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Predictors of readmission and health related quality of life in patients with chronic heart failure: a comparison of different psychosocial aspects

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Abstract Psychological distress is common in patients with chronic heart failure. The impact of different psychological variables on prognosis has been shown but the comparative effects of these variables remain unclear. This study examines the impact of depression, anxiety, vital exhaustion, Type D personality, and social support on prognosis in chronic heart failure patients. One hundred eleven patients (mean age 57 ± 14 years) having participated in an exercise based ambulatory cardiac rehabilitation program were enrolled in a prospective cohort study. Psychological baseline data were assessed at program entry. Mortality, readmission, and health-related quality of life were assessed at follow up (mean 2.8 ± 1.1 years). After controlling for disease severity none of the psychological variables were associated with mortality, though severe anxiety predicted readmission [HR = 3.21 (95% CI, 1.04–9.93; $P = .042$)]. Health-related quality of life was independently explained by vital exhaustion, anxiety and either body mass index (physical dimension) or sex (emotional dimension). As psychological variables have a strong impact on health-related quality of life they should be routinely assessed in chronic heart failure patients' treatment.

Keywords Psychological stress · Depression · Anxiety · Heart failure · Mortality · Quality of life

Introduction

Chronic heart failure is characterized by high mortality and readmission rates (Lloyd-Jones et al. 2009; Muntwyler et al. 2002) and a marked decrease in health-related quality of life (Juenger et al. 2008). Despite advances in medical treatment, prognosis for patients with chronic heart failure is still poor. Important clinical parameters such as left ventricular ejection fraction (Mahadevan et al. 2008), peak oxygen consumption (Mancini et al. 2000), and age (Pocock et al. 2006) have been found to be predictive for the course of chronic heart failure.

During recent years growing evidence supports the importance of psychological variables on the prognosis and health-related quality of life in patients with chronic heart failure. Especially for depression numerous studies demonstrated an adverse effect on mortality (Pelle et al. 2008; Rutledge et al. 2006), readmission (Jiang et al. 2001; Song et al. 2009) and health-related quality of life (Carels 2004; Faller et al. 2010; Lane et al. 2001; Müller-Tasch et al. 2007), independent of other biomedical risk factors. Other psychological variables with potential relevance are vital exhaustion (Appels et al. 1987; Carini et al. 1997; Smith et al. 2009) and the so called Type D personality construct,

This work is dedicated to Andreas Volz who died in a tragic accident in the Swiss alps during the publication process. It is hard to accept that you have passed away that early, Andi. You will be present in our memories as an open minded person and as a friend. We would like to express our deepest thanks to you for sharing your time with us.

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a combination of the experience of negative emotions with the tendency to inhibit self expression (Denollet 2005; Schiffer et al. 2005, 2010).

For some other aspects, like social support and anxiety, the results in prognostic studies are less conclusive. Though single studies report a prognostic impact of social support on mortality (Coyne 2001; Friedmann et al. 2006; Luttik et al. 2005; Murberg and Bru 2001) and health-related quality of life (Bennett et al. 2001), in their review Pelle et al. (2008) did not find an associations with prognostic outcomes. For anxiety most of the studies report no association with mortality (Friedmann et al. 2006; Jiang et al. 2004; Pelle et al. 2008) but an impact on health-related quality of life was already demonstrated in some studies (Chung et al. 2009; Lane et al. 2001).

A limitation of most studies is that they focus only on one or two psychological variables. Keeping in mind that studies have demonstrated that the psychological constructs applied in cardiovascular disease research are often highly correlated and tend to overlap, the relevance of specific psychological variables remains unclear (Kudielka et al. 2004; Pelle et al. 2008; Suls and Bunde 2005). It is therefore possible, that studies overestimate the relevance of a single variable by not assessing the other psychological variables. To compare the specific impact of each psychological variable the independent impact of each psychological variable on prognosis has to be investigated first. In a second step one should include multiple psychological variables which are related to outcome to control for their differential prognostic impact.

The objective of our study was therefore to investigate the differential prognostic impact of depression, anxiety, vital exhaustion, social support and Type D personality on prognosis of patients with chronic heart failure. Relevant outcome variables were mortality, readmission and health-related quality of life. To our knowledge this is the first study which assessed five psychological variables in one sample of patients with chronic heart failure.

Methods

Patients and design

The sample included 111 patients with chronic systolic and diastolic heart failure who were consecutively enrolled in a standard 3 month outpatient cardiac rehabilitation program between August 2004 and April 2008 at the unit of Cardiovascular Prevention and Rehabilitation at the University Hospital of Bern, Switzerland. We restricted inclusion to patients before April 2008 to have for all included patients at least 1 year of follow-up by April 2009.

Since August 2004, all patients completed baseline questionnaires at the entry of the rehabilitation program, assessing depression, anxiety, vital exhaustion, Type D personality, and social support as part of an ongoing cohort study. Between April and July 2009 mortality, readmission, and health-related quality were assessed.

Systolic heart failure was diagnosed if the patients had symptoms of heart failure (exercise intolerance, fatigue, and exertional dyspnoea) and a left ventricular ejection fraction lower than 40%, patients with symptoms but an ejection fraction $\geq$40% were diagnosed diastolic heart failure. The study protocol was approved by the local ethics committee and the study conformed with the Helsinki Declaration.

Demographic and clinical variables at baseline

Demographic variables included sex, age, and education. Clinical variables comprised left ventricular ejection fraction, etiology of chronic heart failure, New York Heart Association functional class, peak oxygen consumption, minute ventilation/carbon dioxide production relationship (VE/VCO_2 slope), exercise capacity (watts), body mass index, history of smoking, cardiac medication (angiotensin-converting enzyme-inhibitors/angiotensin receptor blockers, diuretics, beta-blockers), and comorbidities (hypertension, diabetes, dyslypidemia).

Psychological variables at baseline

Depression and anxiety

Symptoms of depression and anxiety were assessed by the German version (Herrmann et al. 1995) of the 14-item self-report Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith 1987). Each item is rated on a four-point Likert scale (range from 0 = "mostly" to 3 = "not at all"). The seven-item subscales for anxiety and depression yield a score of 0–21 points each. The level of anxiety and depressive symptoms in our study were interpreted as normal (0–7 points), mild (8–10 points), moderate (11–14 points) or severe (15–21 points) (Herrmann et al. 1995). The Hospital Anxiety and Depression Scale has extensively been used in various cardiac populations (Herrmann 1997) and is a valid screening tool to detect anxiety and depressive disorders in cardiac patients.

Exhaustion

In order to assess feelings of psychological (not physical) exhaustion, the German version (Schnorpfeil et al. 2002) of the nine-item short form of the Maastricht Vital Exhaustion Questionnaire (MVEQ) (Appels et al. 1987) was applied.

Undue fatigue, trouble falling asleep, waking up at night, general malaise, apathy, irritability, loss of energy, demoralization, and waking up exhausted are symptoms covered by this questionnaire.

Each item is rated with 0 ("no"), 1 ("don't know") or 2 ("yes") points, giving rise to a total exhaustion score between 0 and 18. Higher scores indicate a higher vital exhaustion. In our study, values ranging from 0 to 2 were interpreted as normal, 3–10 as serious, and >10 as clinically relevant (Appels et al. 1987). Over the last 20 years, the construct of vital exhaustion has been demonstrated to be a reliable precursor of different manifestations of chronic heart disease (Appels 2004). The German version of the Maastricht Vital Exhaustion Questionnaire has been validated and evidenced strong reliability (Cronbach's alpha = .78) (Rector et al. 1987) in assessing feelings of vital exhaustion (Kudielka et al. 2004, 2006).

Negative affect and social inhibition

To assess negative affect and social inhibition, the German version of the standard assessment of negative affectivity, social inhibition, and Type D personality, the DS 14, a standardized self report instrument, was applied (Grande et al. 2004). In 14 items, subjects rated their personality on a five-point Likert scale ranging from 0 = "totally disagree" to 4 = "totally agree". The seven-item subscales for negative affect and social inhibition yielded a score of 0–28 points each. Patients who scored above 10 on both scales were classified as having Type D personality (Denollet 2005). The DS 14 is a reliable and valid measure for assessing negative affect and social inhibition in cardiac patients (Cronbach's alpha = 0.86 − 0.87) (Grande et al. 2004; Kudielka et al. 2004) with moderate stability over a 18 month period after controlling changes in mood (Martens et al. 2007).

Social support

To assess social support, patients completed the German version (Knoll and Kienle 2007) of the Enrichd Social Support Instrument (ESSI) (Mitchell et al. 2003) which is a seven-item self report test that assesses the four defining attributes of social support: emotional, instrumental, informational, and appraisal. Each item is rated on a five-point Likert scale (range from 0 = "never" to 5 = "always"). Higher scores indicate a higher perceived level of social support. In this study the cut-off point for low social support was set at <18 according to the authors' recommendations (Mitchell et al. 2003). The Enrichd Social Support Instrument has been extensively used in various cardiac populations and has demonstrated strong reliability (Cronbach's alpha = .88) (Vaglio et al. 2004).

Follow up outcomes

The endpoints of this study were total mortality, cardiac-related readmission, and health related quality of life. Between April and June 2009 an invitation letter was sent to the patients, informing them about the study and its purpose. Afterwards patients were contacted by phone call to collect data on mortality and readmissions. Living and consenting patients received a questionnaire assessing health-related quality of life. If the patients did not return the questionnaire within 2 weeks follow-up reminder calls were placed.

For mortality, variables of interest were cause and the exact date of death. These data were gathered from the relatives of deceased patients. For readmission, variables of interest were cause, date, length of stay and if the readmission was planned or unplanned. For the analysis we only used the first cardiac-related unplanned readmission after entry into the study. A planned readmission was for example hospitalization for a staged percutaneous coronary intervention or the implantation of an internal cardioverter defibrillator in a prophylactic intention. Unplanned readmissions were all emergency readmissions due to a deterioration of the health status. A cardiologist (second author), blind to the extent of the patients' psychological distress, rated the readmissions as cardiac-related, all-cause, planned or unplanned. All information on death and readmission were validated with clinical records from the corresponding hospitals or the patient's general practitioner.

Health-related quality of life was assessed with the German version (Quittan et al. 2001) of the Minnesota Living with Heart Failure Questionnaire (MLWHFQ) (Rector et al. 1987). The questionnaire assesses the degree to which heart condition has affected the patient's life during the past month. It consists of 21 items that are rated on a Likert scale between 0 (no impairment) and 5 (very much impaired), resulting in a total score between 0 and 105. A high score indicates a high impairment of quality of life due to the heart condition. It also allows subscores to be computed for the physical and emotional dimensions of health-related quality of life. The Minnesota Living with Heart Failure Questionnaire has good reliability (Cronbach's alpha = .95) (Lloyd-Jones et al. 2009) and is frequently used to assess health status in chronic heart failure patients (Gottlieb et al. 2004).

Follow-up data for death and readmission was 100% complete. Of the sample of 111 patients, 100 were alive at the point of follow-up. Patients who had cardiac transplantation ($n = 2$) were considered as survivors until the date of their transplantation, regardless of their postoperative outcome. Of the living patients, 90% completed the questionnaire, leaving 10 living patients without health-related quality of life assessment. Patients with missing questionnaires were

younger, more likely to be obese, and had a lower mean minute ventilation/carbon dioxide production relationship, indicating less severe chronic heart failure. With regards to the psychological variables, patients lost to follow up were more likely to have low social support.

Statistical analysis

The data were analyzed using the SPSS (version 16.0) statistical software package (Chicago, IL, USA) and STATA (version 9.0). Differences in clinical, demographic, and psychological variables between the groups (survivor vs. non-survivor) were analyzed by independent sample *t*-tests or chi^2-tests for dichotomized data, respectively. If the distribution was not normal, non-parametric tests for independent samples were applied.

For the time to event analysis investigating the prognostic impact of psychological variables on the outcomes of mortality and cardiac-related readmission, Cox proportional hazard regression was applied. For each individual, time started at date of entry into the cardiac rehabilitation program and ended at the event of interest (death or unplanned cardiac readmission) or at the last date known to be alive, whichever was first. Initially each psychological variable was uniquely entered into a Cox proportional hazard model. To obtain reliable estimates, we selected a maximum of two additional predictors as control variables for disease severity, namely left ventricular ejection fraction (<35%) and peak oxygen consumption (<14 ml/kg/min.), dichotomized according to established cut-offs (Mahadevan et al. 2008; Stelken et al. 1996). The psychological and the control variables for disease severity were entered into the model as dichotomized and continuous variables. The cut offs for the dichotomized variables were as following: for depression, no depressive symptoms vs. depressive symptoms (>7) and no to mild depressive symptoms vs. moderate to severe depressive symptoms (>10); for anxiety, no symptoms of anxiety vs. symptoms of anxiety (>7) and no to mild vs. moderate to severe symptoms of anxiety (>10); vital exhaustion (>2); Type D personality (DS-14 social inhibition and negative affect >10); and low social support (<18).

Secondly we applied a Cox proportional hazard model including ejection fraction and peak oxygen consumption and all psychological variables to test for the differential prognostic impact of single psychological variables.

Multivariate linear regression was used to analyze the impacts of depression, anxiety, vital exhaustion, Type D personality, and low social support on health-related quality of life. The Pearson-product moment correlation was used as a measure of association between variables. All clinical and psychological baseline variables which correlated significantly with health-related quality of life were included in a stepwise multiple linear regression model. Although the correlating variables did not have a normal distribution, this violation could be disregarded due to the sample size and the low numbers of predictors (Bortz 2000). Multicolinearity was tested. Patients with missing health-related quality of life questionnaires at follow-up were excluded from the multiple linear regression, as otherwise associations could be over- or underestimated (Hair et al. 2006).

Results

Patients' characteristics

Demographic data and clinical parameters for the whole sample and for survivors vs. non-survivors are summarized in Table 1. Mean age was 57 ± 14 years with a range from 18 to 79 years. The predominant cause of chronic heart failure was ischemic cardiopathy (47.7%). Other causes were idiopathic dilated cardiomyopathy (23.4%), hypertensive cardiomyopathy (7%) and other diseases (21.6%). The majority of the patients had New York Heart Association functional class II. Fifty-eight percent of the patients had a left ventricular ejection fraction <35 and 25% had an oxygen consumption of less than 14 ml/kg/min. Non-survivors and survivors differed significantly on the variables of left ventricular ejection fraction at baseline and cardiac-related readmission. Non-survivors had a lower left ventricular ejection fraction at baseline and were more likely to be readmitted to hospital due to cardiac causes before death.

Psychological variables at baseline

Of the patients 16.2% percent reported mild and 9.9% moderate depressive symptoms resulting in 26.1% of the patients with elevated depression scores. Nineteen percent of the patients reported mild, 5.4% moderate, and 3.6% severe symptoms of anxiety, resulting in a total of 28.8% of patients with elevated anxiety scores. Fifty point six percent reported severe symptoms of vital exhaustion and 27.9% clinically relevant symptoms resulting in a total of 78.4% of the patients with elevated vital exhaustion scores. Of the patients 5.4% reported low social support. At baseline, survivors and non-survivors did not differ on any of the psychological variables neither as continuous nor as dichotomized variables.

Mortality and readmission

In the mean follow-up period of 2.8 (SD = 1.1) years, with a range from 1 to 5 years, 11 patients died. Seven patients died due to cardiac causes and one due to kidney failure. As no further information about the deaths of the three

Table 1 Sociodemographic, clinical and functional characteristics of the patient sample at baseline

Variables	Total ($n = 111$)	Survivors ($n = 100$)	Non-survivors ($n = 11$)	*P*
Age (years)	57 ± 14	58 ± 14	57 ± 15	.92
Gender (male %)	82	87	100	.10
Education (%)				
Basic education	19.8	20	18.2	
Vocational training	57.7	56	72.7	
High school degree	19.8	21	9.1	
University	2.7	3	0	
Cardiac-related readmissions (%)	21.6	19	45.5	.04
Aetiology of chronic heart failure (%)				
Ischaemic cardiopathy	47.7	46	63.6	
Idiopathic dilated cardiomyopathy	23.4	23	27.3	
Hypertensive cardiopathy	7.3	8	8	
Other	21.6	23	9.1	
New York Heart Association (NYHA) functional class (%)				
Class I	23.4	25	9.1	
Class II	59.5	60	54.5	
Class III	16.2	14.1	36.4	
Class IV	0.9	0.9	0	
NYHA Class > I (%)	67.6	75.0	90.9	.12
Peak oxygen uptake (ml/kg/min)[b]	18 ± 15.4	18.1 ± 15.4	17.9 ± 5.6	.79
Peak oxygen uptake, % of predicted (%)	68.1 ± 17.9	68.2 ± 18.3	66 ± 15.3	.77
VE/VCO_2[a] slope	33.1 ± 7.4	32.6 ± 6.1	37.6 ± 13.7	.26
Left ventricular ejection fraction (LVEF) (%)[b]	32.6 ± 13.6	33.6 ± 13.8	23.2 ± 6.4	.01
Exercise capacity (watt)	96.9 ± 35.5	96.9 ± 34.6	96.3 ± 45.3	.95
Exercise capacity (%)	65.8 ± 24.1	66.7 ± 24.1	57.5 ± 22.8	.23
Medication (%)				
ACE-inhibitor/ARB	75	75	81	.65
Diuretics	73	72	81	.52
Beta-blocker	90	89	100	.24
Comorbidities/risk factors (%)				
Body mass index	26 ± 5	26 ± 5	27 ± 5	.52
Diabetes	18	19	9	.41
Hypertension	55	57	54	.90
Dyslipidemia	47	46	54	.61
Current smoking status	23	23	27	.77
History of cardiovascular disease in the family	30	29	36	.63

Means ± SD, or percentage of total patient sample

ACE angiotensin-converting enzyme, *ARB* angiotensin receptor blocker

[a] VE/VCO_2 slope, minute ventilation-carbon dioxide production relationship

[b] Same results for dichotomized and continuous variables

remaining patients could be acquired, all-cause mortality was chosen as first endpoint.

Table 2 shows the hazard ratios for the psychological and clinical predictor variables. None of the deceased patients had an Enrichd Social Support Instrument score lower than 18. Therefore, no Cox proportional hazard regression was conducted for low social support and all-cause mortality. The associations of depression, anxiety, vital exhaustion, and Type D personality with all-cause mortality revealed no significant results, neither for dichotomized nor for continuous variables. As the single associations already did not reveal any significant results, we did not conduct further analysis including multiple psychological variables as control variables.

Table 2 Multivariate adjusted hazard models of mortality and readmission with dichotomized psychological variables

Variable	Mortality			Readmisson		
	HR[c,d]	95% CI	*P*	HR[c,d]	95% CI	*P*
Depression (≤7 vs. >7)	0.89	[0.23–3.40]	.87	1.37	[0.55–3.37]	.49
Moderate depression[a] (≤10 vs. >10)	0.65	[0.08–5.17]	.70	1.64	[0.48–5.56]	.43
Anxiety (≤7 vs. >7)	0.92	[0.24–3.57]	.91	1.06	[0.41–2.75]	.90
Moderate to severe anxiety (≤10 vs. >10)	1.75	[0.37–8.21]	.47	3.21	[1.04–9.93]	.04
Vital exhaustion (≤2 vs. >2)	2.74	[0.34–21.67]	.34	1.02	[0.37–2.81]	.95
Type D (social inhibition >10; negative affect >10)	0.91	[0.25–3.32]	.90	1.28	[0.53–3.06]	.58
Social support[b] (<18 vs. ≥18)				2.56	[0.57–11.52]	.22

HR hazard ratio, *CI* confidence interval

[a] No patients reported severe symptoms of depression

[b] No hazard ratios for mortality for low social support were conducted

[c] Adjusted for left ventricular ejection fraction and peak oxygen uptake

[d] The results of the dichotomized values were confirmed in analyses using continuous variables

Twenty-four of the patients had an unplanned cardiac-related readmission. Reasons for readmission were: (1) symptomatic arrhythmias (25%), including syncope and palpitations; (2) worsening of the course of the disease (54.2%), including left heart decompensation or symptoms of angina; (3) deterioration of the clinical status (12.5%), including exercise intolerance and increase of exertional dyspnoea; and (4) the need for cardiac interventions (8.3%), including implantable cardioverter defibrillator (ICD) implantation, cardiac surgery, or percutaneous coronary intervention.

With severe symptoms of anxiety vs. no or mild symptoms of anxiety, the hazard ratio for cardiac-related readmission was 3.21 (95% CI, 1.04–9.93; $P = .04$). Controlled for the other psychological variables (depression, vital exhaustion, social support, Type D), the hazard ratio for severe anxiety for cardiac-related readmission was 2.94 (95% CI, 0.81–10.59; $P = 0.1$). The associations between depression, vital exhaustion, Type D personality, low social support, and cardiac-related readmission revealed no significant results.

The graphical display of the cumulative incidence functions for patients with and without moderate to severe anxiety and cardiac-related readmission are shown in Fig. 1.

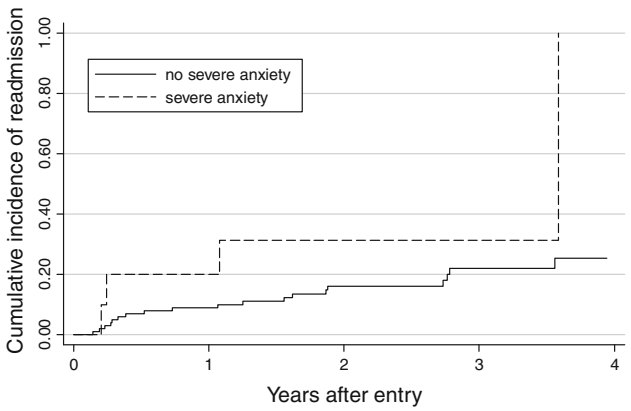

Fig. 1 Cumulative hazard ratios for readmission comparing patients with severe anxiety (HADS-A >10) and with no to mild anxiety (HADS-A ≤10)

Health-related quality of life

Table 3 indicates that all psychological variables at baseline correlated significantly with the physical and

Table 3 Correlation between baseline variables and health related quality of life (physical and emotional dimension) at follow up among survivors

Variables	Physical dimension[b] Correlation (*r*)	Emotional dimension[b] Correlation (*r*)
Depression	0.39**	.50**
Anxiety	0.49**	.52**
Vital exhaustion	0.53**	.53**
Type-D personality	0.21*	.29**
Social support	−0.32**	−.32**
Sex	0.19	.30**
Body mass index	0.27*	.04
Exercise capacity (%-age of predicted value)	−0.23*	−.03
Peak oxygen consumption	−0.32**	−.17
Smoking	0.21	.07
NYHA[a] functional class	0.32**	.11

* $P < .05$; ** $P < .01$

[a] New York Heart Association

[b] Increased scores indicate worse health-related quality of life

Table 4 Baseline predictors of health related quality of life at follow up

Variable	*B*	95% CI
Health related quality of life: physical dimension[b]		
Constant	−21.03*	[−33.45, −8.61]
Body mass index	0.30**	[0.34, 1.12]
Anxiety	0.29*	[0.19, 1.23]
Vital exhaustion	0.27*	[0.99, 0.96]
NYHA[a] functional class	0.20*	[0.18, 5.70]
Health related quality of life: emotional dimension[b]		
Constant	−3.89*	[−7.26, 0.50]
Anxiety	0.37*	[0.23, 0.91]
Sex	0.26*	[1.25, 6.20]
Vital exhaustion	0.24*	[0.19, 0.53]

$N = 90$, *CI* confidence interval

* $P < .05$; ** $P < .01$

[a] New York Heart Association

[b] Increased scores indicate worse health-related quality of life

emotional dimension of health-related quality of life at follow-up. Also correlated were sex, body mass index, percentage of predicted exercise capacity, peak oxygen consumption, smoking, and New York Heart Association functional class at baseline.

For the physical dimension of health related quality of life, the body mass index at baseline provided the best prediction at follow-up. Vital exhaustion and anxiety entered the model as nearly equivalent predictors. The New York Heart Association functional class also entered the model. The model accounted for 41.2% of the variance of the physical dimension.

For the emotional dimension of health related quality of life anxiety at baseline provided the best prediction. Vital exhaustion and sex also entered the model. The model accounted for 37.6% of the variance on the emotional dimension (Table 4).

Discussion

In this prospective cohort study we investigated the prognostic impact of different psychological variables on mortality, cardiac-related readmission, and health-related quality of life after a follow-up of about 3 years. Unexpectedly, a link between psychosocial aspects at baseline and mid term mortality and morbidity was not found. For depression this result is in contrast to previous studies reporting associations between depression and mortality in chronic heart failure patients (Jiang et al. 2001; Pelle et al. 2008; Rutledge et al. 2006). Yet, the strength of the association varies with the degree of depressive symptoms. Associations were especially demonstrated for patients with severe depressive symptoms though no associations were found for patients with mild or moderate symptoms. Since in our study no patients reported severe depressive symptoms, compared to prevalence rates of 10–20% in other studies (Jiang et al. 2001, 2004; Song et al. 2009), the missing association might be the result of the overall mild depressive symptomatology of our patients. The results of the other psychological variables, namely anxiety, vital exhaustion, and Type D personality were similar.

Beyond the low clinical impairment a possible explanation for the missing relationship between the psychological variables and mortality could be the high level of social support in our study. Over 95% of the patients in our sample reported that they were socially well-integrated. Good social support is known to improve the prognosis of other cardiac diseases (Barth et al. 2010) for example by improving the compliance of patients to medical treatment (Strömberg et al. 1999). This is supported by the results of a post-hoc analysis in our study showing, that social support weakens the impact of severe anxiety on cardiac-related readmission. Severe anxiety controlled for the other psychological variables depression, vital exhaustion and Type D personality still predicted cardiac-related readmission in trend [hazard ratio: 3.18 (95% CI, 0.93–10.88; $P = 0.06$)] if social support was excluded from the analysis. In contrast the effect of severe anxiety became clearly non-significant if social support was included in the analysis. Future studies are warranted to investigate a possible protective effect of social support in chronic heart failure-patients.

To our knowledge, this is the first study that has investigated and found an impact of anxiety on cardiac-related readmission. Patients with severe anxiety had a threefold risk of cardiac-related readmission, compared to the rest of the sample. These results seem reasonable as highly anxious patients with different chronic illnesses are known to report more symptoms than less anxious patients, independent of the disease severity (Katon et al. 2007). However, post-hoc analysis in our sample revealed that those patients with severe anxiety who were readmitted had severe symptomatic arrhythmias that were life-threatening and readmission was therefore mandatory and not driven by exaggerated anxiety. As the analyses were controlled for disease severity, it is unlikely that a worse functional status at the point of entry of severely anxious patients led to the higher readmission rates.

Although mortality and readmission remain key outcomes in treating cardiovascular diseases, health-related quality of life came into focus as an important outcome in cardiovascular research as well. In line with previous research (Lane et al. 2001; Smith et al. 2009), the results of the present study show that anxiety and vital exhaustion

were strong predictors of both, physical and emotional dimensions of long term health-related quality of life, independent of disease severity and known risk factors for chronic heart failure patients. The physical dimension of the Minnesota Living with Heart Failure Questionnaire assesses impairment in physical activities, for example climbing stairs, working in the garden, or doing sports which is highly related to activity itself. Whereas vital exhaustion results in a lack of the physical and psychological energy needed for physical activity (Appels et al. 1987), anxiety may also prohibit patients from engaging in physical activities because they fear a cardiac event. Other psychological factors had no independent additional effect in our multivariate model.

Our study has several limitations. The sample is comparably small and an existing effect of psychological variables on mortality might therefore have been undiscovered due to lack of statistical power. Post hoc power analyses revealed that our study size had sufficient power, to detect effects at a hazard ratio of 4.7 or higher, which has been reported earlier (Juenger et al. 2005). The reason for the limited power in our study, when analyzing mortality was the low cumulative mortality over 3 years of 11%. If cumulative mortality over 3 years would have been around 25%, as reported in other studies (Mosterd et al. 2001), the study would have had sufficient power to detect effects at a hazard ratio between 2.7 and 3.3 which has been reported in various studies (Faller et al. 2007; Juenger et al. 2005; Rutledge et al. 2006). Larger studies are warranted in order to investigate the differential prognostic effect of psychological variables on mortality.

The second limitation is that our sample consisted of patients referred to a cardiac rehabilitation program. Possible selection biases may have excluded patients with more severe psychological distress and heavier chronic heart failure. Therefore, it is only possible to generalize the results to a limited extent. A third limitation of our study is a potential overlap of the Minnesota Living with Heart Failure Questionnaire (quality of life) and the psychological measures at baseline. However, the results of our study demonstrate evidence for a strong predictive power of psychological variables for emotional *and* also physical quality of life.

In conclusion we found no clear support for a prognostic impact of psychological variables on mortality and readmission in CHF patients. Yet, psychological variables have a negative impact on long term health-related quality of life of chronic heart failure patients. Especially anxiety and vital exhaustion were related to the physical and emotional dimensions of health-related quality of life. As improving health-related quality of life for itself is a valuable goal, patients with chronic heart failure should be routinely screened for anxiety and vital exhaustion and if necessary treated adequately.

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