

Psychometric Assessment of Cardiac Transplantation Candidates

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Psychometric assessment protocols were used to chart the course of 287 end-stage cardiac patients' psychological adjustment at pretransplantation and, again, in 34 who were subsequently transplanted. The regression and repeated-measures analyses suggested that psychological distress is typical of the adult transplantation candidate, although impaired cognitive functioning is more typical of the acute postoperative stage. Negative affect, cognitive, personality, and coping measures are interrelated at pretransplantation; depression and mental control show significant decreases at 2 weeks posttransplantation. Whereas the transplantation process is inherently distressing, psychological testing may identify cognitive and personality features that require more specific clinical attention.

KEY WORDS: psychometric assessment; cardiac transplantation; personality; normative data.

INTRODUCTION

Cardiac transplantation is often the only treatment option for end-stage cardiac disease, and most studies report survival rates of 70–85% at 1 year (Aravot *et al.*, 1989; Baumgartner, Augustine, Borkon, Gardner, & Reitz, 1987; Cooper & Lanza, 1984; Kaye, 1992; Nieminen, 1990; O'Brien, Buxton, & Ferguson, 1987). A comprehensive assessment of the candidate's functioning and resources allows the medical team to ensure optimal opportunity for positive outcomes; interventions can be tailored to proactively address potential complications. Kay and Bienenfeld (1991) review the

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clinical criteria for assessment of cardiac transplant candidates and distinguish between clinical assessment and measures used for research purposes. Psychometric assessment for research purposes has multiple functions, including identification of measures with predictive utility and development of normative standards for measures that may be relevant at different stages of the process.

We have viewed the transplantation process as a series of four stages: Decision-Making, Waiting, Hospitalization, and Follow-Up (Rodrigue, Greene, & Boggs, 1994). The Decision-Making stage may be subdivided into the diagnosis and candidate selection phases. The diagnosis of a chronic or terminal illness naturally elicits a response of anxiety, fear, and uncertainty, especially if onset has been sudden and unexpected. The candidate selection process brings a mixture of hope and apprehension, which interact with the individual's coping style to result in varying levels of acceptance of the risks of transplantation. The Waiting period may vary in length depending on the recipient status, the requisites for donor matching, and donor availability (Freeman, Folks, Sokol, & Fahs, 1988; Kuhn, Davis, & Lippman, 1988; Kuhn, Meyers, & Davis, 1988; Mischel & Murdaugh, 1987). The most significant psychosocial aspect is the lack of control over the circumstances and the deterioration of health that accompanies this period. The Hospitalization phase includes the surgery, which may take the better part of a day, and the postsurgical hospitalization. This stage may be marked by perioperative complications including delirium, adverse reactions to medications, and infections. The Follow-Up stage is usually a tapering process of gradually less frequent clinic visits, rehospitalization, somatic preoccupation, and adjustment to long-term limitations.

Recently, there has been an emergence of psychometric studies that provide information that may be relevant at different stages of the transplantation process. For example, Shapiro and Kornfeld (1989) examined 73 cardiac transplant recipients at varying periods posttransplant and found that affective disturbances had been experienced by 51%. Several authors have reported that anxiety and depression are common in adult heart transplant candidates (Brennan, David, Bucholz, Kuhn, & Gray, 1987; Kuhn, Davis, & Lippman, 1988; Kuhn, Meyers, & Davis, 1988; Mai, 1986; Mai, McKenzie, & Kostuk, 1986).

The data regarding cognitive changes are also somewhat unclear, as the typical candidate may present with psychomotor retardation or minor deficits in sustained concentration which may not improve significantly posttransplant (Hecker, Norvell, & Hills, 1989; Kuhn *et al.*, 1990; Nussbaum & Goldstein, 1992). However, in other cases where there has been evidence of impairment due to organic brain syndrome, satisfactory quality of life

at posttransplant has been reported (Brennan *et al.*, 1987). A lack of agreement also exists over the adaptiveness of certain personality and coping responses prior to surgery (e.g., the role of denial) (Freeman *et al.*, 1988; Mai, 1986) as well as whether there is a typical course or correlates of psychological adaptation to transplantation (Lane, Roche, Leung, Greco, & Lange, 1988; Maricle *et al.*, 1989; Shapiro & Kornfeld, 1989).

This paper presents one model for psychometric assessment of the cardiac transplantation candidate and explores the principal components and covariation of the dimensions of the candidate's adjustment. In addition, repeated-measures analyses and prediction models are presented to provide a multidimensional perspective on the adjustment of the adult cardiac transplant recipient.

METHOD

In addition to a clinical interview, the psychological assessment for cardiac transplantation candidates at Shands Hospital at the University of Florida included a battery of measures assessing negative affect, personality, coping and cognitive functioning. The specific measures included the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970), State-Trait Anger Expression Inventory (Spielberger, 1988), Beck Depression Inventory (Beck, Steer, & Garbin, 1988), Minnesota Multiphasic Personality Inventory (Hathaway & McKinley, 1967), Medical Coping Modes Questionnaire (Feifel, Strack, & Nagy, 1987), Interest in Religion Survey (Pargament, 1990), Wechsler Memory Scale — Form I (Wechsler, 1945), and Block Design and Vocabulary Subtests of the Wechsler Adult Intelligence Scale — Revised (Wechsler, 1981).

The full battery was administered to all candidates for transplantation, and the results of the evaluation presented to the medical review board to assist in the decision-making process. With the exception of the MMPI, the full battery was readministered prior to discharge posttransplantation (usually within 2 to 3 weeks after surgery). These data were transcribed from the clinic files onto data summary sheets, using standard precautions to protect patient confidentiality. The data were then entered into a computerized database for aggregation and subsequent analyses. Because the data were collected over the course of several years and the assessment protocol underwent three revisions over that period, some patients have missing data for some of the measures that were added later.

Subjects

Two-hundred thirty-eight men (82.4%) and forty-nine women (17%) with end-stage cardiac disease were available for analysis. As shown in Table I, the sample was 84% white, 12% black, and 4% other. The majority was married, and over half were either disabled, retired, or unemployed. The most prevalent diagnoses were ischemic cardiomyopathy and congestive heart failure, with an average duration of 6 years. The average age was 49.9 years (SD = 11.2 years), with a range from 18 to 65 years. The

Table I. Demographic Data

Variable	N
Occupation	
Retired	59 (20.4%)
Management/sales	52 (17.9%)
Disabled	36 (12.5%)
Unemployed	36 (12.5%)
Skilled/technical	31 (10.7%)
Laborer/unskilled	26 (9.0%)
Professional/executive	16 (5.5%)
Office/clerical	11 (3.8%)
Diagnosis	
Ischemic cardiomyopathy	89 (30.8%)
Congestive heart failure	66 (22.8%)
Idiopathic cardiomyopathy	33 (11.4%)
Dilated cardiomyopathy	14 (4.8%)
Viral cardiomyopathy	11 (3.8%)
Coronary artery disease	8 (2.8%)
Missing or other	68 (23.5%)
Gender	
Males	238 (82.4%)
Females	49 (17.0%)
Ethnicity	
White	242 (83.7%)
Black	34 (11.8%)
Hispanic	3 (1.0%)
Marital status	
Single	34 (11.8%)
Married	212 (73.4%)
Divorced	28 (9.7%)
Widowed	4 (1.4%)
Separated	2 (.7%)
Cohabiting	2 (.7%)

average level of education was 12.4 years ($SD = 2.8$ years), ranging from 4 to 21 years.

RESULTS

Factor Analyses

Principal-components extraction methods were applied to each of the four domains of adjustment as assessed by the protocol. Scree plot, eigenvalue magnitude, and goodness-of-fit criteria were used to determine the best interpretation of number of factors. Varimax rotation was selected to simplify interpretation of the factors. The factor structure for Negative Affect is presented first, followed by the Personality Variables, then the Cognitive Functioning, and finally, Coping.

Negative Affect. The principal-components analysis for the Negative Affect measures resulted in three factors which accounted for 74.6% of the variance. The first factor is labeled Anger and includes state and trait anger and anger-in. The second factor, marked by Depression, consists of the depression scale and an inverse relation with anger-out. The third factor, characterized by Anxiety, includes trait anxiety and an inverse relation with anger-control (see Table II).

Personality. The factor analysis of the MMPI scales resulted in a four-factor solution which accounted for 76.8% of the variance. Factor 1 reflects a variety of indices of Distress, including somatic complaints, depression, emotional lability, anger and resentment, anxiety, and alienation. Factor 2

Table II. Principal-Components Factor Structure: Negative Affect Variables

Variable	Factor 1	Factor 2	Factor 3
"Anger"			
State anger	.849	.184	.033
Anger-in	.808	.019	-.067
Trait anger	.776	-.153	.376
State anxiety	.521	.491	.398
"Depression"			
Beck Depression	.188	.767	.058
Anger-out	.363	-.763	.229
"Anxiety"			
Trait anxiety	.277	.569	.630
Anger control	.019	.113	-.954

is labeled Withdrawal and consists of social isolation, anxiety, and an inverse relation with ego strength. Factor 3, characterized by Repression, consists of the repression scale and low scores on the MacAndrews Alcoholism scale. Finally, Factor 4, labeled Active Distrust, consists of features of high activity and suspiciousness (see Table III).

Cognitive Functioning. A three-factor solution was produced which accounted for 57.1% of the variance in intellectual and memory functioning. The first factor is labeled Cognitive Flexibility and contains the subscales of Block Design, Visual Reproduction, Digit Span, and Mental Control as well as the overall Memory Quotient. The second factor is characterized by retention of Verbal Information and consists of the Information and Memory for Passages subscales. The third factor consists solely of the Orientation subscale (see Table IV).

Coping. The coping variables were represented by three factors as well, which accounted for 70.1% of the variance. The first factor is composed entirely of religious variables, including Interest in Religion and the three religious problem-solving styles. Interestingly, a Self-Directed religious coping style was negatively related to the other measures of religion. The second factor is labeled Acceptance and consists of the Acceptance-Resignation scale of the Medical Coping Modes Questionnaire and Extrinsic-Social Religiousness. The third factor, characterized by Confron-

Table III. Principal-Components Factor Structure: Personality Scales

Variable	Factor 1	Factor 2	Factor 3	Factor 4
"Distress"				
Psychopathy	.839	-.063	-.215	.130
Hysteria	.815	-.119	.248	.110
Depression	.810	.319	.286	-.052
Hypochondriasis	.800	.320	.154	-.048
Psychaesthesia	.663	.070	.300	.417
Schizophrenia	.602	.128	.232	.550
"Withdrawal"				
Ego strength	-.110	-.862	.126	-.061
Social introversion	.122	.799	.371	-.204
Manifest anxiety	.016	.786	-.428	.173
"Repression"				
MacAndrews scale	-.063	.147	-.875	-.119
Repression	.407	.037	.757	-.146
"Active Distrust"				
Mania	-.126	.063	-.264	.825
Paranoia	.300	-.080	.150	.714

Table IV. Principal-Components Factor Structure: Cognitive Functioning

Variable	Factor 1	Factor 2	Factor 3
"Flexibility"			
Vocabulary	.485	.424	-.292
Block design	.782	-.018	.282
Mental control	.585	.227	-.126
Digit span	.667	.112	-.142
Visual reproduction	.753	-.136	.319
Associate learning	.387	.273	-.113
Memory quotient	.771	.515	.066
"Verbal information"			
Information	-.004	.765	.190
Memory for passages	.199	.663	.034
"Orientation"			
Orientation	.041	.169	.857

tation, consists of this subscale from the MCMQ and a negative loading for the Avoidance subscale (see Table V).

Intercorrelations of Pretransplantation Adjustment

A series of stepwise multiple regression analyses was performed. Each factor of the domains of adjustment (negative affect, personality, cognitive, and coping) was used independently as a criterion variable, with the remaining factors of the other domains used as predictors.

Negative Affect. The Anger factor of the negative affect domain was significantly predicted by the Verbal Information factor of the cognitive variables [$F(1, 25) = 9.33, p < .01$]. This factor accounted for 27% of the variance in Anger scores, such that higher scores on Verbal Information were associated with higher levels of Anger ($\beta = .52$).

In a second regression model, the Depression factor was significantly predicted by the Cognitive Flexibility factor [$F(1, 25) = 7.31, p < .02$]. Higher scores on Cognitive Flexibility were associated with lower scores on the Depression factor ($\beta = -.48$), accounting for 23% of the variance.

Finally, in a third model, 16% of the variance in the Anxiety factor was significantly predicted by the Orientation factor [$F(1, 25) = 4.75, p < .04$], such that higher scores on the Orientation factor were related to higher anxiety ($\beta = .40$).

Table V. Principal-Components Factor Structure: Coping Variables

Variable	Factor 1	Factor 2	Factor 3
"Religion"			
Collaborative	.905	-.082	-.053
Intrinsic	.885	.150	.126
Deferring	.867	.124	-.192
Interest	.851	-.004	.115
Self-directing	-.830	.138	.172
Extrinsic—personal	.736	.051	.151
"Acceptance"			
Acceptance	.040	.799	-.149
Extrinsic—social	.050	.674	.161
"Confrontation"			
Avoidance	.077	-.121	-.837
Confrontation	.154	-.504	.610

Personality. The first factor of the MMPI scores, the Distress factor, was significantly predicted by the Depression factor [$F(1, 25) = 6.09, p < .03$], accounting for 20% of the variance. Higher scores on the Depression factor were associated with higher scores on the Distress factor ($\beta = .44$). In the second model, the Active Distrust factor was significantly predicted by the Cognitive Flexibility factor [$F(1, 25) = 4.88, p < .04$]. Cognitive Flexibility accounted for 16% of the variance in Active Distrust, and higher Flexibility scores were related to higher Active Distrust scores ($\beta = .40$).

Cognitive. As already mentioned, the Cognitive Flexibility factor was significantly associated with the Depression factor ($\beta = -.49$) and the Active Distrust factor ($\beta = .42$), which together accounted for 40% of the variance in Cognitive Flexibility [$F(2, 24) = 8.01, p < .01$]. In a second model, the Information factor was significantly predicted by Anger, as was also described previously, but no other predictors entered the equation. Similarly, the Orientation factor was predicted by the Anxiety factor, with 16% of the variance being explained by this relationship.

Coping. Although no significant predictors were revealed for the Acceptance or Confrontation factors, the Religion factor was significantly associated with Cognitive Flexibility and Orientation [$F(2, 24) = 4.87, p < .02$]. Accounting for 29% of the variance in Religiousness, higher levels of Cognitive Flexibility were associated with lower levels of Religiousness ($\beta = -.51$), and higher Orientation scores were related to higher Religion factor scores.

Pre- and Posttransplantation Repeated Measures

Repeated-measures analyses of variance were then conducted to explore changes in the dimensions of adjustment from pretransplantation to shortly afterward. Stage of transplantation was used as the within-subjects repeated variable. The original subscales were used as the dependent variables rather than the factor scores, as there were not enough subjects at posttransplant to factor their scores. Also, the personality scale scores were not included, as this measure was not readministered immediately posttransplantation.

Negative Affect. There was a significant main effect of stage for Depression [$F(1,33) = 8.81, p < .01$], such that Beck Depression Inventory scores decreased significantly from pretransplant to transplant recipient status. There were no other significant changes in any of the negative affect dimensions from Decision-Making to the Hospitalization stage.

Cognitive. The main effect for stage was barely significant for Mental Quotient [$F(1, 31) = 4.77, p < .05$], such that there were modest declines from pre- to posttransplant.

Coping. The number of subjects available for these variables was inadequate for this analysis.

DISCUSSION AND SUMMARY

This paper has presented a multidimensional and pre-post perspective on the adjustment of adult cardiac transplant candidates and recipients. The discussion of the results follows, with emphasis on clinical and heuristic value.

Negative Affect

Anger, anxiety, and depression are again implicated as the major dimensions of negative affect in patients presenting with cardiac disease. This is consistent with previous metaanalytic reviews of the literature with this population (Booth-Kewley & Friedman, 1987; Matthews, 1988). The negative affect factors were all predicted by cognitive factors, in that higher anger was associated with better verbal information processing, more depression was associated with less cognitive flexibility, and more anxiety was correlated with being better oriented. The clinician may benefit the patient by tailoring their approach to fit the mood displayed, such that the angry candidate may respond to more spirited verbal interaction and may be

processing information better compared to the depressed candidate, who has become fixated on some negative thought to the exclusion of others.

With respect to posttransplantation differences in negative affect, only depression indicated a significant decline from the period of decision-making to the postoperative stage. Postsurgical negative affect was not significantly predicted by any of the assessment variables, perhaps due to the lack of variability in this population on these dimensions.

Personality

Four factors were created based on MMPI scores, which suggested that candidates may present as (1) highly distressed, (2) withdrawn, (3) repressed, and (4) active and distrustful. Not surprisingly, global distress was significantly related to depression scores. Therefore, any premorbid psychopathology is likely to contribute to the depressive symptoms typical of the transplantation process.

Cognitive

The principal components of intellectual functioning were labeled cognitive flexibility, information, and orientation. This flexibility factor was inversely related to depression and directly related to the active distrust personality factor. Higher scores on the information factor were associated with higher levels of anger, and higher scores on the orientation factor were predicted by higher anxiety scores. Clinically, the more aware of their environment and their situation, the more anxious the candidate is likely to be. Therefore, this anxiety should be normalized and worked through rather than pharmacologically alleviated or minimized.

Posttransplantation cognitive scores were significantly lower due to a modest decline in Mental Quotient scores. These data appear to be inconsistent with previous studies reviewed by Nussbaum and Goldstein (1992), who suggested that neuropsychological functioning improves posttransplantation. However, these authors concluded that the changes were nonsubstantial although significant, which is more consistent with the present findings. Another consideration is the influence of medication, which is an uncontrolled variable in a clinical setting. Given the present findings, it must be concluded that posttransplantation cognitive functioning is multidetermined and somewhat unpredictable.

Coping

The dimensions of the coping domain were suggested to include a religion factor, an acceptance factor, and a confrontation factor. The religion factor was inversely related to cognitive flexibility and directly related to orientation. Interestingly, intrinsic religiousness (adopting one's religion as the major motive in life) increased from the decision-making stage to the post-surgical assessment. This finding is consistent with Pargament's (1990) assertion that greater involvement in religion can be a product of the coping process.

Overall, these findings suggest that negative affect and general psychological distress are part of the typical presentation of the adult cardiac transplantation candidate. Impairment of cognitive functioning may occur at any stage of the process and should be routinely monitored. Importantly, these adjustment features vary with premorbid information processing abilities and personality functioning. Age and psychosocial history become important clinical variables in this regard in that developmental and pre-senile influences may interfere with posttransplantation adjustment. Future research that examines the contributions of demographic features and more longitudinal tracking of posttransplantation quality of life would contribute even further to clinical practice with this growing population. It would also be helpful to know if similar relationships are found among transplant recipients of other organs.

Although the features of the adjustment of adult cardiac transplant recipients are multidetermined, these data suggest that the strongest relationships may be found between pre- and posttransplantation cognitive functioning and between predecision psychosocial adjustment and postsurgical depression. While the battery presented here is probably too extensive for most clinical applications, the domains of negative affect, personality, cognitive functioning, and coping are necessary components to assess. The implication is that the assessment battery may have its most important research utility in objectifying the cognitive functioning of the candidate and attempting to distinguish premorbid psychosocial distress from the negative affect typically associated with the transplantation process.

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