Predictive Relationship Between Depression and Physical Functioning After Coronary Surgery

Friederike Kendel, PhD; Götz Gelbrich, PhD; Markus Wirtz, PhD; Elke Lehmkuhl, MD; Nina Knoll, PhD; Roland Hetzer, MD; Vera Regitz-Zagrosek, MD

Background: Depression is a prevalent condition in patients undergoing coronary artery bypass graft surgery (CABG) and is often associated with a less favorable health status. The aim of this study was to investigate the relationship between depression and physical functioning in patients undergoing CABG.

Methods: The analyses were based on a sample of 883 consecutive subjects (aged 35-93 years; 19.8% women) undergoing CABG. Depression was assessed using the Patient Health Questionnaire (PHQ); the subscale “physical functioning” was taken from the 36-Item Short-Form Health Survey. Questionnaires were administered 1 to 3 days before surgery (T1) and 2 months (T2) and 1 year (T3) after surgery.

Results: A cross-lagged path analytic model showed that an increase in depressive symptoms predicted a decrease in physical functioning (β₁,₁₂ = −0.15 [P < .001]; β₁,₁,₁₃ = −0.17 [P < .001]), but not the other way around. Multigroup comparisons revealed one moderator effect: in patients with systolic heart failure (left ventricular ejection fraction [LVEF] ≤ 45%), the effect of depression on physical functioning from T2 to T3 was significantly stronger than in patients with preserved LVEF (β₄,₄,₄₃ = −0.30 [P < .001] vs β₂,₂,₂₃ = −0.14 [P < .001]; χ²diff = 3.885 [P = .049]).

Conclusions: More attention should be paid to diagnosis and treatment of depression in patients undergoing CABG. After surgery, patients with systolic heart failure and depressive symptoms in particular seem at risk of a deterioration of their physical functioning.

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Original Investigation

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PROCEDURE AND MEASUREMENT

After the institutional review board approved the study protocol, potential candidates were identified through daily screening of the admission records. The initial sample consisted of 1570 consecutive patients undergoing CABG at the Department of Cardiothoracic and Vascular Surgery, Deutsches Herzzentrum (German Heart Institute) Berlin, Berlin, Germany, between January 1, 2005, and July 31, 2008. Exclusion criteria were (1) inability to read or answer the study questionnaires (eg, dementia, difficulties with the language) and (2) age younger than 18 years. All patients participating provided written consent. Questionnaires were administered 1 to 3 days before surgery (T1), 2 months after surgery (T2), and 1 year after surgery (T3). Clinical and sociodemographic data were abstracted from the admission records. The initial sample consisted of 1610 of 1917 consecutive patients consented to the study; 1570 fulfilled the inclusion criteria and returned the questionnaire at the first measurement point (Figure 1, path a). Of these patients, 112 (7.1%) died during the 1-year follow-up. For all patients who were not identified as deceased, we were able to confirm vital status by directly contacting the patient or his or her general practitioner. A total of 883 patients (56.2%) responded at all 3 time points (Figure 2, path c) as well as the cross-sectional covariances between depression and PF (Figure 1, path b) were taken into account. The predicitve priority of either PF or depression could be assumed only if the respective predictor (depression or PF) made an independent contribution to the crossed criterion (PF or depression, respectively) after controlling for the effects at earlier time points and cross-sectional associations.

Because cross-lagged path models are based on continuous variables, the scales for depression and PF were used in their continuous form. Depression and PF were understood as latent constructs, which were estimated by 2 randomly selected split-half “subtests” at all 3 measurement points. To detect moderator effects, constraints that required the cross-lagged paths to be equal were imposed on the model and tested through hierarchical model comparisons. The following subgroups were tested for differences in the cross-lagged paths: (1) patients with systolic HF, as defined by a left ventricular ejection fraction (LVEF) below 45%, vs preserved LVEF; (2) age below vs above the median of 67 years; (3) men vs women; and (4) patients living alone vs living with a partner.

The statistical analyses were performed using AMOS 7.0 for structural equation modeling. Statistical software SPSS 16.0 was used to conduct t tests for independent samples; if the variables were categorical, x2 tests were used. Changes in depression and PF over time were tested by ANOVAs. For all analyses, P < .05 was considered statistically significant.

MISSING DATA ANALYSIS

Of 1917 consecutive patients, 1610 consented to the study; 1570 patients fulfilled the inclusion criteria and returned the questionnaire at the first measurement point (Figure 2). Of these patients, 112 (7.1%) died during the 1-year follow-up. For all patients who were not identified as deceased, we were able to confirm vital status by directly contacting the patient or his or her general practitioner. A total of 883 patients (56.2%) responded at all 3 time points (“continuer sample”).

Missing data due to item nonresponse were estimated using the expectation maximization algorithm. To show potential effects of attrition on a unit level, Table 1 gives all study variables for the full sample as well as for continuers and noncontinuers separately. A higher proportion of noncontinuers compared with continuers were living without a partner, were more...
often female, and reported higher levels of depression and lower levels of PF.

Because patient dropout did not occur completely at random, we decided to repeat the analyses using the full information maximum likelihood procedure as implemented in AMOS to estimate the empirical covariance matrix from all available information including all available data from the full sample (N=1570).

Descriptive data are presented in Table 1. The following results are presented for the continuer sample (n=883; 19.8% women) unless otherwise specified. Mean age was 66.74 years (range, 35-93 years), mean LVEF was 56.29%. The prevalence for major depression in our patient population was 8.5%, compared with a rate of 3.8% obtained from a German representative sample also using the PHQ-9. Over 1 year, PF improved significantly (main effect for time, F 2,882=80.809; P <.001, testing for the predictive priority of depression vs physical functioning: χ2diff=8.712; P =.07). However, on a path-specific level the path leading from depression 2 months after surgery to PF 1 year after surgery indicated significant group differences (χ2diff=3.885; P =.09). Thus, in patients with systolic HF, changes in depression over this period were significantly more closely related to changes in PF compared with patients with preserved LVEF (Table 2).

Assuming group independent model parameters by simultaneously restricting all model paths to be equal between patients with systolic HF and patients with preserved LVEF, no overall group differences could be found (χ2diff=8.512; P =.26). Differences (P =.26) and partner status (P =.28) were also significantly related to changes in depression over this period. For these groups, the unconstrained initial model was valid.

Table 1. Baseline Characteristics for Full Sample, Continuers, and Noncontinuers

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Full Sample (N=1570)</th>
<th>Continuers (n=883)</th>
<th>Noncontinuers (n=687)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>66.91 (9.04)</td>
<td>66.74 (8.40)</td>
<td>67.13 (9.82)</td>
<td>.41</td>
</tr>
<tr>
<td>Living alone, %</td>
<td>26.94</td>
<td>22.0</td>
<td>33.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Female, %</td>
<td>23.25</td>
<td>19.7</td>
<td>27.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>LVEF, %</td>
<td>54.47 (13.97)</td>
<td>56.33 (13.28)</td>
<td>52.0 (14.48)</td>
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<tr>
<td>Depressive symptoms</td>
<td>5.99 (4.61)</td>
<td>5.38 (4.09)</td>
<td>6.76 (5.09)</td>
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<td>Physical functioning</td>
<td>52.20 (27.03)</td>
<td>56.29 (26.07)</td>
<td>46.1 (27.32)</td>
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Abbreviation: LVEF, left ventricular ejection fraction.

Figure 3 displays the empirical estimates for the cross-lagged panel model, which allows the identification of the predictive directionality between the constructs “depression” and “PF” (overall model fit, χ2=275.28; P <.001). Indices of approximate fit that are robust to sample size showed a sufficiently close fit of model variables (CMIN/df [minimum value of the discrepancy function divided by degrees of freedom], 6.714; RMSEA [root mean square error of approximation], 0.08; CFI [comparative fit index], 0.98; and NFI [normed fit index], 0.97). The model fit can thus be classified as acceptable to good. Controlling for the respective cross-sectional and baseline scores, depressive symptoms showed a pronounced predictive priority over PF. This predictive priority could be demonstrated for both time intervals: from baseline (T1) to 2 months after surgery (T2) and from 2 months (T2) to 1 year after surgery (T3). In contrast, the paths from prior PF to later depression were not significant (Figure 3).

Figure 3. Cross-lagged relationships between depressive symptoms and physical functioning (PF) over time (n=883). Ovals indicate unobserved latent variables. Values are standardized regression weights (β). All paths shown are significant except for those drawn with a broken line. ***P <.001. Testing for the predictive priority of depression vs physical functioning: χ2diff=26.624; P <.001.

Table 2. Baseline Characteristics for Full Sample, Continuers, and Noncontinuers

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To avoid interpretation bias caused by dropout of patients, the analyses were repeated on the full sample (N=1570) (see “Methods” section). Again, standardized regression weights indicated that depressive symptomatology was related to deterioration of PF (βT1,T2=-0.12 [P <.001]; βT2,T3=-0.18 [P <.001]; continuer sample, βT1,T2=-0.15 [P <.001]; and βT2,T3=-0.17 [P <.001]), whereas there was no evidence for a predictive inference from PF to depressive symptomatology (βT1,T2=-0.01 [P =.71]; βT2,T3=-0.04 [P =.26]; continuer sample, βT1,T2=-0.03 [P =.44]; and βT2,T3=-0.01 [P =.74]). Model fits were also good (CMIN/df, 3.934; RMSEA, 0.04; CFI, 0.98; and NFI, 0.97). In accordance with the analyses based
on the continuous sample, no moderator effects were found for gender, age, and partner status. In patients with systolic HF, the path from depression 2 months after surgery to PF 1 year after surgery was significant ($\beta_{T2,T3} = -0.34 \ [P < .001]$; continue sample, $\beta_{T2,T3} = -0.30 \ [P < .001]$). Thus, the danger of an $\alpha$ error, ie, the danger of postulating a difference where there is none, was minimized.

The present study provides strong support for the assumption that depression may lead to a deterioration of PF in patients after CABG, but a bad health status is not predictive of an increase in depression in this context. The influence of depression on the course of recovery after cardiac events or a bypass operation has been the object of intense debate over the past few years. Findings of Rumsfeld et al23 and Mallik et al1 showed that depression appeared to be a strong inverse risk factor for worse quality of life after CABG. In a study testing the reciprocal relationship with no superiority of either path, symptoms, (2) a higher level of depression could be predictive of an increase in depressive symptoms, and pathophysiological pathways for the association of depression and PF cannot be excluded and should be subject to further studies. Further studies are also needed to elucidate possible behavioral and pathophysiological pathways for the association of depression and PF in CABG patients.

There are possible limitations to this study, which should be taken into account when interpreting the results. First, the PHQ-9 is a brief screening instrument to assess severity of depressive symptoms and cannot replace a formal clinical diagnosis of depression. However, since there is strong evidence for both high sensitivity and specificity when diagnosing major depression, this instrument seems appropriate for the investigation of epidemiological questions. Second, with respect to the first measurement point, it cannot be excluded that anxiety and the exceptional mental state before surgery may have influenced the response to the depression items at the first measurement point. Third, the study had to face a substantial dropout rate owing to mortality and morbidity. In addition, we cannot exclude minor associations between cognitive impairment and completion of questionnaires. To avoid a systematic bias by interpreting results based on the reduced sample, all analyses were repeated using the full data set, estimating the missing units. These analyses provide additional support for our main finding that depression is predictive for PF. Fourth, all patients were recruited at a single center, the Deutsches
Herzzentrum Berlin. Given the high reputation of this institution, it is possible that more complicated cases may have been referred to this hospital and thus the study sample may represent a less healthy population.

Our results emphasize the vitally important role depression plays in the CABG recovery process. This was confirmed by evidence of a unidirectional relationship of depression with PF. On the basis of these results, screening for depression should be recommended both before and after CABG treatment. After surgery, this seems to be particularly important for patients with heart failure.

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REFERENCES