.36	general population (n=1296) [40]
hostility	20.9	6.7	18.2	6.7	.40	general population (n=5686) [40]

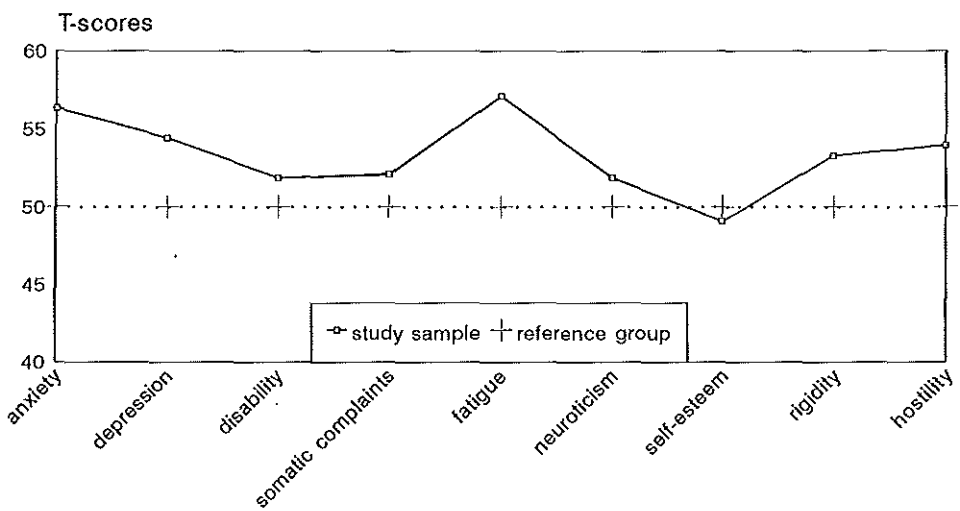
disability = feelings of disability; somatic = somatic complaints; [1] M (sd) reference group is a weighted mean and pooled standard deviation based on M (sd) men/women reference group (anxiety: 36.4(10.3)♂/38.8(13.2)♀; neuroticism: 10.1(7.5)♂/13.9(8.3)♀) and the number of men/women in the study sample (221/49); [2] M (sd) reference group is based on 21 items; mean (sd) study sample score is based on 17 items and therefore multiplied by 21/17; [3] the reference group is based on individuals using medical services

Psychological differences between the study sample and external reference groups

In Table 3 the psychological differences between the study sample and reference groups are shown. Except for feelings of disability and somatic complaints, the reference groups represented the general population. Figure 1 illustrates the psychological profile of patients at baseline with regard to the reference scores. Patients in the study sample, showed more problems, in particular anxiety, fatigue and depression, than control subjects from the general population. The level of self-esteem for the study sample was lower than that for the general

population, but the magnitude of this effect was low. Patients in the study sample reported more feelings of disability than heart patients in general, but the magnitude of this effect was low. Finally, levels of somatic complaints for the study population were higher than those for individuals using medical services, but again the magnitude of this effect was low.

Figure 1. Psychological profile of patients at baseline



Analysis of participation bias

The group that was lost to follow-up did not differ significantly from the participants on both demographic and medical variables. Regarding the psychological variables, significant differences appeared for depression (M=5.2 vs. M=6.6, $t(268)=-2.21$, $p=0.03$) and somatic complaints (M=5.9 vs. M=7.5, $t(268)=-2.61$, $p=0.01$). Patients lost to follow-up showed higher levels of both preoperative depression and somatic complaints than those completing all assessment, but the magnitude of effect was low ($\delta=-0.34$ and $\delta=-0.40$,

respectively). Using the backward elimination procedure with the criterion variable participation bias and all psychological variables as the predictor variables, only somatic complaints (β=-0.39) remained in the model.

Discussion

In this study the focus was on demographic, medical and psychological factors in patients scheduled for CABG. First, regarding the gender differences, the results indicated that women were more likely than men to be widowed or to live alone, to have less education, to do the housekeeping and to have a history of diabetes, which confirms other reported data [25]. With regard to the psychological differences between men and women, anxiety and in particular feelings of disability were of relatively high importance, with women reporting higher levels than men. The finding that women were more anxious prior to CABG is in line with earlier work [13, 19, 25]. The female excess of feelings of disability might be a function of the actual somatic status [27-29, 43], or of the general tendency to report more somatic symptoms than men [44].
Furthermore, it seems that women are bothered much more by daily physical symptoms than men [45]. Finally, the psychological differences between men and women could be due to the fact that women are more willing to report the feelings they experience than men [13, 28, 44].

Second, psychological differences between the study sample and reference groups were presented, with patients in the study sample reporting more anxiety, depression and fatigue than control subjects from the general population. Based on these differences, waiting for CABG can be considered as a frightening and depressing experience. Moreover, increased preoperative anxiety and depression have been reported by several studies [3, 12, 19, 46, 47]. The relatively high level of preoperative fatigue might be related to both angina pectoris, especially unstable angina [48] and feelings of anxiety and depression [49].

Finally, with respect to follow-up assessments, the participation bias was analyzed. Compared with patients completing all follow-up assessments, the group that was lost to follow-up showed more somatic complaints at baseline.

The magnitude of this effect was however low and generalization of results at follow-up to all patients present at baseline seems reasonable.

In conclusion, waiting for CABG can be regarded as a stressful event. In particular women reported high rates of psychological problems. For a better understanding of the preoperative psychological situation and its implications for psychological outcome, one would need to evaluate both the course of psychological factors and the underlying psychological processes. Since gender differences appeared, their influence should be considered.

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CHAPTER 5

THE COURSE OF ANXIETY AND DEPRESSION IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT SURGERY

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Abstract

A longitudinal study was designed to follow up the course of anxiety and depression in patients undergoing Coronary Artery Bypass Graft surgery (CABG). The focus was on possible effects of gender and age on variations in both mean level and interindividual differences over time. At two timepoints before and two after surgery, 217 patients completed self-report questionnaires. Multivariate testing revealed an overall decrease in mean levels of anxiety and depression in the postoperative period but different trends for men and women. Compared with men, women reported more anxiety and depression, both pre- and postoperatively, but showed a relatively stronger decrease in the early postoperative period. Regarding variations in interindividual differences over time, multivariate testing revealed different trends of depression for men and women. Women appeared to be most homogenous in the early days after surgery, whereas interindividual differences for men showed a stable trend.

Introduction

Although coronary artery bypass graft surgery (CABG) is usually successful in relieving angina, it is experienced as a stressful event by many patients. Increased feelings of anxiety and depression have been reported, both pre- and postoperatively [1-9]. Anxiety is the most dominant feeling, particularly in the preoperative period. Although depression has been observed before surgery, it is more common in the postoperative period [2, 4, 7, 8].

Among preoperative fears are those related to the surgical procedure, loss of control, postoperative pain and dying [10]. In addition, waiting for surgery has been reported as a main source of concern because of the patient's fear of suffering a heart attack or of dying prior to surgery [11, 12]. Moreover, because of long waiting lists, another source of worry is uncertainty of the exact day of surgery [12]. Patients feel more insecure during this period than on the day prior to surgery, when time remaining can be counted off in fixed units [13] and the patient can prepare psychologically. On the other hand, the day of admission can

also be very stressful as patients have to cope with both the stress of hospitalization and the anxiety about the impending surgery [14].

In the days following surgery, some patients react with relief and a decrease in anxiety, whereas others exhibit increased feelings of anxiety and depression [2, 3, 15]. Patients may be preoccupied with their discomfort or concerned about the success of surgery [7, 8, 15]. Persisting feelings of anxiety and depression in the late postoperative period can be an expression of disappointment with their state of physical health or refer to problems adapting to the changed situation [2, 15]. In addition, there may be a strong fear of failure combined with career and family problems [2].

While some studies reported differences between pre- and postoperative states of anxiety and depression [1, 8, 16-18], most recent studies have focused on preoperative determinants of postoperative anxiety and depression [1, 5, 6, 9, 15, 16, 19]. These prospective studies may facilitate the identification of patients at risk of postoperative anxiety and depression. Yet, information about variations in anxiety and depression over time is still lacking. For instance, there may be specific variations in mean level, starting prior to surgery until the late postoperative period. Additionally, the extent to which levels vary interindividually may fluctuate over time.

Because gender and age are potentially critical variables in terms of effect on psychological outcome after surgery [20], their influence should be considered with regard to variations in anxiety and depression over time. Only gender differences have already been reported [1, 16, 20-24], but these findings are rather inconsistent.

The present semi-longitudinal study was designed to examine variations in anxiety and depression over time in patients undergoing CABG. The focus was on variations in both mean level and interindividual differences over time. In addition, we examined whether these variations over time differed between men and women, and between three age groups (<55, 55-65, >65 years of age), after controlling for medical factors. Anxiety and depression were assessed prior to surgery, during early convalescence and in the late postoperative period.

Methods

Selection of patients

The study was conducted at the departments of cardiopulmonary surgery of a regional and a university hospital, where all operations were carried out by the same surgical team. The follow-up study took place between October 1994 and May 1996. Patients awaiting elective CABG were eligible for inclusion in this study. The only exclusion criteria were insufficient command of the Dutch language, a history of psychiatric illness, and CABG with a concomitant surgical procedure.

A total of 307 consecutive patients were included in the study. Following elimination of patients due to procedural problems (n=13), unwillingness to participate (n=23) and inconclusive data (n=1), 270 patients completed baseline assessment. The present study combined data for 80.4% of these patients (n=217), who were tested at four points in time, starting prior to surgery until six months after surgery, including 176 men and 41 women (mean age 60.8, range 28-78, sd 8.8 years). The remainder of patients was lost during follow-up: measurements 2, 3 or 4 were missed by 10.7% of the patients completing baseline assessment, 3% died before all data could be obtained and 5.9% did not respond to their last follow-up.

Procedure

Patients underwent standard preoperative medical testing at the cardiology outpatient clinic, about two weeks before surgery (T1). Following their visit to the cardiologist, patients were informed about the study. After informed consent was obtained, patients were requested to complete questionnaires to assess anxiety and depression and to return them in an enclosed pre-paid envelope within one week. On the day of admission to the hospital (i.e., one day prior to surgery), anxiety was reassessed (T2). Follow-up assessments of anxiety and depression by questionnaire took place seven days after surgery in the hospital (T3) and six months postoperatively through the post (T4). Before the questionnaires were posted, patients were interviewed by telephone to gain information about their physical condition. Medical records were used to obtain medical data.

Medical assessment

Based on earlier findings [9, 25-29], four medical variables were assessed from the medical records, including left ventricular ejection fraction (LVEF), previous CABG, number of days in intensive care, and total hospital stay. Data on postoperative cardiac events and rehospitalization were obtained during postoperative interview and from medical records.

The medical characteristics of a patient were considered complicated if one or more of the following events occurred: impaired LVEF (<0.55[30]) (32.3% of patients), previous CABG (8.3%), prolonged stay in intensive Care (>1 day) (18.0%), prolonged hospital stay (>14 days) (10.6%), postoperative cardiac event(s) (8.5%) and rehospitalization (8.3%). Elsewhere, the medical characteristics were considered uncomplicated (45.2%).

Pre- and postoperative psychological assessment

Anxiety and depression were assessed with two relevant questionnaires [5, 16, 23, 31, 32]. To assess anxiety, the Dutch State version of the State Trait Anxiety Inventory (STAI) was used [33], with scores ranging from 20 to 80, and higher scores reflecting greater anxiety. Moderate anxiety is defined by scores in the range 32.1 to 40.7 for men and 33.1 to 44.5 for women [34]. Reliability and validity of the STAI are adequate [33].

The Hospital Anxiety and Depression scale (HAD) [35] was used to assess depression. The relevant subscale is specifically designed to screen physically ill patients and does not include somatic symptoms for the assessment of depression. It consists of seven items, with depression scores ranging from 0 to 21, and higher scores indicating more intensity. Scores over 8 indicate that patients are likely to be depressed. Reliability and validity are adequate for the Dutch population [36].

Statistical analyses

Before answering the research objectives, calculated estimates were substituted for missing data on the psychological variables. This was done by regression of the relevant variable on all remaining variables having acceptable values ($p < 0.05$, two-sided).

To examine variations in anxiety and depression over the course of the study, a multivariate analysis of covariance (MANCOVA) was used for repeated

measurements with time as the within-subject factor [37]. Anxiety was assessed at four points in time (T1, T2, T3 and T4), depression at three (T1, T3 and T4). Between-subjects factors included gender (men and women) and three age categories (<55, 55-65, >65 years of age). Absence or presence of complicated medical characteristics was included as a time-constant covariate. Anxiety and depression scores on the different points in time were decomposed into orthonormalized polynomial contrasts to identify linear and curvilinear trends.

The effects of time, gender, age and their interactions on anxiety and depression, were estimated using Pillai's multivariate test. Subsequently, stepdown analysis was performed to estimate linear, quadratic and cubic (in the case of anxiety) trends. *P*-values, <0.05 (two-tailed) were considered statistically significant. Regarding variations in interindividual differences, MANCOVA was based on scores representing the absolute distance of individual scores to the mean (i.e., standard deviation) at the respective points in time.

Results

Table 1 shows means and standard deviations of pre- and postoperative anxiety and depression, distinguished by gender and age.

Variations in mean level over time

Anxiety A repeated measures MANCOVA indicated a significant time effect and a significant effect of time modified by gender. With respect to the trend of the significant effects, stepdown analysis showed a linear trend. Additionally, a quadratic trend was found, which was, however, different for men and women (Table 2). Anxiety strongly decreased over the course of the study. Regarding gender, mean levels of anxiety for women were higher than those for men, in particular preoperatively. Both men and women showed a slight decrease in anxiety at the day prior to surgery and a strong decrease seven days after surgery, which seemed to have stabilized at six months, postoperatively. This trend was stronger for women than for men (Figure 1). Finally, there was no significant evidence for effects of age.

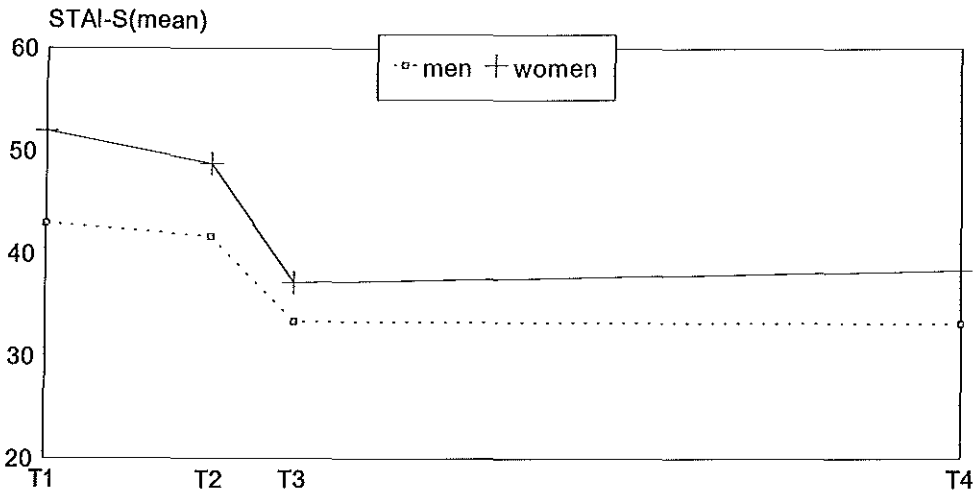
Table 1. **Means and standard deviations of the course of anxiety and depression for gender and age**

	men (n=176)		women (n=41)		< 55 years (n=55)		55-65 years (n=84)		> 65 years (n=78)	
variable	M	sd	M	sd	M	sd	M	sd	M	sd
STAI-S										
T1:	43.0	12.3	52.0	11.9	45.1	13.5	46.3	12.7	42.8	11.9
T2:	41.7	9.9	48.8	12.2	43.9	10.3	43.1	10.8	42.3	10.9
T3:	33.4	8.6	37.2	9.5	33.7	9.6	33.8	8.3	34.7	9.0
T4:	33.2	11.6	38.4	11.5	36.8	13.4	33.9	11.3	32.8	10.9
HAD-D										
T1:	4.7	3.7	7.5	4.7	5.5	4.4	5.4	4.8	4.9	4.0
T3:	4.9	3.6	5.4	3.4	4.5	4.0	4.8	3.6	5.5	3.1
T4:	3.4	3.5	4.9	4.0	4.0	4.1	3.5	3.4	3.6	3.5

STAI-S = state version of the State Trait Anxiety Inventory; HAD-D = depression scale of the Hospital Anxiety and Depression scale; T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

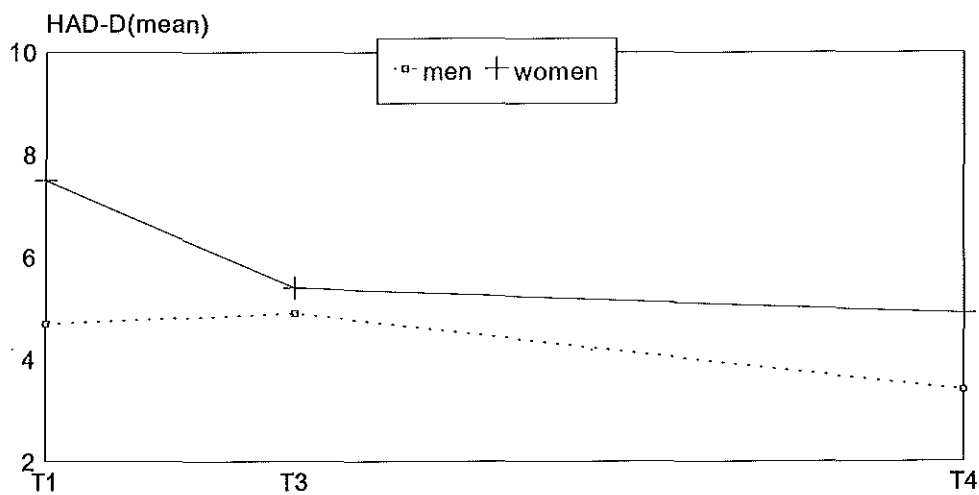
Depression Multivariate testing with respect to depression yielded results similar to those for anxiety. First, both a significant time effect and a significant effect of time modified by gender were found. Next, stepdown analysis revealed a linear trend and, in addition, a quadratic trend, which again represented different trends for men and women (Table 2). The overall course of depression showed a decrease. Women reported more depression at all points in time. Compared with preoperative levels of depression, women showed a strong decrease at seven days postoperatively and a slight decrease at six months after surgery. Men, on the other hand, showed little change over time (Figure 2). A marginally significant effect of time modified by age was found but there was no significant interaction between gender and age (Table 2). Seven days after surgery, patients above 65 years of age showed an increase in depression, whereas the other age categories showed a decrease (Table 1).

Figure 1. Variations in mean level of anxiety for men and women



STAI-S = state version of the State Trait Anxiety Inventory; T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

Figure 2. Variations in mean level of depression for men and women



HAD-D = depression scale of the Hospital Anxiety and Depression scale; T1 = 14 days before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

Table 2. **Multivariate testing on variations in mean level of anxiety and depression for gender and age, adjusted for complicated medical characteristics**

	Time			Gender x Time			Age x Time			Age x Gender x Time		
variable	df	*F*	*p*	df	*F*	*p*	df	*F*	*p*	df	*F*	*p*
STAI-S												
Multivariate[a]	3.0	51.96	.00	3.0	2.63	.05	6.0	1.27	.27	6.0	.44	.85
Stepdown:												
linear trend	1.0	71.32	.00	1.0	1.96	.16	2.0	.04	.96	2.0	.94	.39
quadratic trend	1.0	56.85	.00	1.0	5.92	.02	2.0	3.55	.03	2.0	.16	.85
cubic trend	1.0	5.61	.02	1.0	.00	.95	2.0	.26	.77	2.0	.23	.80
HAD-D												
Multivariate[a]	2.0	25.61	.00	2.0	7.12	.001	4.0	2.28	.06	4.0	1.59	.18
Stepdown:												
linear trend	1.0	40.17	.00	1.0	2.22	.14	2.0	.65	.52	2.0	2.73	.07
quadratic trend	1.0	9.44	.002	1.0	11.90	.001	2.0	3.96	.02	2.0	.48	.61

STAI-S = state version of the State Trait Anxiety Inventory; HAD-D = depression scale of the Hospital Anxiety and Depression scale; [a] Pillai's multivariate test

Variations in standard deviation over time

Anxiety A repeated measures MANCOVA demonstrated a significant effect of time. Stepdown analysis revealed a significant quadratic trend (Table 3). As can be seen in Table 1, standard deviations of anxiety showed a strong decrease at seven days after surgery and a strong increase at six months postoperatively. The entire group of patients was most homogenous at seven days after surgery. The effect of time was not significantly modified by gender or age.

Depression Multivariate testing indicated a significant effect of time and a significant effect of time modified by gender. Stepdown analysis revealed a quadratic trend, which differed between men and women (Table 3). Standard deviations for men remained stable over time, whereas those for women showed a strong decline

at seven days after surgery and a slight increase at six months postoperatively (Figure 3). Women were most homogenous at seven days after surgery.

Table 3. Multivariate testing on variations in standard deviation of anxiety and depression for gender and age, adjusted for complicated medical characteristics

	Time			Gender x Time			Age x Time			Age x Gender x Time		
variable	df	*F*	*p*	df	*F*	*p*	df	*F*	*p*	df	*F*	*p*
STAI-S												
Multivariate[a]	3.0	6.16	.00	3.0	1.11	.35	6.0	.61	.72	6.0	.79	.58
Stepdown:												
linear trend	1.0	.01	.95	1.0	1.39	.24	2.0	.46	.63	2.0	.99	.37
quadratic trend	1.0	17.40	.00	1.0	.00	.96	2.0	1.19	.31	2.0	.99	.37
cubic trend	1.0	1.07	.30	1.0	1.94	.17	2.0	.17	.84	2.0	.40	.67
HAD-D												
Multivariate[a]	2.0	9.08	.00	2.0	6.93	.001	4.0	.21	.93	4.0	.86	.49
Stepdown:												
linear trend	1.0	2.00	.16	1.0	.65	.42	2.0	.34	.71	2.0	.56	.57
quadratic trend	1.0	16.02	.00	1.0	13.17	.00	2.0	.08	.92	2.0	1.16	.31

STAI-S = state version of the State Trait Anxiety Inventory; HAD-D = depression scale of the Hospital Anxiety and Depression scale; [a] Pillai's multivariate test

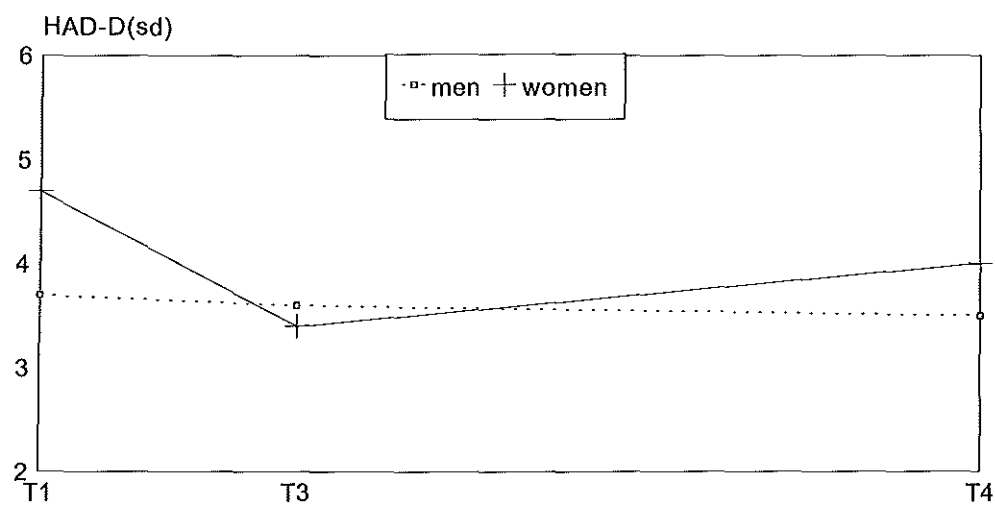
Discussion

In the present study, we examined variations in both mean level and interindividual differences over time. In addition, we tested whether these variations were modified by gender and age, after controlling for medically complicating factors.

With respect to variations in mean level, the results revealed a decrease, both in anxiety and in depression, during the postoperative period, which is in line with earlier work [8, 16-18]. Apparently, the preoperative period was experienced as most frightening and depressing by the majority of the patients. Additionally, gender differences appeared to be significant, with women reporting more anxiety and depression than men, both pre- and postoperatively, but showing a relatively

stronger decrease in the early postoperative period. These findings are consistent with those of other studies, in which substantial psychological improvement has been reported in women after cardiac surgery [16, 23]. In these latter studies, however, initial differences between men and women had disappeared in the postoperative period. One study was even more positive by suggesting that women fared better psychologically than men, even prior to surgery [20]. On the other hand, Burker *et al.* [1] found that depression significantly increased, for both men and women, in the early postoperative period. Unfortunately, all of the studies mentioned, including the present study, involved small samples of women, which makes the interpretation of the gender differences more difficult. Although there was a minority of women, significant gender differences were found that need to be explained.

Figure 3. Variations in standard deviation of depression for men and women



HAD-D = depression scale of the Hospital Anxiety and Depression scale; T1 = 14 days before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

First, gender differences in anxiety and depression may be a function of somatic differences between men and women [20, 38-40]. Compared with men, women have more somatic problems after CABG (e.g., higher in-hospital mortality rate and a lower long-term bypass graft patency rate) [26, 41], which suggests

that women have a more difficult postoperative course. Second, the gender differences may be attributed to sociocultural differences between men and women [20, 23, 42]. It seems more acceptable for women to express their feelings, and to prepare for dealing with discomfort and dependency, while men tend to deny and rationalize their feelings [20, 23]. This may explain why, in the present study, men reported less anxiety and depression than women, especially so because the data were obtained by means of self-report measures, which are prone to be influenced by social desirability.

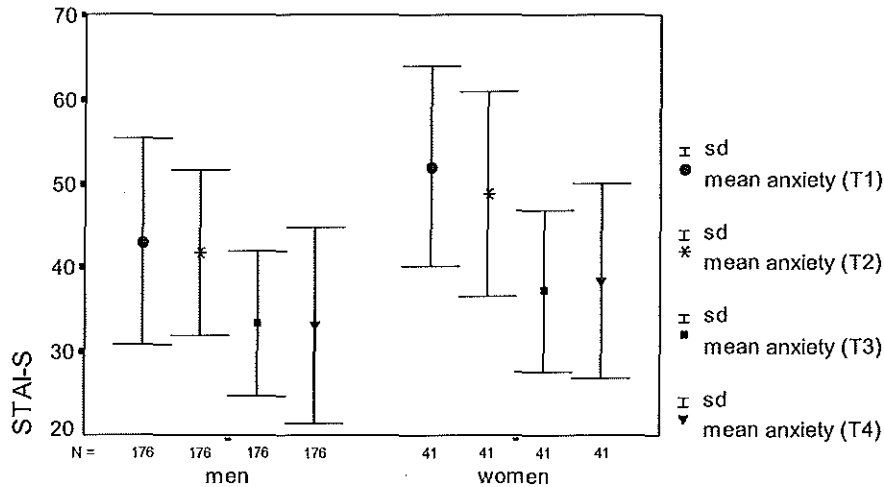
Although variations in mean level of anxiety and depression appeared to be different in women from that in men, significant effects with regard to age were not found. The only tendency was an increase in depression at seven days after surgery for both men and women above 65 years of age.

In addition to variations in mean level, variations in interindividual differences were examined. With regard to anxiety, the entire group of patients undergoing CABG appeared to be most homogenous at seven days after surgery. Together with the overall decrease in anxiety, seven days postoperatively, this might indicate that most patients, and in particular those patients reporting high rates of preoperative anxiety, felt relieved during early convalescence after CABG (Figure 4).

With respect to depression, variations in interindividual differences for women differed from those for men. Women were most homogenous in the early postoperative period, whereas interindividual differences for men remained consistent over time. Because women showed a strong decrease in depression in the early postoperative period, the relatively small interindividual differences might indicate a common feeling of relief. In particular those reporting high rates of preoperative depression might show improvement (Figure 5).

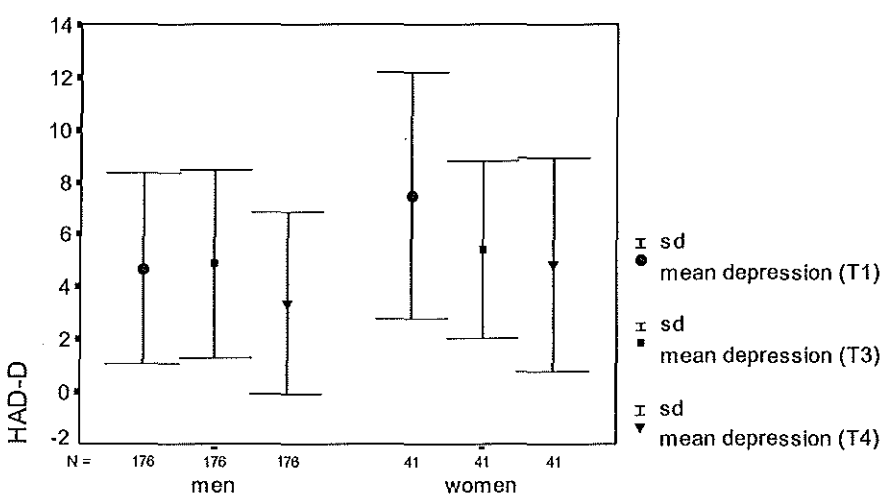
To explain the variations in interindividual differences for both men and women, one would need to understand the underlying psychological processes. Future studies should focus on these processes to identify individuals at risk of high rates of anxiety and depression, both pre- and postoperatively. Better identification might then improve the development of intervention strategies for both men and women at risk. Finally, as the number of women undergoing CABG increases, future research should continue to focus on gender differences in order to gain more insight into explanatory theories.

Figure 4. Variations in mean level and standard deviation of anxiety for men and women



STAI-S = state version of the State Trait Anxiety Inventory; T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

Figure 5. Variations in mean level and standard deviation of depression for men and women



HAD-D = depression scale of the Hospital Anxiety and Depression scale; T1 = 14 days before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

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CHAPTER 6

A STRUCTURAL MODELLING ANALYSIS OF ANXIETY AND DEPRESSION IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT SURGERY: A MODEL GENERATING APPROACH

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Abstract

The present study was a longitudinal study designed to explore structural relationships between anxiety, depression, personality and background factors (e.g., gender, age and complicated medical characteristics) in patients undergoing Coronary Artery Bypass Graft surgery (CABG). At two time points before and two after CABG, 217 patients completed self-report questionnaires. To explore structural relationships, the structural equation modelling (SEM) method was applied. Using the model generating approach, a model was developed providing a good fit. The structural relationships revealed in particular the key position of neuroticism, which was related to both pre- and postoperative anxiety and depression. Relationships between anxiety and depression over time, both intra- and interrelationships, were relatively weak. Relationships between anxiety and depression at the same points in time were relatively strong, with preoperative depression leading to preoperative anxiety, and postoperative anxiety leading to postoperative depression. To provide a useful framework for development of intervention strategies, further research is needed to evaluate the plausibility of the final structural model.

Introduction

Coronary artery bypass graft surgery (CABG) is usually successful in relieving angina but psychological adjustment to this surgical procedure is often disappointing [1-5].

Undergoing CABG implies a stressful experience for most patients, both before and after surgery. The stress of waiting for surgery is followed by the threat of the surgical procedure itself. Increased anxiety and depression have been reported in the preoperative period [2, 4, 6, 7]. Preoperative fears mainly concern the illness itself, anaesthesia, surgical procedures and thoughts relating to the period after surgery (e.g., fear of the unknown, surgical failure, death, painful wounds and fear of loss of control) [8].

While anxiety dominates prior to surgery, feelings of depression are more common in the early weeks after surgery [8-11]. Discomfort and weakness during early convalescence make it difficult for patients to believe that they are doing well and that surgery was successful [10, 11]. Postoperative anxiety mainly involves concerns about returning to normal life and related physical activities [9]. Moreover, after release from the hospital, the patient may feel more insecure and fearful because of the absence of the support system provided by the hospital [11, 12]. Finally, feelings of anxiety and depression weeks or months after surgery can be an expression of difficulties adapting to the changed postoperative and future situation,. and career and family problems [8].

Several attempts have been made to study predictors of psychological outcome after cardiac surgery [2, 3, 13-18]. Prediction of psychological outcome may improve identification of patients at risk of later psychological problems. Evaluation of prospective studies shows that specific psychological outcomes are strongly predicted by their preoperative assessments, especially in the case of anxiety and depression [19]. Additionally, it is assumed that poor adjustment is more a reflection of the patient's personality than the surgical procedure itself [3, 18]. Especially patients with a generally fatalistic attitude seem to experience postoperative feelings of anxiety and depression [3].

Identification of determinants, leading to either good or poor psychological outcome, may have implications for the development of intervention strategies to assist those patients in need of support. In attempting to develop efficient intervention strategies, one would need to understand the underlying processes of the psychological factors involved. Examination of the structure of intrarelationships (i.e., relationships within the same variable over time) and interrelationships (i.e., relationships between different variables, both over time and at the same points in time) will provide insight into how the various factors might affect one another. This structure, then, might be a useful framework for development of clinical interventions.

So far, the aim of prospective studies was to identify preoperative demographic, medical and psychological determinants of specific psychological outcomes, without regard for the overall structure of relationships between the various variables. Therefore, the present study was designed to integrate the

factors involved into one simultaneous analysis to explore the structure of intra- and interrelationships. The focus was on feelings of anxiety and depression over time in relation to personality and background factors (e.g., gender, age and medical factors). Feelings of anxiety and depression were assessed prior to surgery and in the early and late postoperative period.

To explore structural relationships, structural equation modelling (SEM) has recently emerged as an accepted method [20]. SEM deals with identifying, specifying and testing models for structural relationships between substantively meaningful variables [21]. A major advantage of SEM is its ability to estimate all the parameters in the model simultaneously and to provide an overall test of model fit. Moreover, SEM has the advantage to adjust for measurement error, which requires specification of a measurement model that depicts relationships between observed variables (i.e., measured variables) and latent variables (i.e., hypothetical or theoretical constructs) [20]. Although SEM is generally used to test prespecified conceptual models, it can also be used in an exploratory manner. Using the model generating (MG) approach [21, 22], SEM permits to develop a structural model, which can be considered as a first step towards building a theory. Because a specific theoretical basis is lacking in this study, it was anticipated that the exploratory use of SEM would improve the understanding of psychological processes in patients undergoing CABG.

This study is a part of a longitudinal follow-up study on psychological factors in patients undergoing CABG. The aim is to enhance the understanding of psychological processes in order to contribute to the development of intervention strategies. Information about variations in mean level and interindividual differences in anxiety and depression is presented in a separate study [23].

Methods

Selection of patients

The study was conducted at the departments of cardiopulmonary surgery of a regional and a university hospital, where all operations were carried out by the same surgical team. The follow-up study took place between October 1994 and May 1996. Patients awaiting elective CABG were eligible for inclusion in this

study. The only exclusion criteria were insufficient command of the Dutch language, a history of psychiatric illness, and CABG with a concomitant surgical procedure.

A total of 307 consecutive patients were included in the study. Following elimination of patients due to procedural problems (n=13), unwillingness to participate (n=23) and inconclusive data (n=1), 270 patients completed baseline assessment. The present study combined data for 80.4% of these patients (n=217) who were tested at four points in time, starting prior to surgery until six months after surgery, including 176 men and 41 women (mean age 60.8, range 28-78, sd 8.8 years). The remainder of patients was lost during follow-up: measurements 2, 3 or 4 were missed by 10.7% of the patients completing baseline assessment, 3% died before all data could be obtained and 5.9% did not respond to their last follow-up.

Procedure

Patients underwent standard preoperative medical testing at the cardiology outpatient clinic, about two weeks before surgery (T1). Following their visit to the cardiologist, patients were informed about the study. After informed consent was obtained, patients were requested to complete questionnaires to assess anxiety, depression and personality and to return them in an enclosed pre-paid envelope within one week. On the day of admission to the hospital (i.e., one day prior to surgery), anxiety was reassessed (T2). Follow-up assessments of anxiety and depression by questionnaire took place seven days after surgery in the hospital (T3) and six months postoperatively through the post (T4). Before the questionnaires were posted, patients were interviewed by telephone to gain information about their physical condition. Medical records were used to obtain medical data.

Medical assessment

Based on earlier findings [12, 13, 18, 24-26], four medical variables were assessed from the medical records, including left ventricular ejection fraction (LVEF), previous CABG, number of days in intensive care, and total hospital stay. Data on postoperative cardiac events and rehospitalization were obtained during postoperative interview and from medical records.

The medical characteristics of a patient were considered complicated if one or more of the following events occurred: impaired LVEF (<0.55 [27]) (32.3% of patients), previous CABG (8.3%), prolonged stay in intensive care (>1 day) (18.0%), prolonged hospital stay (>14 days) (10.6%), postoperative cardiac event(s) (8.5%) and rehospitalization (8.3%). Elsewhere, the medical characteristics were considered uncomplicated (45.2%). So the medically complicating factor (MCF) score was calculated, representing the absence and presence of complicated medical characteristics.

Pre- and postoperative psychological assessment

Psychological variables were assessed with the following relevant questionnaires [2, 3, 6, 28, 29].

To assess anxiety, the Dutch State version of the State Trait Anxiety Inventory (STAI) was used [30], with scores ranging from 20 to 80, and higher scores reflecting greater anxiety. Moderate anxiety is defined by scores in the range 32.1 to 40.7 for men and 33.1 to 44.5 for women [31]. Reliability and validity of the STAI are adequate [30].

The Hospital Anxiety and Depression scale (HAD) [32] was used to assess depression. The relevant subscale is specifically designed to screen physically ill patients and does not include somatic symptoms for the assessment of depression. It consists of seven items, with depression scores ranging from 0 to 21, and higher scores indicating more intensity. Scores over 8 indicate that patients are likely to be depressed. Reliability and validity are adequate for the Dutch population [33].

The following subscales of the Dutch Personality Questionnaire (DPQ) [34] were used to assess personality: neuroticism (scores range from 0 to 42), self-esteem (scores range from 0 to 38), rigidity (scores range from 0 to 50) and hostility (scores range from 0 to 38). Reliability and validity are adequate for the Dutch population [34].

Statistical analyses

Before answering the research objectives, calculated estimates were substituted for missing data on the psychological variables. This was done by regression of

the relevant variable on all remaining variables having acceptable values ($p <$ 0.05, two-sided).

To explore structural relationships, the MG approach of SEM was applied [21, 22]. This approach involves the examination of a number of models obtained by modifying a starting model.

The general structural equation model incorporates both the measurement model (e.g., factor analysis model) and the structural model. A desirable property of the measurement model is that each latent variable of the model is adequately represented by the respective observed variables. The structural model concerns the direct and indirect relationships between exogenous (independent) variables and endogenous (dependent) variables, both latent variables [35].

Table 1. **Reliability of psychological assessments**

psychological variable	Cronbach's α
Neuroticism	.86
Self-esteem	.77
Rigidity	.80
Hostility	.80
Anxiety (T1)	.95
Anxiety (T2)	.92
Anxiety (T3)	.91
Anxiety (T4)	.95
Depression (T1)	.83
Depression (T3)	.69
Depression (T4)	.84

T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

The analyses for constructing structural equation models were conducted with the LISREL8 program for Windows [21]. For practical reasons, the measurement errors of the observed variables were estimated a priori using Cronbach's alpha, a measure of reliability [36] (Table 1). Subsequently, the measurement error (1-Cronbach's alpha) was specified in the input file [21, page

37]. Parameters were estimated by using the method of maximum likelihood, based on the correlation matrix of the observed variables. To test the assumption of multivariate normality, distributional properties of the observed variables were evaluated in terms of skewness by means of PRELIS [37]. Skewed distributions were successfully normalized by square root transformation. The rationale for using correlations was to gain insight into the relative importance of the variables involved. In the next section we will concentrate on developing a plausible structural model.

Strategy of analysis The process of fitting structural equation models started with the estimation of autocorrelations of the endogenous variables (i.e., anxiety and depression) [19]. In the next steps, the initial model was modified to explore interrelationships of the endogenous variables: (a) the disturbance terms of anxiety and depression were allowed to covary at T1, T3 and T4, (b) these covariances were replaced by paths leading from anxiety to depression (lag 0), (c) paths between anxiety and depression were reversed, with depression leading to anxiety, (d) paths leading from anxiety to depression (lag > 0) were added to (b), (e) paths leading from depression to anxiety (lag > 0) were added to (c). Finally, the exogenous variables (i.e., background and personality factors) were added, initially free to affect all endogenous variables and allowed to intercorrelate freely.

For each model estimated, the fit was evaluated by examination of the parameter estimates, measures of overall fit and detailed assessment of fit (fitted and standardized residuals and modification indices), which can be found in the output from LISREL [21, 22].

Parameter estimates should have the right sign and size on substantive grounds. Only statistically significant terms were maintained in the model; nonsignificant paths were removed, one by one. Paths with the smallest t values were discarded first.

The aim of the estimation method is to minimize the discrepancy between the sample correlation matrix and the hypothesized or theoretical matrix. In literature there are numerous measures of goodness-of-fit [38-40]. In this study the following performance measures were selected to test the hypothesized models for fit: (1) chi-square (including degrees of freedom and p-value) for

model fit: a nonsignificant value indicates that the model at issue can not be rejected, (2) standardized root mean squares of residuals (SRMR): the lower the better the model fits, (3) goodness-of-fit adjusted for degrees of freedom (AGFI), with a theoretical range from 0.0 (no fit at all) to 1.0 (perfect fit), and (4) root mean squares error of approximation (RMSEA): a value of 0.05 indicates a close fit. Ideally, a model should be tested against independent data. Because we had no independent sample, the expected crossvalidation index (ECVI) was included, representing the stability of a model: the lower the better [40].

Fitted and standardized residuals were used to determine the source of misspecification in the model; modification indices were helpful to improve model fit.

In developing the structural model, the problem of equivalent models was taken into account [41, 42]. For any given model there will generally be alternative models which are mathematically indistinguishable from the original model. Such models, then, can only be distinguished in terms of other criteria such as interpretability of parameter estimates and meaningfulness of the model [41]. Therefore, in the present study, support of a particular model from a set of equivalent models was based on substantive arguments.

The final model should be one that fits the data of the sample reasonably well and in which all parameters are meaningful and substantively interpretable. Standardized path coefficients indicate the strength of associations. The amount of variance explained by direct and indirect paths together is represented by R^2 which can theoretically vary from 0.0 (no variance explained at all) to 1.0 (all variance explained).

Results

Regarding the assumption of multivariate normality, which underlies the method of maximum likelihood, the square root transformation did not reveal results different from those of analyses based on untransformed variables. As a result, further analyses were based on untransformed variables.

Table 2 shows the observed correlations for both the psychological and background variables. LISREL analysis on this correlation matrix produced a number of intermediate and alternative models, which are presented in Table 3.

Table 2. Correlation matrix of psychological and background variables (N=217)[a]

variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Neurot	12.1±8.1													
2. Rigidity	.19	33.1±7.6												
3. Hostility	.46*	.31*	20.9±6.3											
4. S-est	-.55*	.03	-.13	27.6±6.2										
5. Anx (T1)	.54*	.31*	.26*	-.31*	44.7±12.7									
6. Dep (T1)	.60*	.24*	.19	-.50*	.65*	5.2±4.0								
7. Anx (T2)	.40*	.21	.14	-.29*	.69*	.48*	43.0±10.7							
8. Anx (T3)	.44*	.15	.14	-.31*	.39*	.36*	.39*	34.1±8.9						
9. Dep (T3)	.33*	.17	.13	-.25*	.31*	.39*	.30*	.56*	4.9±3.6					
10. Anx (T4)	.63*	.11	.24*	-.42*	.53*	.56*	.43*	.50*	.37*	34.2±11.8				
11. Dep (T4)	.58*	.18	.32*	-.41*	.45*	.62*	.33*	.45*	.40*	.75*	3.6±3.6			
12. Gender	.18	.10	.01	-.16	.28*	.27*	.26*	.17	.06	.17	.16	176/41[b]		
13. MCF	.08	.08	.03	-.09	.08	.11	.09	.05	.15	.06	.04	.06	98/119[c]	
14. Age	-.06	.30*	.01	-.03	-.04	-.06	-.06	.06	.17	-.13	-.03	.16	.21*	60.8±8.8

[a] means and standard deviations for the interval variables and frequencies for the categorical variables are shown in bold on the diagonal; Neurot = neuroticism; S-est = self-esteem; Anx = anxiety; Dep = depression; T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG; MCF = medically complicating factor; * two-tailed significance: $p < 0.001$; [b] men/women; [c] absence/presence of complicated medical characteristics

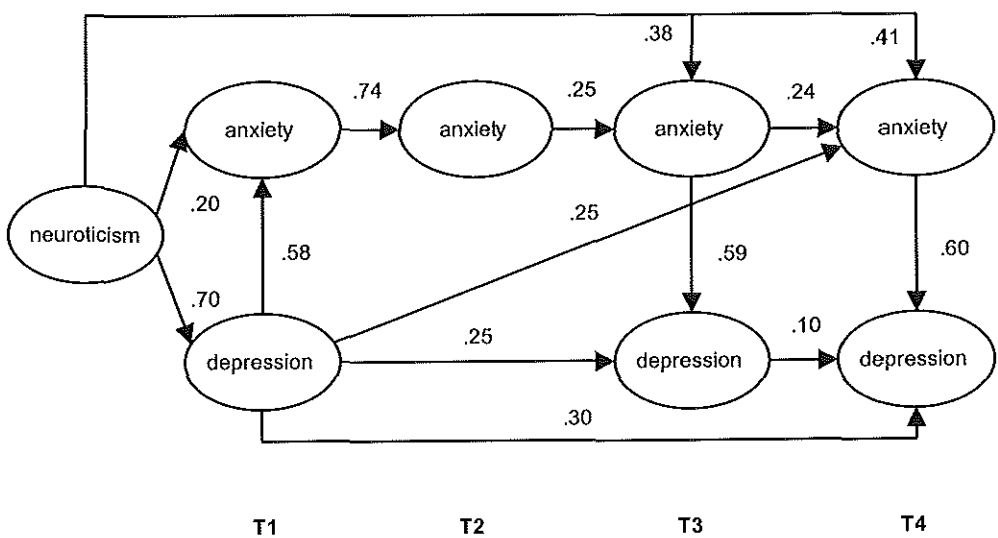
Table 3. Results of model search: goodness of fit tests

Model description		χ^2	df	p	RMSEA	SRMR	AGFI	ECVI
Intermediate models:								
1	autocorrelations	280.57	15	.00	.29	.22	.57	1.42
2	1 + covariances between disturbance terms of anxiety and depression at T1, T3, T4	109.39	13	.00	.19	.18	.76	.65
3	1 + crosscorrelations (lag 0): from anxiety to depression at T1, T3, T4	100.99	13	.00	.18	.16	.79	.61
4	1 + crosscorrelations (lag 0): from depression to anxiety at T1, T3, T4	85.07	13	.00	.16	.10	.79	.53
5	3 + crosscorrelations (lag>0): from depression T1 to anxiety T4	25.35	11	.01	.08	.05	.92	.27
Alternative models:								
6	5 + neuroticism: to anxiety and depression at T1, T3, T4	14.51	12	.27	.03	.02	.95	.29
7	6 - neuroticism to depression T3, T4	15.52	14	.34	.02	.02	.96	.28
8	6 - neuroticism to depression T1	44.53	13	.00	.11	.05	.87	.42
9	6 - neuroticism to anxiety T3, T4	57.86	14	.00	.12	.08	.85	.47
10	6 - neuroticism to anxiety T1	91.95	13	.00	.17	.19	.77	.64

RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AGFI = adjusted goodness of fit index; ECVI = expected cross-validation index; T1 = 14 days before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

With respect to the exogenous variables, only neuroticism was related to the endogenous variables. Adding the remaining exogenous variables produced a less good fit. Both model 6 and 7 showed a good fit. Model 6, however, included nonsignificant paths between neuroticism and postoperative depression. Elimination of these paths resulted in model 7. This final model with its respective path coefficients is shown in Figure 1.

Figure 1. Final structural model of anxiety and depression in patients undergoing coronary artery bypass graft surgery



T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

All of the parameter estimates for the final model were statistically significant. The starting point of the model appeared to be neuroticism, which was associated with both anxiety and depression. As can be seen from Figure 1, neuroticism, as an exogenous variable, was directly and highly related to depression at T1 and moderately related to anxiety at T1, T3 and T4. Regarding the endogenous variables, depression at T1 was directly and highly

related to anxiety at T1 and moderately related to anxiety at T4 and postoperative depression. Anxiety at T1 was directly and highly related to anxiety at T2, which was in turn moderately related to anxiety at T3. Anxiety at T3 was directly and highly related to depression at T3 and moderately to anxiety at T4. Anxiety at T4 was directly and highly related to depression at the same time. Finally, depression at T3 was directly but only slightly related to depression at T4.

Table 4. Total and indirect effects of exogenous and endogenous variables

tot/indir	Anx(T1)	Anx(T2)	Anx(T3)	Anx(T4)	Dep(T1)	Dep(T3)	Dep(T4)
Neurot	.61/.41	.45/.45	.49/.11	.70/.29	.70/.00	.47/.47	.68/.68
Anx(T1)	-	.74/.00	.18/.18	.04/.04	.00/.00	.11/.11	.04/.04
Anx(T2)	.00/.00	-	.25/.00	.06/.06	.00/.00	.15/.15	.05/.05
Anx(T3)	.00/.00	.00/.00	-	.24/.00	.00/.00	.59/.00	.20/.20
Anx(T4)	.00/.00	.00/.00	.00/.00	-	.00/.00	.00/.00	.60/.00
Dep(T1)	.58/.00	.43/.43	.11/.11	.28/.03	-	.31/.06	.50/.20
Dep(T3)	.00/.00	.00/.00	.00/.00	.00/.00	.00/.00	-	.10/.00

tot = total effect; indir = indirect effect; Neurot = neuroticism; Anx = anxiety; Dep = depression; T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

Table 5. Explained variances (R^2) and error variances of the endogenous variables

variance	Anx(T1)	Anx(T2)	Anx(T3)	Anx(T4)	Dep(T1)	Dep(T3)	Dep(T4)
Explained	.54	.54	.29	.57	.49	.53	.77
Error	.46	.46	.71	.43	.51	.47	.23

Anx = anxiety; Dep = depression; T1 = 14 days before CABG; T2 = 1 day before CABG; T3 = 7 days after CABG; T4 = 6 months after CABG

Besides direct effects, there were also indirect effects. Indirect effects were determined by subtracting the direct effects from the total effects. Neuroticism showed for instance an indirect effect on anxiety at T1 through depression at T1. Total and indirect effects on the endogenous variables of the final structural

model are depicted in Table 4. Regarding the total effects, relationships including neuroticism and relationships between anxiety and depression (lag 0) were of relatively high importance. Table 5 shows the variances explained by direct and indirect paths together (R^2). The hypothesized relationships of the final model accounted in particular for the variance of depression at T4. The explained variance of anxiety at T3, on the other hand, was relatively low.

Discussion

In this study an attempt was made to find a structural equation model to clarify psychological processes in patients undergoing CABG. Specifically, we were interested in feelings of anxiety and depression over time in relation to personality and background factors. The search for an adequate model was guided by both substantive and statistical criteria to reduce misspecification of the final model.

Intra- and interrelationships of anxiety and depression, personality and background factors were modeled. A final structural model was constructed and provided a good fit. Examination of structural relationships revealed a key position of neuroticism. Neuroticism exposed both direct and indirect effects on anxiety and depression over time. Preoperative depression appeared to be an important mediator between, on the one hand, neuroticism and, on the other, pre- and postoperative anxiety and postoperative depression. Intrarelationships were relatively weak, in particular for depression. Interrelationships at the same points in time were relatively strong, with preoperative depression leading to preoperative anxiety, and postoperative anxiety leading to postoperative depression. Finally, self-esteem, rigidity, hostility and background factors appeared to be of no relevance.

Although the final model provided a good fit, the results already showed that more than one structural equation model can fit the data. Regarding the plausibility of a model, this implies that structural relationships should not only fit the data well but should also make good theoretical sense [43]. To support the plausibility of the final model, we need to consider the theoretical implications.

The absence of background factors in the final model is in line with results of other studies showing little or no relationship between background factors (e.g., gender, age and medical factors) and psychological outcome [2, 3, 16, 18]. Although there is a possibility that self-esteem, hostility and rigidity played a role in the onset of anxiety and depression, their influence apparently did not affect the course of anxiety and depression. The importance of neuroticism, on the other hand, is in concordance with results of other studies [3, 18], and with the general assumption that neurotic individuals are inclined to experience negative emotions, at all times and regardless of the situation [44, 45].

Contrary to our expectations [19], intrarelationships of anxiety and depression were relatively weak, in particular the one between depression in the early and late postoperative period. With respect to the early period after CABG, it is conceivable that scores on the depression scale represent discomfort and weakness rather than depression. In accounting for the relatively weak intrarelationships, from baseline assessment to the late postoperative period, effects of denial might interfere with the course of anxiety and depression. Denial is very common before surgery and its impact varies over time [10, 11]. For instance, preoperative denial may be helpful in reducing preoperative feelings of anxiety and depression [11] but may lead to anxiety and depression in the late postoperative period [15]. Unfortunately, anxiety and depression were measured by use of self-report questionnaires. A problem with self-report questionnaires is that they are susceptible to social desirability and therefore unreliable to distinguish between 'true' and 'masked' levels of anxiety and depression [46]. To adjust for effects of masking, clinical ratings should be included [46].

Relationships between anxiety and depression at the same points in time, on the other hand, were relatively strong. With respect to the relationship between anxiety and depression there is, however, ongoing discussion regarding the distinctiveness of these concepts [47-49], as studies have consistently shown that self-report measures of anxiety and depression are strongly interrelated [50]. It is suggested that both constructs share a substantial component of general negative affect, which is responsible for the strong association [50-52]. Since neuroticism is more or less synonymous with this component of general

negative affect [53], neuroticism may account for the strong interrelationships found. The directions of influence, on the other hand, need further explanation.

Given the final model, reversal of the path between preoperative depression and preoperative anxiety led to an equivalent model which is an example of the so-called replacing rule (i.e., rule for generating equivalent models) [41, 42]. This change presented a substantially different path diagram, with preoperative anxiety leading to preoperative depression. Regarding the preoperative situation, one could argue that patients high in depression tend to experience more anxiety than those low in depression. Conversely, patients may experience depressive feelings in response to anxiety. With a view to the impending surgery and supported by findings from literature [8, 9, 10, 11] we expected that anxiety is the most prominent feeling in the period prior to CABG. Therefore, it seems more likely that depressive patients become anxious, than the other way round.

It is clear that the phenomenon of equivalent models represents a problem in interpreting SEM results, in particular if alternative explanations cannot be excluded on compelling arguments. To support our final model, it becomes necessary to conduct additional research, designed to either eliminate model equivalence (e.g., inclusion of additional variables) or make one of the two equivalent models substantively implausible (e.g., experimental manipulation of variables) [41].

Structural modelling of anxiety and depression raised at least two further issues. First, alpha reliabilities were used instead of developing a measurement model. We did this to keep the exploration of an already complex model manageable. Examination of relationships between observed and latent variables might have improved insight into the psychological processes in patients undergoing CABG. Second, it should be noted that relevant additional variables, beyond the scope of this study, might be responsible for feelings of anxiety and depression. Identification of these variables, either theoretically or empirically, may result in an increase of explained variances of anxiety and depression.

For a more definite answer concerning the stability of the final model, the present study should be replicated. In addition, a multimethod approach (e.g., self-report questionnaires, interviews, observations and clinical ratings) is

recommended to increase the validity of the constructs in the model. Eventually, it might be necessary to include additional variables to reduce the risk of omitted variables.

Assuming that the final model appears to be stable, several clinical implications are apparent. According to our findings, neuroticism has a significant impact on both pre- and postoperative anxiety and depression. To reduce feelings of anxiety and depression, intervention strategies should focus on neuroticism. Starting early in the preoperative period seems to be most appropriate, because this might affect both pre- and postoperative states. While preparation should be routine for all patients awaiting CABG, more emphasis needs to be placed on treatment of those patients high in neuroticism. Although it is unlikely that neuroticism can be modified by preoperative intervention, those patients high on neuroticism scales seem to benefit from group therapy and individual counselling [54]. Since, the waiting period before surgery is often lengthy [55, 56] and a main source of stress [57], this period seems to be an appropriate opportunity for interventions.

In considering the limitations of the present study, the results clarified the relationships between pre- and postoperative anxiety and depression in patients undergoing CABG, accounting for a substantial amount of variance. To provide a useful framework for development of intervention strategies, further research is needed to evaluate the stability of the final structural model.

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CHAPTER 7

A STRUCTURAL MODELLING ANALYSIS OF PSYCHOLOGICAL FACTORS IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT SURGERY: A MODEL GENERATING APPROACH.

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(submitted)

Abstract

The present study was a longitudinal study designed to explore structural relationships between psychological and background factors (e.g., gender, age and complicated medical characteristics) in patients undergoing Coronary Artery Bypass Graft surgery (CABG). The focus was on anxiety, depression, feelings of disability, somatic complaints and fatigue over time in relation to personality. Prior to surgery and six months postoperatively, 217 patients completed self-report questionnaires. Medical data were collected from medical records. To explore structural relationships, the structural equation modelling (SEM) method was applied. Using the model generating approach, a model was developed providing a good fit. The structural relationships revealed in particular the key position of neuroticism. Neuroticism was directly and positively related to preoperative anxiety, depression and somatic complaints and postoperative anxiety. Postoperative anxiety was an important mediator between neuroticism and postoperative depression, feelings of disability, fatigue and somatic complaints. Relationships between variables over time were relatively weak, with intrarelationships being positive, and interrelationships being negative. Pre- and postoperative interrelationships, on the other hand, were relatively strong and positive. To provide a useful framework for development of intervention strategies, further research is needed to evaluate the plausibility of the final structural model.

Introduction

Undergoing Coronary Artery Bypass Graft surgery (CABG) is a stressful experience. Many patients have difficulties to adapt psychologically and increased feelings of anxiety and depression have been noted [1-9]. In addition, feelings of disability [3, 10], vague somatic complaints [2, 4, 11] and fatigue [12-14] have frequently been recognized. It is assumed that these problems, weeks or months after surgery are associated with feelings of anxiety and depression, rather than a manifestation of the existing medical situation [4, 5, 11, 12]. Little attention has

however been given to the extent to which these problems are psychologically determined.

With respect to these findings, there seems to be a need to evaluate psychological processes in patients undergoing CABG and to identify patients at risk of later psychological problems. Recent prospective studies have so far mainly focused on preoperative determinants of psychological outcome [2, 6, 7, 9, 15-18]. Evaluation of their results shows that specific psychological outcomes are strongly predicted by their preoperative assessments. In addition, personality factors appear to be relevant predictors of psychological outcome [19]. Although these findings are of clinical relevance, it is more profound to identify the structure of relevant underlying processes of the factors involved. Simultaneous examination of intrarelationships (i.e., relationships within the same variable over time) and interrelationships (i.e., relationships between different variables, both over time and at the same points in time) may improve the understanding of the way in which the various factors affect one another. The overall structure of these relationships, then, might be a useful framework for development of clinical interventions.

To improve insight into underlying processes of anxiety, depression, feelings of disability, somatic complaints and fatigue, the present study integrated both pre- and postoperative assessments of the respective factors into one simultaneous evaluation to explore the overall structure of relationships. The focus was on intra- and interrelationships in relation to personality factors. In addition, background factors including gender, age and medical factors were involved to adjust for modifying effects.

To explore structural relationships, structural equation modelling (SEM) has recently emerged as an accepted method [20]. SEM deals with identifying, specifying and testing models for structural relationships between substantively meaningful variables [21]. Compared to multiple regression analysis, structural modelling has several advantages [20]. A major advantage of SEM is its ability to estimate all the parameters in the model simultaneously and to provide an overall test of model fit. Moreover, SEM has the advantage to adjust for measurement error, which requires specification of a measurement model that depicts relationships between observed or measured variables and latent variables (i.e., hypothetical or theoretical constructs) [20]. Using the model generating (MG) approach

[21], SEM permits to develop a structural model, which can be considered as a first step towards building a theory. It was anticipated that this exploratory approach of SEM would improve the understanding of psychological processes in patients undergoing CABG.

Methods

Selection of patients

The study was conducted at the departments of cardiopulmonary surgery of a regional and a university hospital, where all operations were carried out by the same surgical team. The follow-up study took place between October 1994 and May 1996. Patients awaiting elective CABG were eligible for inclusion in this study. The only exclusion criteria were insufficient command of the Dutch language, a history of psychiatric illness, and CABG with a concomitant surgical procedure.

A total of 307 consecutive patients were included in the study. Following elimination of patients due to procedural problems (n=13), unwillingness to participate (n=23) and inconclusive data (n=1), 270 patients completed baseline assessment. The present study combined data for 80.4% of these patients (n=217) who were tested prior to surgery and six months after surgery, including 176 men and 41 women (mean age 60.8, range 28-78, sd 8.8 years). The remainder of patients was lost during follow-up: measurement 2 was missed by 10.7% of the patients completing baseline assessment, 3% died before all data could be obtained and 5.9% did not respond to their follow-up.

Procedure

All selected patients underwent standard preoperative medical testing at the cardiology outpatient clinic, about two weeks before surgery (T1). Following their visit to the cardiologist, patients were informed about the study. After informed consent was obtained, patients were requested to complete questionnaires to assess personality, anxiety, depression, feelings of disability, somatic complaints and fatigue, and to return them in an enclosed pre-paid envelope within one week. Postoperative assessment was carried out six months after surgery (T4) through the post. Before the questionnaires were posted, patients were interviewed by

telephone to gain information about their physical condition. Medical records were used to obtain medical data.

Medical assessment

Based on earlier findings [9, 15, 16, 22-24], four medical variables were assessed from the medical records, including left ventricular ejection fraction (LVEF), previous CABG, number of days in intensive care, and total hospital stay. Data on postoperative cardiac events and rehospitalization were obtained during postoperative interview and from medical records.

The medical characteristics of a patient were considered complicated if one or more of the following events occurred: impaired LVEF (<0.55 [25]) (32.3% of patients), previous CABG (8.3%), prolonged stay in intensive care (>1 day) (18.0%), prolonged hospital stay (>14 days) (10.6%), postoperative cardiac event(s) (8.5%) and rehospitalization (8.3%). Elsewhere, the medical characteristics were considered uncomplicated (45.2%). So the medically complicating factor (MCF) score was calculated, representing the absence and presence of complicated medical characteristics.

Pre- and postoperative psychological assessment

Psychological variables were assessed with the following relevant questionnaires [2, 6, 26-28].

To assess anxiety, the Dutch State version of the State Trait Anxiety Inventory (STAI) was used [29], with scores ranging from 20 to 80, and higher scores reflecting greater anxiety. Moderate anxiety is defined by scores in the range 32.1 to 40.7 for men and 33.1 to 44.5 for women [30]. Reliability and validity of the STAI are adequate [29].

The Hospital Anxiety and Depression scale (HAD) [31] was used to assess depression. The relevant subscale is specifically designed to screen physically ill patients and does not include somatic symptoms for the assessment of depression. It consists of seven items, with depression scores ranging from 0 to 21, and higher scores indicating more intensity. Scores over 8 indicate that patients are likely to be depressed. Reliability and validity are adequate for the Dutch population [32].

The disability subscale of the Heart Patients Psychological Questionnaire (HPPQ) [33] was used to assess feelings of disability, with scores ranging from 12

to 36, and higher scores indicating more intensity. Reliability and validity are adequate for the Dutch population [33].

Somatic complaints were measured by means of the Psychosomatic Stress Questionnaire (PSQ) [34]. This questionnaire comprises 17 (after excluding 4 items associated with heart disease) vague complaints of neurovegetative nature and can be answered by the subject in a positive or negative response mode. Scores range from 0 to 17 and reliability and validity are adequate for the Dutch population [34].

To assess fatigue, the general fatigue scale of the Multidimensional Fatigue Inventory (MFI) [35] was used, with scores ranging from 4 to 20, and higher scores indicating more intensity. Reliability and validity have been proven for Dutch studies [35].

The following subscales of the Dutch Personality Questionnaire (DPQ) [36] were used to assess personality: neuroticism (scores range from 0 to 42), self-esteem (scores range from 0 to 38), rigidity (scores range from 0 to 50) and hostility (scores range from 0 to 38). Reliability and validity are adequate for the Dutch population [36].

Statistical analyses

Before answering the research objectives, calculated estimates were substituted for missing data on the psychological variables. This was done by regression of the relevant variable on all remaining variables having acceptable values ($p < 0.05$, two-sided).

To explore structural relationships, the MG approach of SEM was applied [21, 37]. This approach involves the examination of a number of models obtained by modifying a starting model.

The general structural equation model incorporates both the measurement model (e.g., factor analysis model) and the structural model. A desirable property of the measurement model is that each latent variable of the model is adequately represented by the respective observed variables. The structural model concerns the direct and indirect relationships between exogenous (independent) variables and endogenous (dependent) variables, both latent variables [38].

The analyses for constructing structural equation models were conducted with the LISREL8 program for Windows [21]. For practical reasons, the measure-

ment errors of the observed variables were estimated a priori using Cronbach's alpha, a measure of reliability [39] (Table 1). Subsequently, the measurement error (1-Cronbach's alpha) was specified in the input file [21, page 37]. Parameters were estimated by using the method of maximum likelihood, based on the correlation matrix of the observed variables. To test the assumption of multivariate normality, distributional properties of the observed variables were evaluated in terms of skewness by means of PRELIS [40]. Skewed distributions were successfully normalized by square root transformation. The rationale for using correlations was to gain insight into the relative importance of the variables involved. In the next section we will concentrate on developing a plausible structural model.

Table 1. Reliability of psychological assessments

psychological variable	Cronbach's α
Neuroticism	.86
Self-esteem	.77
Rigidity	.80
Hostility	.80
Anxiety (T1)	.95
Anxiety (T4)	.95
Depression (T1)	.83
Depression (T4)	.84
Disability (T1)	.85
Disability (T4)	.89
Fatigue (T1)	.84
Fatigue (T4)	.88
Somatic complaints (T1)	.83
Somatic complaints (T4)	.85

T1 = 14 days before CABG; T4 = 6 months after CABG

Strategy of analysis The process of fitting structural equation models started with the estimation of autocorrelations of the endogenous variables (i.e., anxiety, depression, feelings of disability, somatic complaints and fatigue) [19]. In the next steps, the initial model was modified to explore interrelationships of the endogenous variables: (a) the disturbance terms were allowed to covary at T1 and T4, (b) these covariances were replaced by paths (lag 0), (c) paths (lag > 0) were added.

Finally, the exogenous variables (i.e., background and personality factors) were added, initially free to affect all endogenous variables and allowed to intercorrelate freely.

For each model estimated, the fit was evaluated by examination of the parameter estimates, measures of overall fit and detailed assessment of fit (fitted and standardized residuals and modification indices), which can be found in the output from LISREL [21, 37].

Parameter estimates should have the right sign and size on substantive grounds. Only statistically significant terms were maintained in the model; nonsignificant paths were removed, one by one. Paths with the smallest t values were discarded first.

The aim of the estimation method is to minimize the discrepancy between the sample correlation matrix and the hypothesized or theoretical matrix. In literature there are numerous measures of goodness-of-fit [41-43]. In this study the following performance measures were selected to test the hypothesized models for fit: (1) chi-square (including degrees of freedom and p-value) for model fit: a nonsignificant value indicates that the model at issue can not be rejected, (2) standardized root mean squares of residuals (SRMR): the lower the better the model fits, (3) goodness-of-fit adjusted for degrees of freedom (AGFI), with a theoretical range from 0.0 (no fit at all) to 1.0 (perfect fit), and (4) root mean squares error of approximation (RMSEA): a value of 0.05 indicates a close fit. Ideally, a model should be tested against independent data. Because we had no independent sample, the expected crossvalidation index (ECVI) was included, representing the stability of a model: the lower the better [43].

Fitted and standardized residuals were used to determine the source of misspecification in the model; modification indices were helpful to improve model fit.

In developing the structural model, the problem of equivalent models was taken into account [44, 45]. For any given model there will generally be alternative models which are mathematically indistinguishable from the original model. Such models, then, can only be distinguished in terms of other criteria such as interpretability of parameter estimates and meaningfulness of the model [44]. Therefore, in the present study, support of a particular model from a set of equivalent models was based on substantive arguments.

ble 2. Correlation matrix of psychological and background variables (N=217)[a]

riable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
. Neuroticism	12.1±8.1																
. Rigidity	.19	33.1±7.6															
. Hostility	.46*	.31*	20.9±6.3														
. S-esteem	-.55*	.03	-.13	27.6±6.2													
. Anxiety (T1)	.54*	.31*	.26*	-.31*	44.7±12.7												
. Depression (T1)	.60*	.24*	.19	-.50*	.65*	5.2±4.0											
. Disability (T1)	.29*	.14	.18	-.32*	.24*	.37*	29.1±5.9										
. Fatigue (T1)	.41*	.02	.17	-.39*	.39*	.50*	.65*	13.2±4.9									
. Somatic (T1)	.53*	.10	.19	-.36*	.37*	.46*	.53*	.65*	5.9±3.7								
. Anxiety (T4)	.63*	.11	.24*	-.42*	.53*	.56*	.32*	.41*	.46*	34.2±11.8							
. Depression (T4)	.58*	.18	.32*	-.41*	.45*	.62*	.31*	.37*	.39*	.75*	3.6±3.6						
. Disability (T4)	.43*	.20	.17	-.43*	.33*	.46*	.45*	.43*	.44*	.58*	.62*	21.7±7.1					
. Fatigue (T4)	.54*	.08	.21	-.43*	.41*	.53*	.34*	.50*	.49*	.74*	.69*	.76*	8.8±4.8				
. Somatic (T4)	.55*	.14	.17	-.39*	.46*	.50*	.38*	.44*	.62*	.71*	.62*	.67*	.78*	4.4±3.9			
. Age	-.06	.30*	.01	-.03	-.04	-.06	.19	-.06	-.04	-.13	-.03	.15	-.11	-.06	60.81±8.84		
. Gender	.18	.10	.01	-.16	.28*	.27*	.28*	.31*	.22*	.17	.16	.28*	.21	.20	.16	176/41[b]	
. MCF	.08	.08	.03	-.09	.08	.11	.07	.03	.10	.06	.04	.05	-.01	.09	.21*	.06	98/119[c]

neans and standard deviations for the interval variables and frequencies for the categorical variables are shown in bold on the diagonal; S-esteem = self-esteem; Somatic = somatic complaints; T1 14 days before CABG; T4 = 6 months after CABG; MCF = medically complicating factor score; * two-tailed significance: $p<0.001$; [b] men/women; [c] absence/presence of complicated medical haracteristics.

The final model should be one that fits the data of the sample reasonably well and in which all parameters are meaningful and substantively interpretable. Standardized path coefficients indicate the strength of associations. The amount of variance explained by direct and indirect paths together is represented by R^2 which can theoretically vary from 0.0 (no variance explained at all) to 1.0 (all variance explained).

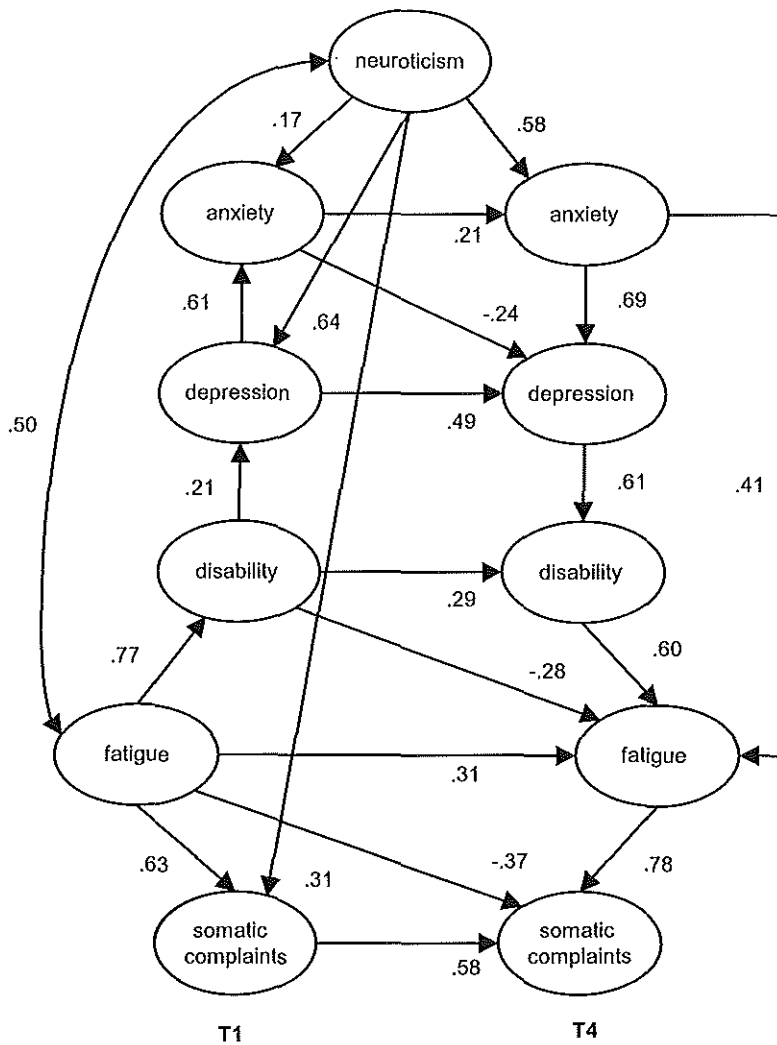
Results

Regarding the assumption of multivariate normality, which underlies the method of maximum likelihood, the square root transformation did not reveal results different from those of analyses based on untransformed variables. As a result, further analyses were based on untransformed variables.

Table 2 shows the observed correlations for both the psychological and background variables. The results of the model search are summarized in Table 3, and the final model with its respective path coefficients is shown in Figure 1. The resulting models represent four different versions of interrelationships at T1, all providing an adequate fit. As can be seen from the goodness of fit tests, the four versions led to two sets of (almost) equivalent models, with models 1 and 2 showing the best fit. With a view to the impending surgery we expected that patients, and in particular those high in neuroticism and depression, would become anxious in the preoperative period. From this substantive point of view, model 1 was to be preferred over model 2 and therefore selected as the final model in the present study.

The path coefficients, as shown in Figure 1, represent standardized estimates of the structural relationships between variables, which were all statistically significant. With respect to the exogenous variables, only neuroticism was related to the endogenous variables. Adding the remaining exogenous variables produced a less good fit. As can be seen from Figure 1, neuroticism was directly and highly related to preoperative depression and postoperative anxiety and moderately related to preoperative anxiety and somatic complaints. While initially considered to be an endogenous variable, preoperative fatigue was presented as an exogenous variable in the final model, which was highly correlated with neuroticism.

Figure 1. **Final structural model of psychological factors in patients undergoing coronary artery bypass graft surgery**



T1 = 14 days before CABG; T4 = 6 months after CABG

Table 3. Results of model search: goodness of fit tests

Model description	χ^2	df	p	RMSEA	SRMR	AGFI	ECVI
1 final model[a]	36.18	33	.32	.02	.03	.94	.47
2 = 1 but the path from depression T1 to anxiety T1 is reversed	36.29	33	.32	.02	.03	.94	.47
3 = 1 but the path from disability T1 to depression T1 is reversed	45.96	33	.07	.04	.04	.93	.52
4 = 3 but the path from depression T1 to anxiety T1 is reversed	45.96	33	.07	.04	.04	.93	.52

[a] for details see text and Figure 1; T1 = 14 days before CABG; T4 = 6 months after CABG

Table 4. Total and indirect effects of exogenous and endogenous variables

tot/in	Anx(T1)	Dep(T1)	Dis(T1)	Som(T1)	Anx(T4)	Dep(T4)	Dis(T4)	Fat(T4)	Som(T4)
Neurot	.56/.39	.64/.00	.00/.00	.31/.00	.70/.12	.66/ .66	.40/ .40	.53/ .53	.60/ .60
Fat(T1)	.10/.10	.16/.16	.77/.00	.63/.00	.02/.02	.07/ .07	.26/ .26	.26/-.05	.20/ .57
Anx(T1)	-	.00/.00	.00/.00	.00/.00	.21/.00	-.10/ .14	-.06/-.06	.05/ .05	.04/ .04
Dep(T1)	.61/.00	-	.00/.00	.00/.00	.13/.13	.43/-.06	.26/ .26	.21/ .21	.16/ .16
Dis(T1)	.13/.13	.21/.00	-	.00/.00	.03/.03	.09/ .09	.34/ .05	-.06/ .22	-.05/-.05
Som(T1)	.00/.00	.00/.00	.00/.00	-	.00/.00	.00/ .00	.00/ .00	.00/ .00	.58/ .00
Anx(T4)	.00/.00	.00/.00	.00/.00	.00/.00	-	.69/ .00	.42/ .42	.66/ .25	.52/ .52
Dep(T4)	.00/.00	.00/.00	.00/.00	.00/.00	.00/.00	-	.61/ .00	.37/ .37	.29/ .29
Dis(T4)	.00/.00	.00/.00	.00/.00	.00/.00	.00/.00	.00/ .00	-	.60/ .00	.47/ .47
Fat(T4)	.00/.00	.00/.00	.00/.00	.00/.00	.00/.00	.00/ .00	.00/ .00	-	.78/ .00

tot = total; in = indirect; Neurot = neuroticism; Anx = anxiety; Dep = depression; Dis = disability; Som = somatic complaints; Fat = fatigue; T1 = 14 days before CABG; T4 = 6 months after CABG

Preoperative fatigue was directly and highly related to both preoperative somatic complaints and feelings of disability and moderately to postoperative fatigue and somatic complaints. Regarding the endogenous variables, autocorrelations were relatively weak, except for depression and somatic complaints. Crosscorrelations (lag 0), on the other hand, were relatively strong, whereas crosscorrelations (lag > 0) were relatively weak and negative.

Besides direct effects there were also indirect effects. The sum of direct and indirect effects determine the total effect on each endogenous variable. Total and indirect effects for the final structural model are depicted in Table 4. Regarding the total effects, relationships including neuroticism and crosscorrelations (lag 0) were of relatively high importance. Table 5 shows the variances explained by direct and indirect paths together (R^2). The hypothesized relationships of the final model accounted for a large amount of variance of the endogenous variables, in particular for variances of pre- and postoperative somatic complaints and postoperative depression and fatigue.

Table 5. Explained variances (R^2) and error variances of the endogenous variables

variance	Anx(T1)	Dep(T1)	Dis(T1)	Som(T1)	Anx(T4)	Dep(T4)	Dis(T4)	Fat(T4)	Som(T4)
Explained	.54	.56	.59	.69	.53	.80	.58	.90	.92
Error	.46	.44	.41	.31	.47	.20	.42	.10	.08

Anx = anxiety; Dep = depression; Dis = disability; Som = somatic complaints; Fat = fatigue; T1 = 14 days before CABG; T4 = 6 months after CABG

Discussion

In the present study it was attempted to identify a structural equation model to clarify psychological processes in patients undergoing CABG. The focus was on anxiety, depression, feelings of disability, somatic complaints and fatigue over time in relation to personality and background factors. The use of the MG approach of SEM permitted simultaneous evaluation of the relationships, directed by both substantive and statistical criteria. This search resulted in a final structural model providing a good fit. Since multiple models can fit the data, structural relationships should both fit the data and make good theoretical sense [46]. To support the plausibility of the final model, theoretical implications have to be considered.

First, although significant correlations were found, in particular between psychological factors and gender (Table 1), background factors were absent in the final structure of relationships. This finding is consistent with those of other studies showing little or no relationship between background factors (e.g., gender, age and medical factors) and psychological outcome [2, 6, 7, 9].

Neuroticism emerged as a key variable in the final model, whereas self-esteem, rigidity and hostility appeared to be of no relevance. Preoperatively, neuroticism exposed direct effects on anxiety, depression and somatic complaints. In addition, there was a strong correlation between neuroticism and fatigue. Postoperatively, neuroticism directly affected anxiety and indirectly depression, feelings of disability, fatigue and somatic complaints. The indirect relationships were particularly mediated by postoperative anxiety. These findings suggest that patients high in neuroticism tend to report more problems (i.e., anxiety, depression, feelings of disability, somatic complaints and fatigue), both pre- and postoperatively, than those low in neuroticism. The importance of neuroticism is in line with results of other studies [6, 9, 47, 48] and with the general assumption that neurotic individuals are prone to experience distress, at all times in different situations [49, 50].

From a methodological point of view, the central role of neuroticism can be explained in terms of a general component of negative affect shared by our self-report measures of anxiety, depression, feelings of disability, somatic complaints and fatigue [49, 51-54]. As a result, neuroticism may account for the strong interrelationships found, both pre- and postoperatively. The directions of influence, on the other hand, need further explanation.

With respect to the final model, directions of interrelationships appeared to be different in the preoperative period from those in the postoperative period. Preoperatively, fatigue led through feelings of disability and depression to anxiety. Postoperatively, anxiety led to depression and to fatigue. Subsequently, depression led to fatigue, mediated by feelings of disability. Both pre- and postoperatively, fatigue led to somatic complaints. Although inferring causality requires caution [38], this structure of interrelationships seems to suggest that fatigue is both an antecedent, as well as a consequence of anxiety. In other words, those patients who reported more preoperative fatigue, were more anxious in the preoperative period. Conversely, those patients who were more anxious in the postoperative period, reported more postoperative fatigue. While this is a speculative point, it is possible that preoperative fatigue is a manifestation of the actual medical situation. To speculate further, preoperative fatigue might be related to unstable angina [55]. Postoperative fatigue, on the other hand, may be regarded as a symptom of anxiety and depression [12]. Apparently, the extent to which feelings of disability,

somatic complaints and fatigue are psychologically determined varies over time and seems to be highest in the postoperative period.

Given the final structure of relationships, reversal of the path between preoperative depression and preoperative anxiety led to a mathematically equivalent model, with preoperative anxiety leading to preoperative depression. The choice for the final model was based on substantive arguments. Although a depressive reaction is more common in the postoperative period [5, 10, 11, 56], there is a possibility that patients may experience preoperative feelings of depression in response to anxiety. As compelling arguments are lacking, additional research is needed (e.g., the inclusion of additional variables or experimental manipulation of variables) to support our choice [44].

Contrary to our expectations [19], intrarelationships were relatively weak, especially for anxiety. Compared with both pre- and postoperative interrelationships, interrelationships of variables over time were relatively weak and negative. In accounting for the relatively weak relationships between variables over time, effects of denial might be evident in our sample. Denial is common before surgery and varies in its impact over time [10, 56]. On the one hand, preoperative denial may be helpful in coping with preoperative stress [56]. On the other hand, preoperative denial may lead to psychological problems in the late postoperative period [4]. Unfortunately, all constructs in this study reflect self-reported levels, which are prone to be influenced by social desirability and therefore unreliable to distinguish between 'true' and 'masked' levels [57]. To identify effects of masking, clinical ratings should be included [57].

Another limitation of the present study might be the use of alpha reliabilities instead of developing a measurement model. We did this to simplify the exploration of an already complex model. Examination of relationships between observed and latent variables might have improved insight into the psychological processes in patients undergoing CABG. In addition, it should be noted that relevant additional variables, beyond the scope of this study, might be responsible for the endogenous variables represented in the final model. Identification of these variables, either theoretically or empirically, may result in an increase of explained variances.

In conclusion, the present study extended earlier research by integrating psychological factors into one semi-longitudinal model to improve the understand-

ing of psychological processes in patients undergoing CABG. To gain insight into the stability of our final model, the present study should be replicated. In addition, a multimethod approach (e.g., self-report questionnaires, interviews, observations and clinical ratings) is recommended to increase the validity of the constructs in the model. Furthermore, it might be necessary to include additional variables to reduce the risk of omitted variables.

Assuming that the final model appears to be stable, several clinical implications are apparent. Our findings lead to the conclusion that neuroticism has a significant impact on both pre- and postoperative psychological problems (i.e., anxiety, depression, feelings of disability, somatic complaints and fatigue) in patients undergoing CABG. In other words, those patients high in neuroticism are at risk of psychological problems, both before and after CABG. This suggests that intervention strategies should focus on neuroticism. To reduce both pre- and postoperative problems, one should start in the early preoperative period. While preparation should be routine for all patients awaiting CABG, more emphasis needs to be placed on identification and treatment of those patients high in neuroticism. Although it is unlikely that neuroticism can be modified by preoperative intervention, those patients high on neuroticism scales seem to benefit from group therapy and individual counselling [48]. Since, the waiting period before surgery is often lengthy [58, 59] and a main source of stress [60], this period seems to be an appropriate opportunity for interventions.

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CHAPTER 8

GENERAL DISCUSSION

Introduction

Undergoing CABG has a significant impact on the patient's everyday life and may lead to both beneficial and troublesome consequences. CABG is usually successful in relieving angina but implies a stressful experience for most patients. Increased feelings of anxiety and depression have often been reported, both pre- and postoperatively [1-6]. In addition to anxiety and depression, feelings of disability [3, 7], vague somatic complaints [2, 4, 8] and fatigue [9-11] have frequently been recognized. Patients may have a wide variety of concerns, with some patients reporting more problems than others. In particular, those patients reporting high rates of problems should be identified in an early phase and offered additional support.

In literature, several attempts have been made to identify patients at risk of psychological problems after CABG [2, 6, 12-18]. Evaluation of their results (chapter 2) showed that the preoperative psychological state and personality factors strongly influenced psychological outcome. Psychological problems in the preoperative period were associated with poor psychological outcome, whereas social support, control and optimism were associated with good psychological outcome.

So far little attention has been given to the underlying processes of the psychological factors involved. Insight into how the various factors affect one another, both over time and at the same points in time, may provide a useful framework to develop efficient intervention strategies. Therefore, our aim was to enhance the understanding of psychological processes in patients undergoing CABG. For this purpose, we attempted to identify the structure of relationships between relevant psychological factors. The focus was on intrarelationships (i.e., relationships within the same variable over time) and interrelationships (i.e., relationships between different variables, both over time and at the same points in time) of psychological problems (i.e., anxiety, depression, feelings of disability, somatic complaints and fatigue) in relation to personality factors. In addition, background factors including gender, age and medical factors were involved to adjust for modifying effects.

To achieve our aim, a follow-up study was performed: (1) to examine demographic, medical and psychological factors in patients scheduled for CABG, the baseline assessment of the study, (2) to examine variations in both mean level and interindividual differences in anxiety and depression, from baseline assessment to the late postoperative period, (3) to explore the structure of intra- and interrelationships of anxiety and depression, from baseline assessment to the late postoperative period, in relation to personality and background factors, and (4) to explore the structure of intra- and interrelationships of anxiety, depression, feelings of disability, somatic complaints and fatigue, at baseline and in the late postoperative period, in relation to personality and background factors.

In the following sections, an evaluation of the main results, methodological issues and suggestions for future research and clinical practice are presented.

Evaluation of the main results

With the above objectives in mind, we will list the main results and subsequently comment on them.

(1) Waiting for surgery was experienced as a frightening and depressing period by the majority of patients undergoing CABG.

(2) Mean levels of anxiety and depression showed a strong decrease in the early postoperative period. Women reported more anxiety and depression than men, both before and after CABG, but showed a relatively stronger decrease during early convalescence.

(3) Interindividual differences in anxiety showed that the entire group of patients was most homogenous in the early postoperative period. With respect to depression, variations in interindividual differences for women differed from those for men. Women were most homogenous in the early postoperative period, whereas interindividual differences for men remained consistent over time.

(4) Neuroticism played a central role in underlying processes of anxiety, depression, feelings of disability, somatic complaints and fatigue. Patients high in neuroticism reported more problems, both pre- and postoperatively, than those low in neuroticism.

(5) Anxiety, depression, feelings of disability, somatic complaints and fatigue were strongly and positively interrelated, both before and after surgery.

(6) Postoperative anxiety, depression, feelings of disability, somatic complaints and fatigue were only marginally affected by their preoperative assessments.

(7) Background factors including gender, age and medical complications did not affect underlying processes of anxiety, depression, feelings of disability, somatic complaints and fatigue.

Increased preoperative levels of anxiety and depression have been reported by several studies [2, 19-22]. Indeed, waiting for surgery has been reported to be a main source of concern in patients undergoing CABG [19, 23]. Waiting lists are often lengthy and in many cases the focus of worry is not only on the surgical procedure itself, but also on the exact date of surgery [24] and on the risk of dying whilst awaiting surgery [25].

With regard to the course of anxiety and depression, previous studies already demonstrated a substantial psychological improvement during the postoperative period [2, 7, 21, 22], especially for women [2, 26]. Little attention has, however, been given to variations in interindividual differences over time. Based on a decrease in both mean level and interindividual differences in anxiety and depression, seven days after CABG, we concluded that the majority of patients, and in particular those reporting high levels of preoperative anxiety and depression, felt relieved during early convalescence (chapter 5).

To explain the variations in interindividual differences and to identify patients at risk of high levels of anxiety and depression, both pre- and postoperatively, one would need to understand the underlying psychological processes. This brings us to the remaining results, which represent the core of this thesis.

The importance of neuroticism is in line with earlier findings [6, 27, 28] and with the general assumption that neurotic individuals are prone to experience distress, at all times, in different situations [29-31]. A rather unexpected finding was that hostility, rigidity and self-esteem did not affect the underlying processes of anxiety, depression, feelings of disability, somatic complaints and fatigue, all the more since they have been found to play a role in the onset of psychological problems [13, 28, 32]. Given the idea that neuroticism is not only a basic dimension of mood, but rather a multidimensional construct encompassing different behavioral and personality components [33, 34], it is possible, although speculative, that neuroticism 'incorporated' the influences from self-esteem, hostility and rigidity. Further research is required to understand the relationships between personality factors.

In considering the impact of neuroticism, it seems obvious that anxiety, depression, feelings of disability, somatic complaints and fatigue were strongly interrelated. An explanation for the directions of the interrelationships is less obvious. It appeared that the interrelationships in the preoperative period differed from those in the postoperative period (chapters 6 and 7). Anxiety tended to come into prominence in the preoperative period, whereas depression and eventually somatic complaints came into prominence in the late postoperative period. Assuming that the preoperative period is a period of intense psychological anticipation and preparation [19, 23] and the postoperative period one of emotional reaction and adaptation [3, 8], it seems plausible that the directions of the interrelationships had changed in the postoperative period.

Contrary to our expectations based on Chapter 2, postoperative assessments of the psychological problems were only marginally affected by their preoperative assessments. One explanation might be related to effects of denial, which is very common prior to surgery [7, 35]. Another explanation might be that the validity of the measures is questionable. More studies are necessary to elucidate this topic.

Finally, background variables including gender, age and medical complications did not affect psychological processes in patients undergoing CABG. This finding is in line with results of other studies showing little or no relationship between, on the one hand, gender, age and medical factors and, on the other hand, psychological outcome [2, 6, 16, 28]. Although gender modified

variations in both mean level and interindividual differences in anxiety and depression over time (chapter 5), gender did not affect the underlying processes of anxiety and depression.

Methodological issues

Evaluating our work from a methodological viewpoint raises certain questions about the study design, the psychological and medical assessment, and the method of statistical analysis. Before addressing the methodological issues, we will briefly introduce the structural equation modelling (SEM) method, which was applied to explore the structural relationships (chapters 6 and 7).

SEM deals with identifying, specifying and testing models for structural relationships between substantively meaningful variables [36, 37]. Compared to multiple regression analysis, SEM has considerable advantages. One major advantage is its ability to estimate all the parameters in the model simultaneously. Furthermore, SEM can adjust for measurement error. Finally, relationships might be bidirectional and it is possible to distinguish between direct and indirect effects [38]. Using the model generating approach [36, 37], we were able to identify and specify relationships simultaneously, providing insight into psychological processes in patients undergoing CABG.

Study design

The design of the present work was semi-longitudinal. Assessments were planned during the period of waiting, about two weeks before surgery, one day before surgery, seven days after surgery and six months after surgery. Using SEM for analyzing longitudinal data raises two issues, which we want to discuss with respect to the present design.

First, longitudinal estimates of the influence of one variable on another tend to be time-specific, and no single time interval can give a complete understanding of the impact of a variable [38]. Ideally, but unrealistic in this kind of clinical research, variables should be continuously measured. Aiming at feasibility, we designed the present work so that it was consistent with the time period in which we expected effects to occur (chapter 3).

Second, although we used a semi-longitudinal design with both pre- and postoperative assessments, no causal inferences from the structural relationships can be made. To infer causality, it must be demonstrated that (a) the potential cause and effect can be isolated from other causes, effects, or confounding variables, (b) there is an association between the potential cause and effect, and (c) the direction of influence must flow from the cause to effect [39]. Therefore, the ability to infer causality is restricted most fundamentally to randomized design and not to statistical analyses [39, 40]. To interpret the findings from the present work, and in particular the relationships between variables assessed at the same points in time (i.e., pre- and postoperative interrelationships), we had to rely on substantive grounds (e.g., clinical and theoretical arguments) (chapters 6 and 7).

Psychological assessment

Validity The psychological variables in this thesis represented sum scores, based on self-reported levels. With respect to the structural validity (i.e., internal characteristics of a measure [39]), it is conceivable that the underlying nature of the psychological variables is multidimensional rather than unidimensional (e.g., neuroticism [33, 34]). In that case, the use of sum scores might be questionable.

Regarding the construct validity (i.e., the relationships of a measure with other measures [39]), it is assumed that self-report measures of negative mood states share a component of general negative affect [29, 31, 41-43]. This would imply that the measures of anxiety, depression, feelings of disability, somatic complaints and fatigue were overlapping. It should be noted, however, that the association between negative mood states is not confined to self-reported data. Considerable overlap is also found in clinical ratings, although the level of differentiation in these data appears to be somewhat greater than in self-ratings [43].

One major problem with self-report questionnaires is that they are prone to be influenced by social desirability and may therefore not always be helpful in discerning real distress. In other words, self-report questionnaires generally do not distinguish between 'true' and 'masked' levels [44].

Reliability One major advantage of SEM is its ability to adjust for measurement error [38]. This requires specification of a measurement model that depicts relationships between measured variables and latent variables (i.e., theoretical constructs) [36, 37]. In this thesis, the measurement errors of the measured variables were estimated a priori using Cronbach's alpha, a measure of reliability [45]. We did this to simplify the exploration of an already complex model. Evaluation of the latent variables underlying the respective measures, on the other hand, might have improved insight into the structure of relationships. For instance, overlap in item content between anxiety and depression could have been recognized by specification of a measurement model.

Medical assessment

Based on earlier findings in literature [12, 13, 28, 46-48], the medical characteristics of a patient were considered complicated if one or more of the following events occurred: impaired LVEF (<0.55 [49]), previous CABG, prolonged stay in intensive care (>1 day), prolonged hospital stay (>14 days), postoperative cardiac event(s) and rehospitalization. To reduce the number of medical variables to one, the medically complicating factor (MCF) score was calculated, representing the absence and presence of complicated medical characteristics. Although the classification has practical advantages, it might be at the expense of relevant information.

Statistical analyses

Multivariate testing was successful in examining variations of both level and interindividual differences over time. The model generating approach of SEM was helpful to explore structural relationships and improved our understanding of psychological processes in patients undergoing CABG. Regarding SEM, there are three issues which we discuss here: (1) the risk of omitted factors, (2) the problem of equivalent models, and (3) the problem of capitalizing on chance.

Omitted factors A major point of criticism in research, although mostly inevitable, is the problem that the constructed model or the process of data collection may have omitted some variables which are of theoretical relevance (i.e., omitted-variable problem [36]). There is no doubt that unravelling

psychological processes is a complicated task. Thus, the models presented in this thesis might be too simple. Consequently, we may have omitted several essential variables, such as social support, denial, optimism and the need for control (chapter 2). Inclusion of these variables might add new information to the models found and thereby result in an increase of explained variances.

Equivalent models Usually ignored, but relevant to the model generating approach, is the phenomenon that for any given model there will generally be alternative models which are mathematically indistinguishable from the original model. Such models, then, can only be distinguished in terms of interpretability of parameter estimates and meaningfulness of the model [50, 51]. If compelling arguments are lacking, it is necessary to conduct additional research to distinguish between alternative equivalent models (e.g., the inclusion of additional variables or experimental manipulation of variables) [50].

Given the constructed models in our studies on psychological processes (chapters 6 and 7), reversal from the path from preoperative depression to preoperative anxiety led to a mathematically equivalent model, with preoperative anxiety leading to preoperative depression. With a view to the impending surgery and supported by findings from literature [5, 7, 8, 35], we argued that anxiety is the most prominent feeling in the period prior to CABG. Therefore, it seems more likely that depressive patients become anxious, than the other way round. Further research is required to give a more definite answer.

Capitalizing on chance There is some scepticism about generalizability of models resulting from the model generating approach. Because this approach is at least data driven, it is inherently susceptible to capitalization on chance characteristics of the data, thus raising the question how well the constructed model fits an independent sample from the same population. Therefore, the use of prespecified conceptual models is recommended as a preferred strategy [52]. In practice, however, well-specified theories will not always be available. Moreover, rejecting 'a priori' models or choosing between a restricted number of prespecified alternative models could be unsatisfactory for most researchers. Careful use of the model generating approach (i.e., directed by both substantive

and statistical criteria), on the other hand, seems promising to answer complex research questions. Taking into account substantive arguments (e.g., clinical and theoretical considerations) may lessen the exploratory character of the analysis and the risk of capitalizing on chance [36, 37]. As is the case with other multivariate statistical methods, 'new' models that are the results of the model generating approach should be tested against independent data (i.e., crossvalidation).

Future research

For a more definite answer concerning the stability of the constructed models, the present work should be replicated. In addition, to correct for the bias of the measurement method, a multimethod approach is recommended including self-report measures, interviews, clinical ratings or observations. The advantage of this approach is that it increases the validity of the selected constructs. Moreover, clinical ratings [44] and observations [53] have been proven successful in distinguishing between 'true' and 'masked' levels of psychological distress. To improve the differentiation of psychological problems (e.g., anxiety and depression), one should focus on symptoms that are relatively unique to each [41-43].

With respect to psychological processes in patients undergoing CABG, it is strongly felt that more complicated models should not be ruled out. Therefore, it seems worthwhile to explore such alternatives. To do so it is necessary to identify relevant additional factors first, either theoretically or empirically (e.g., by means of interviews). Inclusion of additional variables may add new information to the present findings and may lead to identification of mediating variables, which can be used to distinguish between equivalent models [50, 51]. Given the equivalent models found in this thesis, identification of factors that account for the effect between preoperative depression and preoperative anxiety may be helpful to exclude either the constructed model, with depression leading to anxiety, or the equivalent version, with anxiety leading to depression.

In considering recovery from CABG (chapter 2), our findings deal with only one of its multidimensional aspects (e.g., physical, psychological and social functioning). The term 'quality of life' has been used increasingly when

outcomes of CABG are being evaluated. Although there is neither agreement on the definition nor a gold standard for measurement [54, 55], its multidimensionality comes close to the complexity of the recovery process. Figure 1 illustrates changes in quality of life, with respect to our study sample (for more details see: Appendix B). As can be seen, there is an improvement on all of the specific dimensions. Apparently, the subjective perception of the overall quality of life was enhanced for the majority of patients, six months after CABG. In the long run, an integration of psychological factors and factors related to physical, social and role function, pain and overall health seems fruitful to understand the overall recovery process in patients undergoing CABG.

By introducing the above suggestions, it should be noted that inclusion of relevant additional variables would probably generate practical problems with respect to both the process of model generating and interpretation of the relationships found. As we were already faced with difficulties in the present work, it seems more obvious to focus on specific relationships, in particular those between variables assessed at the same points in time (e.g., the relationship between anxiety and depression). Indeed, to improve the structural validity of psychological variables, more attention should be devoted to the complexity of single constructs. For instance, if theory holds a construct to be multidimensional, then a valid measure of the construct should be multidimensional as well.

A related issue then concerns the design of future studies. Care should be taken to determine which design is most appropriate in examining a specific research objective. We believe that to enhance our understanding of psychological processes in patients undergoing CABG, several types of research should be integrated.

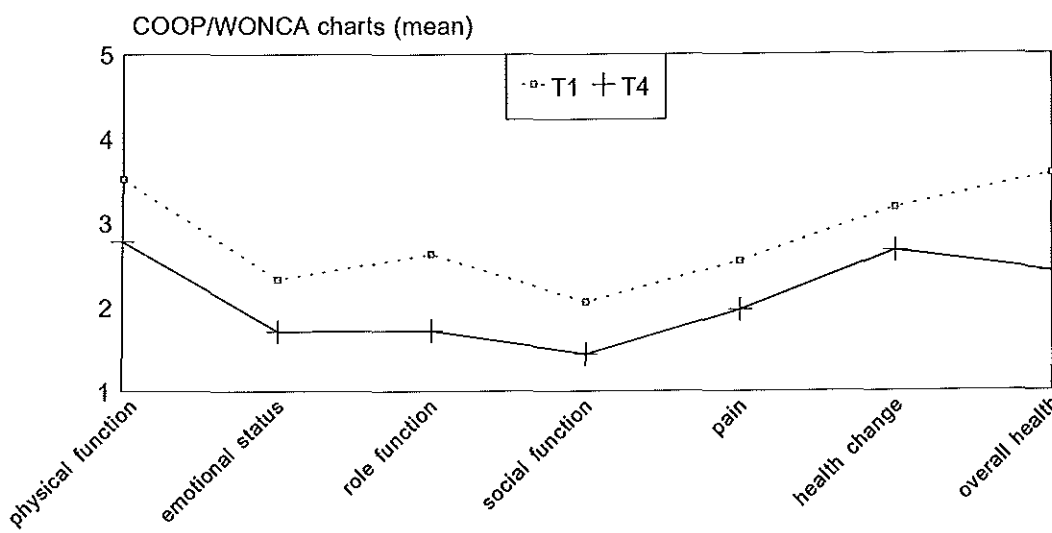
To study psychological processes, longitudinal designs with repeated measurements are warranted. Intervention studies could be useful to test causal relationships. For instance, a favourable change in preoperative anxiety in an experimental group (e.g., patients high in depression receiving specific treatment or medication) and not in a control group (e.g., patients high in depression receiving no treatment or medication) might indicate that depression affects anxiety in the preoperative period. To explore complicated relationships or

fluctuations over time, case studies (e.g., detailed explorations and time series analysis), although difficult to generalize, may offer a valuable basis for further research.

Although SEM is complicated, it seems to be the most suitable statistical technique to study psychological processes in patients undergoing CABG, assumed that the sample size is large enough [36].

In sum, apart from crossvalidation, we believe that future research should be planned in phases, starting with case studies, followed by simple and later more complex longitudinal studies and finally intervention studies to test causal relationships found in the preceding studies.

Figure 1. Quality of life before and after CABG



COOP/WONCA charts = measurement of quality of life [56]; 1 = good; 5 = bad; T1 = 14 days before CABG; T4 = 6 months after CABG

Implications for clinical practice

Assuming that the constructed models appear to be stable, several implications are apparent for clinical practice.

First, our findings can be used to indicate which patients are at risk of psychological problems, both before and after CABG. Second, the structure of relationships may provide suggestions for intervention strategies to help those patients at risk.

The constructed models explicitly showed that neuroticism had a high impact on both pre- and postoperative anxiety, depression, feelings of disability, somatic complaints and fatigue (chapters 6 and 7). Consequently, preoperative screening for levels of neuroticism could be helpful to identify patients who are at risk of increased levels of the above-mentioned problems, both before and after CABG. Screening for neuroticism could be integrated into standard preoperative medical testing at the cardiology outpatient clinic. Ideally, this should be done by means of clinical judgement of an expert (Appendix A). However, with a view to workload and costs, it seems more appropriate to use a self-report questionnaire (e.g., neuroticism subscale of the Dutch Personality Questionnaire [57]).

Second, in considering the negative prognostic implications of neuroticism, intervention strategies should focus on treatment of patients high in neuroticism. In general, those patients are more likely to experience significant levels of distress at all times and in any given situation. Moreover, those patients tend to be less satisfied with themselves and their lives than those low in neuroticism [29-31]. It seems obvious that neuroticism is not accessible to modification without intensive and long-lasting intervention. Notwithstanding this assumption, those patients high in neuroticism seem to benefit from rehabilitation programs including group therapy and individual counselling [27]. Furthermore, several studies have shown that interventions designed to reduce preoperative anxiety (e.g., information, relaxation training and group therapy) may result in better psychological outcome after CABG [58-60]. Given the success of existing intervention techniques, the next issue concerns the timing of interventions.

Starting early in the preoperative period seems to be most appropriate because this might affect both pre- and postoperative problems. Moreover, the time on a waiting list should not be regarded as lost time but as an opportunity for interventions. Indeed, waiting lists are often lengthy [24, 25] and a main source of distress [23]. While preparation should be routine for all patients awaiting CABG, more emphasis needs to be placed on treating or supporting those high in neuroticism.

In conclusion, based on the findings of the present work, we would call for institutionalization of preparation programs for patients undergoing CABG in order to identify and support patients at risk of psychological problems.

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SUMMARY

Coronary artery bypass graft surgery (CABG) is an established treatment procedure for patients suffering from intractable angina and life-threatening ischemic heart disease. With the rapid progress that has been made in the field of heart surgery, there has been an increasing interest in the impact of surgery on everyday life and in psychological outcome of CABG. It has become obvious that the physical results can be excellent, while there is little or no psychological improvement. Undergoing CABG implies a stressful experience for most patients and increased feelings of anxiety and depression have been reported both before and after surgery. In relation to anxiety and depression, feelings of disability, vague somatic complaints and fatigue have frequently been recognized. Patients may have a wide variety of concerns, with some patients reporting more problems than others. In particular those patients reporting high rates of problems should be identified in an early phase and offered additional support.

This thesis presents the results of a follow-up study on psychological problems, including anxiety, depression, feelings of disability, somatic complaints and fatigue, in patients undergoing CABG. The main aim was to gain insight into their underlying processes and into the extent to which these processes were affected by personality and background factors (i.e., gender, age and medical factors). If we learn to understand these processes several clinical implications may become apparent with respect to identification and treatment of those patients with or at risk of psychological problems.

The study was based on one sample of patients undergoing elective CABG, consisting of 270 patients at baseline and 217 at follow-up. Patients were assessed at four points in time: two weeks and one day prior to surgery, and seven days and six months after surgery.

Chapter 1 is a general introduction into the psychological implications of CABG. Four case reports are presented to illustrate the diversity of concerns before and after CABG. Furthermore, the importance of prospective research is discussed. Finally, the relevant psychological problems (i.e., anxiety, depression, feelings of disability, somatic complaints and fatigue) are introduced.

Chapter 2 presents a review of recent prospective studies on recovery from CABG. These studies were mainly based on outcome in terms of quality of life. We particularly focused on psychological outcome. Two types of studies were distinguished: 'broad-based' and 'focused' studies. Both types of studies used a prospective longitudinal design with pre- and postoperative assessments and were primarily interested in relationships between pre- and postoperative variables. Evaluation of their results showed that the preoperative psychological state and personality factors strongly influenced psychological outcome. Psychological problems in the preoperative period were associated with 'poor' psychological outcome, whereas social support, control and optimism were associated with 'good' psychological outcome. We argued that insight into the overall structure of relationships, both over time and at the same points in time, may contribute to the understanding of underlying processes of the various factors involved and thereby provide a useful framework for development of clinical interventions.

Based on the findings in Chapter 2, **Chapter 3** emphasizes the need for research on psychological processes in patients undergoing CABG and describes the aims of the separate studies.

In the first study, **Chapter 4**, the baseline assessment was examined in detail. The focus was on demographic, medical and psychological differences between men and women within the study sample and psychological differences between the study sample and control subjects. The results revealed significant gender differences. Women were more likely than men to be widowed or to live alone, to have less education, to do the housekeeping and to have a history of diabetes. Additionally, women reported more psychological problems than men, in particular anxiety and feelings of disability. Compared with control subjects of the general population, patients in the study sample showed high levels of anxiety, depression and fatigue. We concluded that the period of waiting was experienced as a frightening and depressing period by the majority of patients in the present study sample.

In the second study, **Chapter 5**, the course of anxiety and depression, starting at baseline until the late postoperative period, was investigated to identify variations in both mean level and interindividual differences over time. In addition, we examined whether these variations over time differed between men and women, and between three age groups (<55, 55-65, >65 years), after controlling for medical factors. Multivariate testing revealed an overall decrease in mean levels of anxiety and depression during early convalescence (i.e., seven days after surgery). Significant gender differences were found, with women reporting more anxiety and depression than men, both before and after surgery, but showing a relatively stronger decrease in the early postoperative period. Multivariate testing on standard deviations of anxiety showed that the entire group of patients was most homogenous at seven days after surgery. Regarding depression, variations in interindividual differences for women differed from those for men. Women were most homogenous in the early postoperative period, whereas interindividual differences for men remained consistent over time. Taken together, the findings suggested that most patients, and in particular those reporting high levels of preoperative anxiety and depression, felt relieved during early convalescence after CABG.

In the third study, **Chapter 6**, we focused on underlying processes of anxiety and depression, from baseline to the late postoperative period, and on the extent to which these processes were affected by personality and background factors. For this purpose we explored the structure of intrarelationships (i.e., relationships within the same variable over time) and interrelationships (i.e., relationships between different variables, both over time and at the same points in time) of anxiety and depression in relation to personality and background factors. By means of the structural equation modelling (SEM) method, we were able to explore relationships simultaneously. The constructed model provided a good fit and the structural relationships accounted for a substantial amount of variance, ranging from 0.29 (anxiety in the early postoperative period) to 0.77 (depression in the late postoperative period). Intrarelationships of anxiety and depression were relatively weak. With respect to interrelationships of anxiety and depression over time, we found that preoperative depression was positively related to anxiety in the late postoperative period. This relationship was,

however, relatively weak. Interrelationships of anxiety and depression at the same points in time, on the other hand, were relatively strong and positive, with preoperative depression leading to preoperative anxiety, and postoperative anxiety leading to postoperative depression. In other words, those patients who reported more preoperative depression, were more anxious in the preoperative period, and those patients who were more anxious in the postoperative period, reported more postoperative depression. The structure of relationships showed further that neuroticism had a high impact on both pre- and postoperative anxiety and depression, whereas the remaining personality factors (i.e., self-esteem, rigidity and hostility) and background factors did not show any prospective impact at all. Patients high in neuroticism reported more problems, both pre- and postoperatively, than those low in neuroticism. We concluded that neuroticism played a central role in the underlying processes of anxiety and depression.

In the fourth and final study, **Chapter 7**, we proceeded with the exploration of structural relationships by developing a structural model based on anxiety, depression, feelings of disability, somatic complaints and fatigue, at baseline and in the late postoperative period, in relation to personality and background factors. We were specifically interested in the extent to which feelings of disability, somatic complaints and fatigue were psychologically determined. The constructed model provided a good fit and accounted for a substantial amount of variance, ranging from 0.53 (anxiety in the late postoperative period) to 0.92 (somatic complaints in the late postoperative period). Relationships between variables over time, both intra- and interrelationships, were relatively weak. Interrelationships at the same points in time, on the other hand, were relatively strong. Their structure showed that those patients who reported more preoperative fatigue, reported more preoperative somatic complaints and feelings of disability. Furthermore, those patients who reported more preoperative feelings of disability, were more depressed in the preoperative period. Finally, those patients who were more depressed in the preoperative period, reported more anxiety prior to surgery. Postoperatively, this order was reversed, with anxiety leading to fatigue, both directly and mediated by depression and feelings of disability. Similar to the preoperative situation, postoperative fatigue was leading

to somatic complaints. With respect to the impact of personality and background factors, the structure of relationships revealed that neuroticism had a high impact on both pre- and postoperative anxiety, depression, feelings of disability, somatic complains and fatigue, whereas self-esteem, rigidity, hostility and background factors appeared to be of no relevance. Patients high in neuroticism reported more problems, both pre- and postoperatively, than those low in neuroticism. Again, we concluded that neuroticism played a central role, although this time in the underlying processes of anxiety, depression, feelings of disability, somatic complaints and fatigue. The extent to which feelings of disability, somatic complaints and fatigue were determined by anxiety and depression varied over time and seemed to be highest in the postoperative period.

Finally, **Chapter 8**, presents an overall discussion of the main findings and the methodology used. In considering the methodological limitations, the present work has improved the understanding of psychological processes in patients undergoing CABG. The findings are in line with results of other studies and further strengthen the general assumption that neurotic individuals are prone to experience distress, at all times in different situations. Additional research is needed to test the stability of the constructed models (i.e., crossvalidation). If the models appear to be stable, they may provide a useful framework for identification and treatment of patients at risk of psychological problems, both before and after CABG. For a better understanding of the psychological processes found, in particular of the relationships between variables assessed at the same points in time, further research is needed. In the long run, it might be worthwhile to include additional relevant variables to add new information to the present findings.

SAMENVATTING

Coronaire bypass-chirurgie (CABG) is een succesvol gebleken procedure voor het behandelen van patiënten met ernstige coronaire aandoeningen en angina pectoris. Met de vele ontwikkelingen binnen de hartchirurgie is een toegenomen belangstelling ontstaan voor de mate waarin CABG van invloed is op het dagelijkse leven en voor het psychologisch herstel na een dergelijke operatie. Het is namelijk duidelijk geworden dat een medisch geslaagde operatie niet per definitie hoeft te betekenen dat er sprake is van een psychologische vooruitgang. Het ondergaan van CABG is een ingrijpende ervaring voor de meeste patiënten. Gevoelens van angst en depressie zijn aangetoond, zowel voor als na de operatie. Andere veel voorkomende problemen, veelal gerelateerd aan angst en depressie, zijn gevoelens van invaliditeit, vage somatische klachten en vermoeidheid. De onderliggende gedachten of zorgen lopen sterk uiteen, waarbij sommige patiënten meer problemen rapporteren dan anderen. Met het oog op ondersteunende interventies is het van belang om met name die patiënten die veel problemen rapporteren, vroegtijdig te identificeren.

Dit proefschrift beschrijft de resultaten van een 'follow-up' ofwel vervolg studie naar psychologische problemen, namelijk angst, depressie, gevoelens van invaliditeit, somatische klachten en vermoeidheid, bij patiënten voor en na CABG. Het belangrijkste doel van deze studie was om inzicht te krijgen in de onderliggende processen van bovengenoemde problemen en de mate waarin deze processen werden beïnvloed door persoonlijkheidsfactoren, sekse, leeftijd en medische factoren. Inzicht in dergelijke processen zou de basis kunnen vormen voor het identificeren van patiënten met een verhoogd risico op psychologische problemen, zowel voor als na de operatie, en het ontwikkelen van specifieke, op die 'risico-patiënten' toegespitste, interventies.

Deze studie werd verricht bij aanvankelijk 270 en gedurende de follow-up 217 patiënten die een CABG ondergingen. Op vier tijdstippen rondom de operatie werden gegevens verzameld: twee weken en één dag voor de operatie en zeven dagen en zes maanden na de operatie.

Hoofdstuk 1 betreft een algemene inleiding met betrekking tot de psychologische implicaties van CABG. De diversiteit aan zorgen, zowel voor als na de operatie, wordt geïllustreerd aan de hand van reacties van vier willekeurige

patiënten. Verder wordt het belang van prospectief ofwel voorspellend onderzoek besproken en tenslotte worden de specifieke problemen (angst, depressie, gevoelens van invaliditeit, somatische klachten en vermoeidheid) geïntroduceerd.

Hoofdstuk 2 presenteert een overzicht van recente prospectieve studies met betrekking tot het herstel na CABG. Herstel was in de meeste studies gedefinieerd in termen van kwaliteit van leven. Wij richtten ons met name op psychologische uitkomstmaten. De geselecteerde studies waren te onderscheiden in 'breed georiënteerde' en 'toegespitste' studies. Beide typen studies maakten gebruik van een prospectief longitudinaal design met pre- en postoperatieve metingen en waren primair gericht op de relaties tussen pre- en postoperatieve variabelen. Uit de verschillende resultaten bleek dat psychologische uitkomstmaten sterk werden beïnvloed door hun preoperatieve metingen en persoonlijkheidsfactoren. Psychologische problemen in de preoperatieve periode hadden een ongunstige invloed op het psychologisch herstel, terwijl sociale ondersteuning, gevoelens van controle en optimisme een gunstige invloed hadden op het herstel. Om meer inzicht te krijgen in de onderliggende processen van de betrokken factoren en daarmee een bruikbaar uitgangspunt voor de ontwikkeling van klinische interventies, pleitten wij voor het belang van onderzoek naar de algehele structuur van relaties, zowel door de tijd als binnen één meetmoment.

Gebaseerd op de bevindingen uit Hoofdstuk 2, wordt in **Hoofdstuk 3** het belang van onderzoek naar psychologische processen bij patiënten voor en na CABG benadrukt. Verder worden de vraagstellingen van de verschillende studies beschreven.

In de eerste studie, **Hoofdstuk 4**, werden de gegevens van de eerste meting ofwel de 'baseline' meting uitgebreid onderzocht. De nadruk lag op demografische, medische en psychologische verschillen tussen mannen en vrouwen binnen de studiepopulatie en psychologische verschillen tussen de studiepopulatie en controlegroepen. De resultaten lieten significante sekseverschillen zien. Vrouwen bleken vaker dan mannen alleen te wonen of hun partner te hebben verloren, lager opgeleid te zijn, de huishouding te voeren en diabetes mellitus in hun

medische voorgeschiedenis te hebben. Verder rapporteerden vrouwen meer psychologische problemen dan mannen, met name angst en gevoelens van invaliditeit. Vergeleken met controlegroepen hadden de patiënten in de studiepopulatie hoge scores op angst, depressie en vermoeidheid. Wij concludeerden hieruit dat de wachttijd door de meerderheid van de patiënten als beangstigend en deprimerend werd ervaren.

In de tweede studie, **Hoofdstuk 5**, werd het beloop van angst en depressie, vanaf de eerste tot en met de laatste meting, onderzocht. Het doel was om veranderingen in zowel het gemiddelde niveau als de individuele verschillen te identificeren. Verder werd onderzocht of deze veranderingen door de tijd verschillend waren voor mannen en vrouwen en voor drie leeftijdsgroepen (<55, 55-65, >65 jaar). Hierbij werd gecontroleerd voor de invloed van medische factoren. Multivariate analyses toonden aan dat patiënten zeven dagen na de operatie minder angstig en depressief waren dan voor de operatie. Verschillen tussen mannen en vrouwen waren significant. Vrouwen rapporteerden meer angst en depressie, zowel voor als na de operatie, maar lieten een sterkere daling zien, zeven dagen na CABG. Met behulp van multivariate analyses gebaseerd op standaard deviaties van angstscores, werd gevonden dat de gehele groep van patiënten het meest homogeen was zeven dagen na CABG. Veranderingen in individuele verschillen met betrekking tot depressie lieten significante sekseverschillen zien. Vrouwen waren het meest homogeen zeven dagen na de operatie, terwijl verschillen tussen de mannen in de studiepopulatie nauwelijks veranderingen lieten zien vanaf de eerste tot en met de laatste meting. Samengenomen suggereerden de bevindingen dat de meeste patiënten, en met name diegenen die veel angst en depressie rapporteerden in de preoperatieve periode, zich opgelucht voelden zeven dagen na CABG.

In de derde studie, **Hoofdstuk 6**, lag de nadruk op de onderliggende processen van angst en depressie, vanaf de eerste meting tot en met de laatste meting, en de mate waarin deze processen werden beïnvloed door persoonlijkheidsfactoren, sekse, leeftijd en medische factoren. Om dit te bewerkstelligen, werd de structuur van 'intra'-relaties (relaties tussen dezelfde variabelen door de tijd) en 'inter'-relaties (relaties tussen verschillende variabelen, zowel door de tijd als

binnen één meetmoment) van angst en depressie onderzocht in relatie tot persoonlijkheidsfactoren, sekse, leeftijd en medische factoren. Met behulp van structurele modelleringstechnieken (SEM) waren we in staat om relaties tegelijkertijd te onderzoeken. Het geconstrueerde model toonde een goede 'fit' en de structuur van de relaties verklaarde een aanzienlijk deel van de variantie, variërend van 29% (angst zeven dagen na de operatie) tot 77% (depressie zes maanden na de operatie). Intra-relaties van angst en depressie waren relatief zwak ofwel eerdere metingen van angst en depressie hadden slechts een marginale invloed op metingen later in de tijd. Met betrekking tot inter-relaties van angst en depressie door de tijd, werd gevonden dat preoperatieve gevoelens van depressie een ongunstige invloed hadden op postoperatieve angst. Deze relatie was echter relatief zwak. Inter-relaties van angst en depressie binnen de respectievelijke meetmomenten waren daarentegen sterk. Preoperatieve gevoelens van depressie leidden tot meer angst in de preoperatieve periode, terwijl postoperatieve gevoelens van angst leidden tot meer depressie in de postoperatieve periode. De structuur van relaties liet verder zien dat neuroticisme een ongunstige invloed had op zowel pre- als postoperatieve gevoelens van angst en depressie. Er waren geen aanwijzingen voor invloeden van de overige persoonlijkheidsfactoren (zelfwaardering, rigiditeit en verongelijktheid of vijandigheid), sekse, leeftijd en medische factoren. Wij concludeerden dat neuroticisme een centrale rol speelde in de onderliggende processen van angst en depressie.

In de vierde en laatste studie, **Hoofdstuk 7**, werd het onderzoeken van de structuur van relaties voortgezet. Er werd een model ontwikkeld op basis van angst, depressie, gevoelens van invaliditeit, somatische klachten en vermoeidheid, twee weken voor de operatie (eerste meting) en zes maanden na de operatie (laatste meting), in relatie tot persoonlijkheidsfactoren, sekse, leeftijd en medische factoren. De interesse ging met name uit naar de mate waarin gevoelens van invaliditeit, somatische klachten en vermoeidheid psychologisch waren bepaald. Het geconstrueerde model toonde een goede fit en de structuur van de relaties verklaarde een aanzienlijk deel van de variantie, variërend van 53% (angst zes maanden na de operatie) tot 92% (somatische klachten zes maanden na de operatie). Relaties tussen variabelen door de tijd, zowel intra- als inter-relaties, waren relatief zwak. Inter-relaties van de verschillende variabelen

binnen de respectievelijke meetmomenten waren daarentegen sterk. Preoperatieve vermoeidheid leek te leiden naar meer somatische klachten en gevoelens van invaliditeit in de periode voor de operatie. Preoperatieve gevoelens van invaliditeit leidden vervolgens tot meer depressie in de preoperatieve periode. Preoperatieve gevoelens van depressie leidden tenslotte tot meer angst in de preoperatieve periode. Postoperatief bleek er sprake van een omgekeerde volgorde. Angst leidde tot meer vermoeidheid, zowel direct als via depressie en gevoelens van invaliditeit. Overeenkomstig met de preoperatieve situatie, bleek postoperatieve vermoeidheid te leiden tot meer somatische klachten. Met betrekking tot de invloed van persoonlijkheidsfactoren, sekse, leeftijd en medische factoren, bleek alleen neuroticisme van belang. Neuroticisme had een ongunstige invloed op zowel pre- als postoperatieve gevoelens van angst, depressie, invaliditeit, somatische klachten en vermoeidheid. Wederom concludeerden wij dat neuroticisme een centrale rol speelde, hoewel deze keer in de onderliggende processen van angst, depressie, gevoelens van invaliditeit, somatische klachten en vermoeidheid. De mate waarin gevoelens van invaliditeit, somatische klachten en vermoeidheid psychologisch waren bepaald varieerde door de tijd en bleek het hoogst te zijn in de postoperatieve periode.

Tenslotte, presenteert **Hoofdstuk 8** een algehele discussie met betrekking tot de belangrijkste bevindingen en de gebruikte methoden van onderzoek. Samenvattend kan gesteld worden dat de huidige studie heeft bijgedragen aan kennis met betrekking tot psychologische processen in patiënten voor en na CABG. De bevindingen komen overeen met andere studies en versterken de algemene veronderstelling dat neurotische individuen meer geneigd zijn tot het ervaren van gevoelens van stress, te allen tijde en in verschillende situaties. Aanvullend onderzoek is nodig om de stabiliteit van de geconstrueerde modellen te toetsen (crossvalidatie). Indien de modellen stabiel worden bevonden, kunnen ze de basis gaan vormen voor het identificeren en behandelen van patiënten met een verhoogd risico op psychologische problemen zowel voor als na CABG. Om meer inzicht te krijgen in de gevonden psychologische processen en met name in de relaties tussen variabelen binnen één meetmoment is verder onderzoek noodzakelijk. Op de lange termijn lijkt het waardevol om relevante factoren toe te voegen ten einde de huidige modellen uit te breiden.

APPENDIX A

DEPRESSION IN PATIENTS UNDERGOING CARDIAC SURGERY: A COMMENT

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Abstract

A recent article by Burker *et al.* reported a high prevalence of depression in patients (N = 114) both before (47%) and after (61%) cardiac surgery. Prevalence in the present study (N = 133), on the other hand, was low: between 7.5% and 16.5% preoperatively and 4.5% and 14.3% postoperatively, depending on the assessment instrument used. We recommend using a combination of self-report inventories and expert clinical judgment to determine the prevalence of depression in cardiac surgery patients.

Introduction

Depression after cardiac surgery is common, especially in the early weeks of convalescence [1, 2]. A recent article by Burker *et al.* [3] in the British Journal of Clinical Psychology estimated the prevalence of depression in male and female patients undergoing elective cardiac surgery and examined the factors associated with depression in this population. Psychological and physiological data were collected one day before surgery (T1) and one day prior to discharge from the hospital (T2). Eighty-one men and 33 women completed testing both before and after surgery. Using the Center for Epidemiological Studies-Depression Scale (CES-D) cut-off score of 16 [4], at T1, 47 per cent of the patients were classified as depressed. Scores on the CES-D increased significantly after surgery, with 61 per cent of the patients classified as depressed at T2. A gender difference was noted both before and after surgery; a greater proportion of females was depressed.

The high prevalence of depression both before and after cardiac surgery is a major finding, suggesting that almost half of patients prior to and even more after surgery feel depressed. Given the prognostic importance of depression for cardiac patients [5], it is important to establish accurate prevalence rates. We present depression prevalence data from a current study on recovery after coronary artery bypass grafting (CABG).

Methods

Our sample included 133 consecutive patients, 110 men and 23 women, undergoing elective CABG at the Thorax Centre of the Rotterdam University Hospital. The mean age of the patients was 60.3 years (sd 8.95). Eighty-five per cent were married and 56 per cent had completed at least 10 years of education. Three weeks before surgery (T1) and seven days after surgery (T3) patients completed, among other self-report inventories, the depression subscale of the Hospital Anxiety and Depression scale (HADS) [6] and the Zung Self-rating Depression Scale (ZSDS) [7]. Medical data were collected by studying medical records. A cut-off score of 10 for the HADS [6] and a cut-off point of 63 for the ZSDS [8] were employed to classify patients as depressed or non-depressed.

Results

At T1, 16.5 per cent of the patients (30.4 per cent of women, 13.6 per cent of men) were shown to be depressed by their HADS scores and 7.5 per cent (13.0 per cent of women, 6.4 per cent of men) by their ZSDS scores. At T3, 14.3 per cent of the patients (8.7 per cent of women, 15.5 per cent of men) were categorized as depressed by the HADS and 4.5 per cent (13.0 per cent of women, 2.7 per cent of men) by the ZSDS. There was a nonsignificant decrease in depression from T1 to T3 (HADS: $M_{t1}=5.50$ vs. $M_{t3}=5.28$, $t(132)=0.61$, $p=0.54$; ZSDS: $M_{t1}=37.56$ vs. $M_{t3}=37.11$, $t(132)=0.67$, $p=0.50$).

The gender differences were significant at T1, for both HADS ($M_{\sigma}=5.17$ vs. $M_{\varphi}=7.09$, $t(131)=-2.20$, $p<0.05$) and ZSDS ($M_{\sigma}=36.54$ vs. $M_{\varphi}=42.46$, $t(131)=-3.04$, $p<0.005$) and at T3, although only for ZSDS scores ($M_{\sigma}=36.41$ vs. $M_{\varphi}=40.48$, $t(131)=-2.52$, $p<0.05$). For HADS the T3 gender difference was not significant ($M_{\sigma}=5.20$ vs. $M_{\varphi}=5.65$, $t(131)=-.55$, $p=0.58$). Women reported higher rates of depressive feelings, in particular preoperatively, which is consistent with earlier work [9, 10].

Discussion

Contrary to the results of Burker and her colleagues, the prevalence of depression in our group was relatively low before surgery and hardly changed in the early postoperative period. The HADS and the ZSDS both show low percentages. Our sample had no upper age limit, thus we covered a sufficiently representative sample of patients undergoing CABG. We, therefore, assume that our findings regarding the prevalence of depression cannot be attributed to sample characteristics.

The scales used in both studies included mainly psychological items, since it is important to exclude somatic symptoms of depression. These symptoms may be related to common complaints following surgery such as fatigue, malaise, atypical somatic symptoms (e.g., atypical non-cardiac chest pain and breathlessness) or poor quality of sleep [1]. We assume that the major discrepancy noted between the two studies can hardly be attributed to item characteristics.

It seems more likely that the diverse cut-off points are responsible for the divergent results. A comparison of ranges of scores and cut-off points used for the various depression scales shows a difference between the HADS (range 0-21; cut-off point 10) and the ZSDS (range 25-100; cut-off point 63) on the one hand, and the CES-D (range 0-60; cut-off point 16) on the other hand, with the higher scores indicating more depressive symptoms. The relatively low cut-off score for the CES-D may explain the extreme results of Burker and her colleagues.

Given the differences in prevalence scores between the studies, and also between the HADS and the ZSDS in our study, we conclude that self-report inventories should not be intended as final clinical diagnostic tools and interpretations of individual scores should not be made yet. It is argued that reliance on self-report measures and disregard for clinical judgment have led to many mistaken conclusions [11, 12]. In case of Burker *et al.*'s results, clinical judgment is needed to consider the clinical relevance of the CES-D scores. Clinical judgment, based on a diagnostic interview, will provide answers concerning the number of patients actually showing depressive symptoms, the severity of symptoms and the clinical implications.

Within our patient population, classified as depressed, we checked for the use of medication and psychological or psychiatric consultation to deal with depres-

sive symptoms after surgery. Almost all of these patients received sleep medication, but none of them were seen by a psychologist or psychiatrist.

The use of arbitrary cut-offs on questionnaires like the CES-D, the ZSDS or the HADS are inappropriate for diagnosing depression and should only be used as rough screening methods in combination with clinical judgment by an expert. The continuous scores provided by these scales are, however, useful to study relationships between depressive symptoms and other variables. Future research needs to focus on clinical judgment, in particular for women, who show a trend towards higher risk of depression before and after CABG.

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APPENDIX B

QUALITY OF LIFE IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT SURGERY: COOP/WONCA CHARTS

As a part of a collaborative National study of the Dutch Working Group for the Study of Health Status Measurement, we asked our patients to complete the COOP/WONCA Charts [1] in addition to the questionnaires discussed in the main part of this thesis. In this appendix, preliminary results are presented with respect to pre- and postoperative scores.

The COOP/WONCA charts are designed to assess 'quality of life' or, more specifically, the 'functional status' and form a generic instrument covering a core set of functional aspects: physical function, emotional status, role - and social function, pain, change in health and overall health. Each functional aspect or dimension is represented by a chart, which contains one question, referring to the status of the patient during the past two or four weeks. The five possible responses are illustrated by a drawing, depicting the corresponding level of functioning. The responses range from 'good' to 'bad', on a scale from one to five.

Table 1. Quality of life before and after CABG (N=217)

	quality of life (T1)		quality of life (T4)					
dimension	M	sd	M	sd	*t*	df	*p**	δ^1
physical function	3.52	.85	2.78	.99	9.87	216	.00	.43
emotional status	2.34	1.15	1.72	1.00	7.89	216	.00	.27
role function	2.63	1.06	1.72	.95	11.87	216	.00	.45
social function	2.06	1.17	1.45	.83	7.62	216	.00	.29
pain	2.55	.89	1.98	.99	7.50	216	.00	.31
health change	3.17	.58	2.68	.76	7.51	216	.00	.54
overall health	3.59	.74	2.43	1.05	15.98	216	.00	.70

* significant at 0.05 level, two-tailed; [1] the magnitude of the difference: Cohen's δ [2].

The above results are based on the study sample of the present thesis (i.e., 217 patients undergoing elective CABG including 176 men and 41 women (mean age 60.8, range 28-78, sd 8.8 years)). The assessments took place about two weeks before surgery (T1) and six months after surgery (T4).

Table 1 shows significant improvement on each dimension, from two weeks before CABG to six months afterwards. The magnitude of the difference is moderate for overall health and health change and low for the remaining dimensions. Given the relatively small improvement in emotional status, social function and pain, these results underline the relevance of studies on these specific functions.

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CURRICULUM VITAE

Annelien Duits werd op 10 Oktober 1967 geboren te Weert. In 1986 behaalde zij het VWO-diploma aan de Philips van Horne Scholengemeenschap in dezelfde stad. Van 1986 tot 1987 studeerde zij Medische Biologie aan de Universiteit van Utrecht. Van 1987 tot 1993 studeerde zij Psychologie aan dezelfde universiteit. In 1993 legde zij het doctoraal-examen af met als afstudeerrichting cognitieve functiestoornissen. Aansluitend was zij vier jaar werkzaam als Assistent In Opleiding (AIO) bij de afdeling Medische Psychologie en Psychotherapie van de Erasmus Universiteit Rotterdam. In samenwerking met de afdelingen Thoraxchirurgie van het Academisch Ziekenhuis Rotterdam-Dijkzigt (AZR-D) en Cardiologie van het Zuiderziekenhuis Rotterdam verrichtte zij het onderzoek dat beschreven is in dit proefschrift. Vanaf 1997 is zij werkzaam als neuropsycholoog binnen de Stichting Afasie Rotterdam (SAR) gevestigd in het Revalidatiecentrum Rijndam te Rotterdam en vanaf 1998 ook bij de afdeling Neurologie van het AZR-D.