



Published in final edited form as:

J Cardiovasc Nurs. 2018 ; 33(5): E1–E9. doi:10.1097/JCN.0000000000000487.

Social Support Moderates the Relationship between Perceived Stress and Quality of Life in Patients with a Left Ventricular Assist Device

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Abstract

Background—Living with a left ventricular assist device (LVAD) has significant psychosocial sequelae that impact health related quality of life (HRQOL).

Objective—The purpose of this study was to 1) describe psychosocial indicators of stress including perceived stress, depression, fatigue and coping 2) examine relationships among stress indicators by level of perceived stress 3) examine relationships among indicators of stress and clinical outcomes and 4) test the moderation of social support on the relationship between stress and clinical outcomes.

Methods—Participants were recruited from two outpatient clinics in a cross-sectional study design. Standardized measures were self-administered via survey. Descriptive statistics, correlation and multiple linear regression analysis were done.

Results—The sample (N=62) was mostly male (78%), black (47%), married (66%), with mean age 56.5 ± 13 years. The overall sample had a moderate stress profile: moderate perceived stress (mean 11.7 ± 7), few depressive symptoms (mean 3.2 ± 3.9) and moderate fatigue (mean 14.3 ± 9.1). Increased perceived stress was associated with fatigue, depressive symptoms and maladaptive coping ($p < 0.001$). Regression analysis demonstrated perceived stress and fatigue were significant correlates of overall HRQOL (adj. $R^2=0.41$, $p < 0.0001$). Social support

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Disclosures:

Dr. Russell serves on the Data Safety and Monitoring Board for Thoratec/St. Jude.

Author Contributions:

Study design: MA, CB, KG, PD, SR, HH, SD, CDH

Study Implementation: MA, SR, SD, CDH

Manuscript Development: MA, CB, PD, SR, HH, KG, SD, CDH

Final Approval: MA, CB, PD, SR, HH, KG, SD, CDH

moderated the relationship between perceived stress and HRQOL, controlling for fatigue ($R^2 = 0.49$, $p < 0.001$).

Conclusions—Individuals living with LVAD with high perceived stress have worse depressive symptoms, fatigue and coping. The influence of high social support to improve the relationship between stress and HRQOL underscores the importance of a comprehensive plan to address psychosocial factors.

Living with advanced heart failure (HF) and a left ventricular assist device (LVAD) is complex, stressful and commonly burdensome.¹ The number of individuals living with a LVAD is increasing, underscoring the importance of examining psychological as well as physiological and clinical outcomes such as health-related quality of life (HRQOL), exercise capacity and healthcare utilization.² Emotional and psychological sequelae occur due to challenges of LVAD self-care (e.g., adapting to dependence on a power source and manipulation of the device), impaired sleep, pain, limitations on activities of daily living and management of complex medication regimens.³

Stress has been defined as the experience of appraising events as threatening, due to exceeding personal resources.⁴ Psychological stress response may be characterized by perceived stress, depressive symptoms and fatigue due to common causal pathways.^{5,6} Although little is known about the psychological stress experienced by LVAD patients, perceived stress and depression have been associated with poor health outcomes among cardiac patients.^{7,8} In a study by Arnold et al comparing cardiac patients by level of perceived stress, those with higher perceived stress had worse 2-year mortality compared to those with low perceived stress even after controlling for clinical factors such as depression.⁷ Perceived stress and the relationship between stress and outcomes has not been studied among patients living with an LVAD.

Coping, the cognitive and behavioral efforts to respond to stressful events and chronic stress can take adaptive and maladaptive forms.⁴ Maladaptive coping strategies, such as denial and avoidance, are associated with worse outcomes in HF patients.⁹ One important adaptive coping strategy evaluated by transplant committees is social support. Typically, LVAD patients must have caregivers, identified prior to implantation; however, the caregiver-patient relationship, demonstrated in qualitative studies, can be strained by changes in levels of independence, roles and relationships.^{3,10,11} Higher levels of social support have been associated with better outcomes including HRQOL and HF self-care in HF studies, but have not been studied among LVAD patients.^{12,13}

To our knowledge, no studies to date have taken a comprehensive view of psychological indicators of stress, nor related these indicators to social support and outcomes. Therefore, the purpose of this study was to describe and examine the relationships between indicators of psychological stress, coping, social support and clinical outcomes including HRQOL, exercise capacity, and healthcare utilization. Our aims were to 1) Describe indicators of psychological stress among LVAD patients 2) Compare indicators of stress, social support and outcomes by level of perceived stress 3) Examine the relationships between indicators of psychological stress response and outcomes and 4) Test the role of social support as a moderator of the relationships between psychological stress response and outcomes.

METHODS

Study Design

A cross-sectional study design was used to describe indicators of psychological stress, coping, social support and outcomes among patients living with an LVAD. The conceptual framework for this study is an adaptation of the Lazarus and Folkman Stress Model (see figure 1).⁴ Poor outcomes result from the inability to respond to the demands of stress. In this conceptual framework, individual characteristics of LVAD patients (i.e., implant strategy, emergent implantation, time since implant, stressful life events) influence indicators of psychological stress response (i.e., perceived stress, depressive symptoms, fatigue and coping). In particular, we wanted to examine the relationships between perceived stress and other indicators of psychological stress response. Psychological stress response is related to LVAD patient outcomes (i.e., HRQOL, exercise capacity and healthcare utilization). Based on the literature and clinical experience of the investigators, we hypothesized that social support would moderate the relationship between indicators of psychological stress and outcomes.¹²⁻¹⁴

Setting & Sampling

Patients living with an LVAD and served by the LVAD clinic at two large tertiary care centers in the mid-Atlantic region of the United States were included in the study. Convenience sampling was used to recruit patients living with an LVAD from both centers. Institutional Review Board approval was obtained and informed consent was obtained in person during clinic visits. We recruited outpatients with an LVAD at >2 months post-implant. The timing of recruitment was based on an understanding that early surgical recovery is very stressful with functional and HRQOL improvements that change rapidly.¹⁵ Eligibility criteria included: patients with continuous flow LVAD treated in outpatient clinic, over 21 years of age, had a Montreal Cognitive Assessment (MoCA) score ≥ 17 (no severe cognitive impairment)¹⁶ and could speak and understand English. Patients were excluded if being treated in inpatient rehabilitation or acutely hospitalized with the assumption that stress during inpatient stays would be different than outpatient stress.

Sample Size

A power analysis was conducted to determine the sample size needed based on co-variables in the model and estimated effect sizes. Because of the limited literature demonstrating relationships between our key variables in this population, we used a small effect size ($f^2=0.2$) in our calculations.¹⁷⁻¹⁹ Based on the power analysis for linear regression, an estimated effect size of $f^2=0.2$, $\alpha=0.05$, and power of 80%, we planned to recruit 80 patients.

Study Procedures and Measurement

Patients were recruited on scheduled clinic visit days. Surveys were administered on paper and collected at the end of the visit if completed, but often were completed at a subsequent clinic visit. Demographic characteristics and instruments assessing study variables were self-administered. Widely validated instruments were selected based on their use with HF populations and relevance to the conceptual model for the variables of interest (Table 1).

In addition to survey data, the Six Minute Walk (6MWT) was administered according to the American Thoracic Society Protocol. This test has a reported reliability of 0.86²⁰⁻²² and is used in “standard of care” in many LVAD centers. Healthcare utilization was operationalized as number of outpatient visits, number of days hospitalized and number of outpatient procedures. Relevant data were captured from the electronic medical record for the 6 months prior to the date of survey completion or since the date of LVAD implant. Due to the complicated nature of these patients, only 78% were able to complete the survey; a STROBE diagram is presented in figure 2 to demonstrate completion rates.²³

Data analysis

Data were checked for quality and consistency. All statistical analyses were completed with Stata version 14 (StataCorp, College Station, Texas). Descriptive statistics and graphical displays were used to summarize overall data (aim 1) and by perceived stress level (aim 2). We examined the distribution of perceived stress and ranked low (0-11), moderate and high (12-40), using approximately the upper two quartiles to designate moderate and high stress.⁷ T-tests were used to compare high and low stress groups. We also examined differences between clinic settings. A correlation matrix was created to examine relationships between continuous variables. Categorical variables were examined for their bivariate association using chi-square tests. A multiple linear regression model was then fit using only variables with $p < 0.20$ from the bivariate correlation analysis (aim 3). This analysis was followed by tests for multi-collinearity between model variables using variance inflation factor. The assumptions of this parametric analysis were met. The final model includes only variables with $p < 0.05$.

The moderation of social support was tested using two additional models (aim 4). To test these relationships we dichotomized social support at the median of 20. Interaction terms were created for 1) social support and perceived stress, then 2) social support and fatigue. Building on the multiple linear regression models, social support and interaction terms were tested.

RESULTS

Descriptive findings

The 62 patients who completed the survey were predominantly male (78%), black (47%), and married (66%) with mean age 56.7 ± 13.0 years. (See Table 2) Patients were nearly evenly distributed by implant strategy (destination therapy 49%, bridge to transplant 51%) and mean length of LVAD support was 25.3 ± 24.5 months. (See Table 3) Forty-nine percent were Intermacs Profiles 1 and 2, implanted emergently. On the Holmes & Rahe stressful life event inventory patients reported frequent stressful life events with average life event score 111.9 ± 91.8 (Table 3); 17 participants (27%) had a summed weighted score greater than 150, the hi-risk threshold.

Mean perceived stress for the sample was 11.7 ± 7 (Table 4). The overall sample had a moderate stress profile: moderate perceived stress (mean 11.7 ± 7), few depressive symptoms (mean 3.2 ± 3.9) and moderate fatigue (mean 14.3 ± 9.1). Both adaptive and mal-

adaptive coping strategies were commonly used by all participants. Patients reported very high social support (mean 19.9 ± 5.4).

Overall HRQOL was rated good (mean 73 ± 14.6). Regarding HRQOL domains, LVAD patients reported little interference of heart failure symptom frequency (88 ± 14.7) but social limitation was more severely limiting (64.4 ± 20.3). Mean 6MWT distance was 287 ± 193 meters overall, demonstrating low level of exercise capacity. Participants spent an average of 6.5 ± 4.6 days or 8% of days in the 6 months prior to the study in the hospital or attending outpatient visits. There were no significant differences by clinic setting for any variables studied.

Higher Perceived Stress is related to Depressive Symptoms, Fatigue and HRQOL

When comparing psychological stress response by perceived stress level using t-tests, the higher stress group had more depressive symptoms ($p < 0.01$), more fatigue ($p < 0.001$), used more maladaptive coping ($p < 0.003$) and had less social support ($p < 0.003$). In addition, overall HRQOL was worse in the higher stress group ($P < 0.01$); social limitation and QOL domains were worse in the higher stress group ($p < 0.01$), while the physical limitation and symptom frequency domains trended toward significance ($p = 0.05$). There were no demographic differences between groups, but the higher stress group included 6/31 participants with a history of depression compared to none in the lower stress group ($p = 0.01$). There were also no differences between groups by implant strategy, emergent implantation, time since implant, stressful life events, 6MWT distance or healthcare utilization.

Multi-variate Modeling

In multivariate regression analysis, perceived stress and fatigue were independent predictors of worse HRQOL. Using the model for HRQOL we tested social support as a moderator of the relationships between psychological stress response and HRQOL. High social support moderated the relationship between perceived stress and HRQOL when controlling for fatigue ($R^2 = 0.49$, $p < 0.001$). (See Table 5 & Figure 3) Variance inflation factors were less than 2 on the final models, indicating low likelihood of collinearity. Regression analysis showed no significant multivariate models for exercise capacity or healthcare utilization.

DISCUSSION

We found that most LVAD patients had a moderate level of perceived stress, mild depressive symptoms and moderate fatigue. Those with higher perceived stress had worse depressive symptoms, fatigue and more frequently used mal-adaptive coping compared with those with lower stress. In multivariate analysis, high perceived stress and fatigue was associated with lower HRQOL and this relationship was moderated by social support.

The perceived stress mean score was similar to the age-adjusted normal value of 12, which has been reported for the general population and similar to those reported in other cardiac populations.²⁴ Higher perceived stress has been related to higher mortality in myocardial infarction patients.⁷ Further investigation is warranted to examine the role of perceived stress in LVAD patients, the mechanisms for these effects and the possible impact on adverse

events and survival. These findings suggest that enhanced clinical assessment of psychosocial factors is important for understanding LVAD outcomes. This is a challenge as LVAD patient visits are frequently full, including physical exams and equipment checks. However, early referral for psychological counseling and even palliative care symptom management may reduce the burden felt by patients and providers.

We did not see a relationship between coping strategies and HRQOL, however we did find that more frequent use of adaptive and mal-adaptive coping strategies was associated with a worse perceived stress. This is consistent with the Lazarus and Folkman description of the economics of stress - as stress increases, the demand for coping increases.²⁵ Thus, those with higher levels of perceived stress also reported more frequent use of both mal-adaptive and adaptive coping strategies because more coping is required when more stress is experienced. The brief COPE does not evaluate effectiveness of coping strategies, only frequency of use. Understanding how individuals living with an LVAD cope with stress is important for understanding issues of adherence and self-management and for determining ways to support patients and families throughout LVAD therapy.

Overall, this sample of community dwelling LVAD patients appears similar in HRQOL and exercise capacity compared to previous research. KCCQ-12 average scores 12 months after implant range between 66 and 75.^{15,26,27} HRQOL in this study was within this range, which is nearly double reported KCCQ values prior to LVAD implant and exceeds the minimal clinically important difference for the KCCQ.^{26,28,29} Exercise capacity was also within range of findings from Intermacs.^{2,26} Hospital length of stay has been reported in the literature, but we did not identify any other studies that considered outpatient visits in LVAD healthcare utilization. The frequency of outpatient visits may vary by region and LVAD program as a function of the distance from the patient's home to clinic, use of outreach strategies and stability of the patient, which we did not capture in this study.

Social support was reported at a comparable level to previously reported cardiac populations who were partnered.³⁰ This was expected, as LVAD patients are required to have caregivers available for initial implant care, to support clinic attendance and to manage LVAD care. Multi-variate modeling and moderation analysis revealed that, when comparing those with the same level of perceived stress, those with high social support had a higher HRQOL than those with low social support after controlling for fatigue. This moderation analysis provides evidence for the importance placed on social support when considering advanced HF patients for VAD implantation. However, it was not possible to determine in this study if the caregiver, healthcare team or other sources are responsible for the perceived level of social support. Support is provided by LVAD programs through 24/7 access to providers. Yet, patients and caregivers have reported variable levels of satisfaction with the support provided by LVAD programs, suggesting a need to explore additional ways to increase the type(s) and level of support provided.³¹ Specifically, it is not clear how programs are assessing patient stress or helping patients manage stress. Resources vary between institutions, although some offer support groups and other activities for LVAD patients and caregivers. Support strategies that are tailored to the individual patients' needs may be most effective.

Strengths and Limitations

To our knowledge, this is the first study to examine indicators of psychological stress, coping and social support in a moderate size continuous flow LVAD patient sample, providing important intervention targets for future work. In addition, we evaluated important psychosocial factors and their impact on outcomes in a diverse, multi-center population. Finally, we have introduced evidence that supports LVAD program policies related to social support. To expand these findings, the next step will be to conduct a longitudinal study to examine how psychosocial factors change over time and to establish approaches to tailoring future interventions.

This study has several limitations. As a cross-sectional study, no causal relationships can be drawn from this analysis. Further we had several challenges in completion rates. Long patient clinic visits and frequent complications often resulted in patients who consented being unable to complete the survey. This may have resulted in a self-selection bias and in the under-estimation of variables related to stress and over-estimation of HRQOL compared to the total LVAD population. This concern is consistent with other survey data collected from the LVAD population.³² Also, our statistical approach may not have captured all possible confounders. In addition, the patients in our sample had an average of almost 2 years of LVAD support, which also may have resulted in lower reported stress and higher HRQOL than the overall LVAD population. Another limitation is that we used a HF-specific measure for HRQOL. This measure is not specific to having a VAD, however as of yet there are no VAD-specific measures of HRQOL. Finally, our conceptual framework incorporated coping as a component of psychological stress response, due to the nature of the Brief COPE which measures frequency of coping strategy use. Others have described coping as a mediator of stress and outcomes and another instrument which incorporates a measure of coping effectiveness may provide a more clear understanding of coping as a mediator of stress in this population.

Conclusions

Increased perceived stress was related to worse depressive symptoms, fatigue, mal-adaptive coping and worse HRQOL. Further, the influence of high levels of social support on HRQOL despite fatigue confirms the need to continually assess the social support available to LVAD patients. Thorough, ongoing assessment by healthcare providers and social workers may uncover stressful conditions requiring increased monitoring and possible intervention. Future studies to test the effects of interventions designed to enhance stress management via adaptive coping may improve HRQOL and other LVAD outcomes.

Acknowledgments

Grant Support:

Interdisciplinary Training in Cardiovascular Research T32 NR 012704 (2012-2014)

Predocctoral Training in Research Program (NIH 5TL1TR001078-02 (2014-2015)

1F31NR015179-01A1 National Institute of Nursing Research, NIH (2015-2017)

Heart Failure Society of America Nursing Research Grant (2014-2016)

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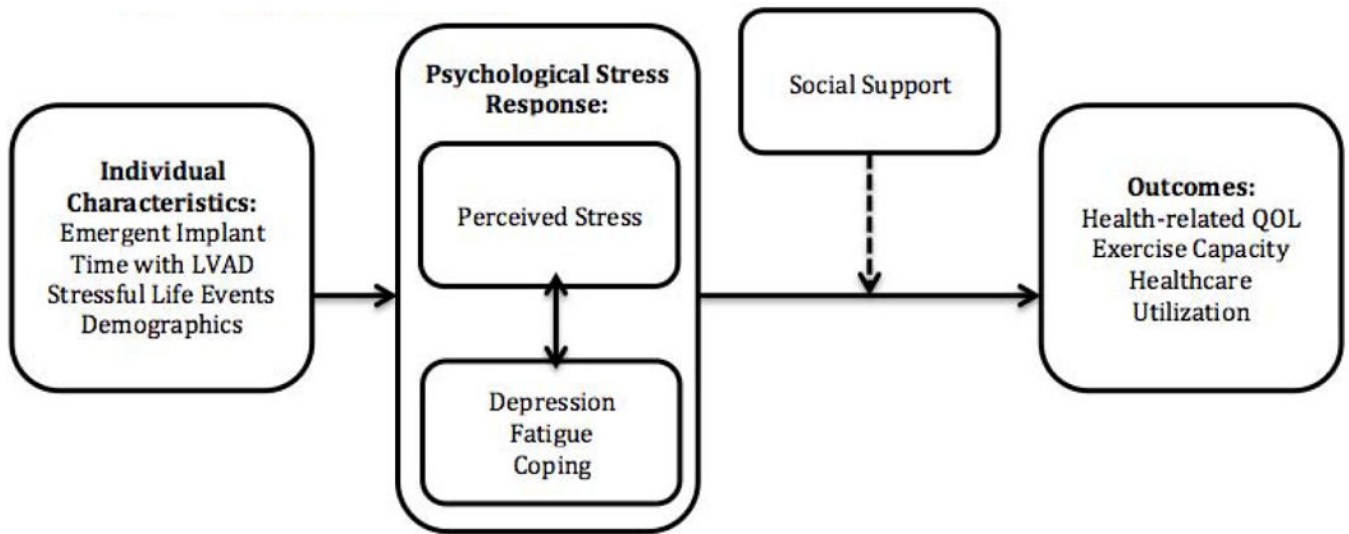


Figure 1.
Conceptual Framework

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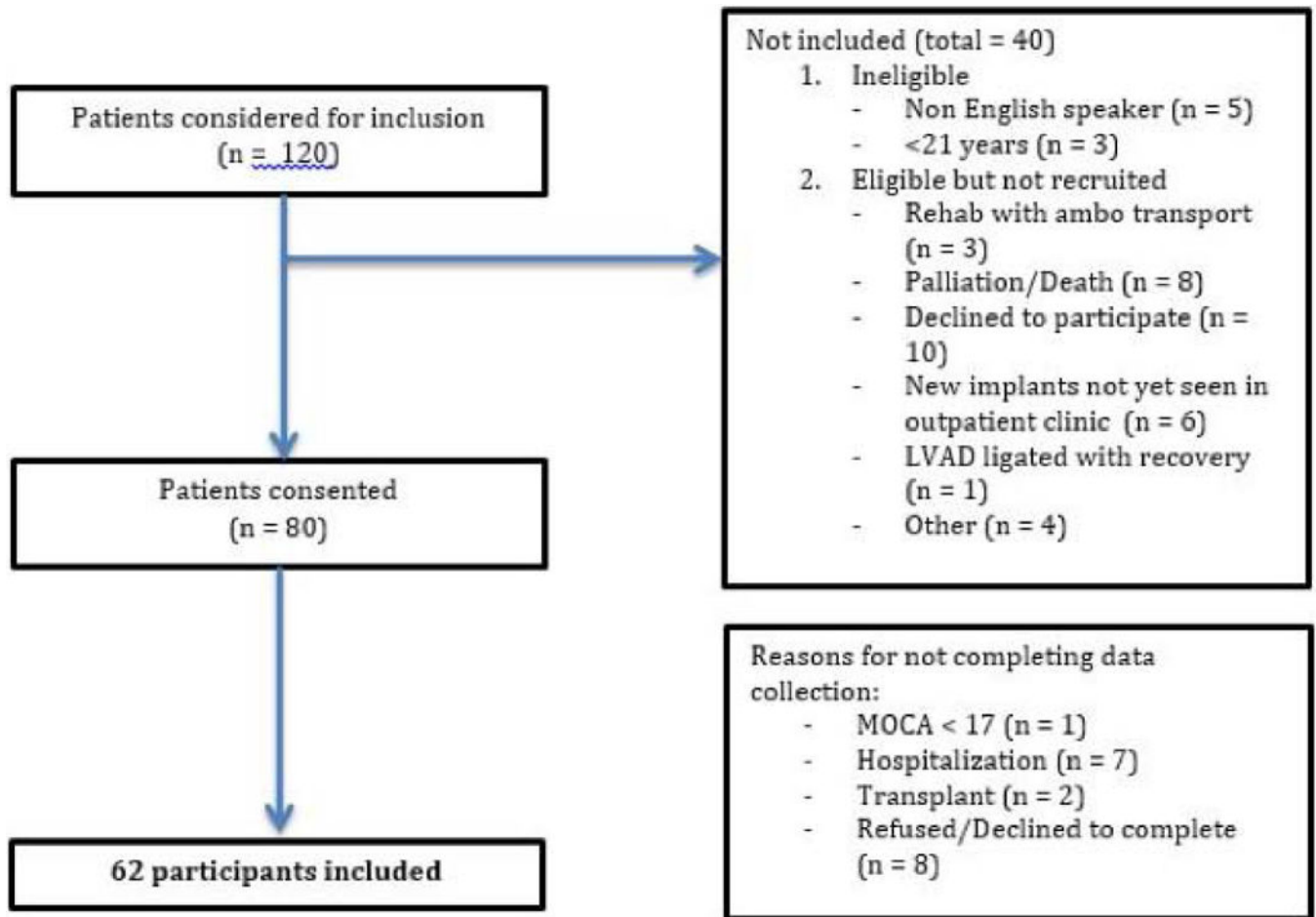


Figure 2.
STROBE diagram of participant selection and inclusion

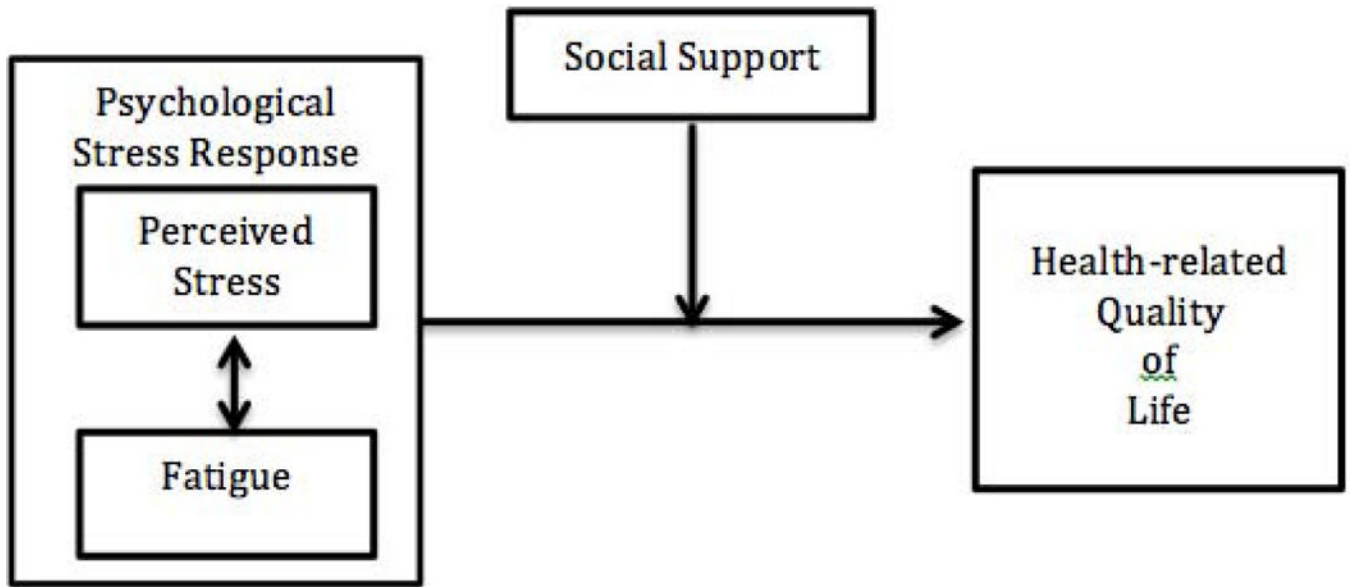


Figure 3.
Final Multi-variate Quality of Life Model ($R^2 = 0.49$, $p < 0.01$)

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Table 1

Instrument Description

Variable Instrument	# Items Sub-scales	Scoring: Score range, Significance of high score, Diagnostic cutoffs
Stressful Life Events Holmes and Rahe Stressful Life Events Scale ^{33,34}	43 Total Weighted Score	0 - 450 Higher total weighted score indicates higher stress. Scores >150 are associated with higher health risk.
Perceived Stress Perceived Stress Scale ²⁴	10 Total Score	0 – 40 Higher score indicates worse stress No diagnostic cutoff
Depressive symptoms Perceived Health Questionnaire ³⁵	9 Total Score	0 - 25 Higher score indicates worse depressive symptoms 5 = mild, 10 = moderate depressive symptoms
Fatigue Multidimensional Assessment of Fatigue ³⁶	16 Global Fatigue Index	1 – 50 A higher score indicates worse fatigue and impact on activities of daily living.
Coping Brief COPE ³⁷	28 Adaptive Coping: (task-focused, seeks social support, religion & acceptance) Maladaptive Coping: (behavioral disengagement, substance abuse & self-blame)	Adaptive Coping: 0 - 64 Maladaptive coping: 0 - 48 Higher Score indicates more frequent use of more strategies. No diagnostic cutoffs
Social Support ENRICH ³⁰	10 Emotional, Instrumental, Informational and Appraisal	0 – 25 Higher score indicates more social support No diagnostic cutoffs
Health-related Quality of Life Kansas City Cardiomyopathy Questionnaire ³⁸	12 Physical Limitation, Symptoms, Quality of Life, Social Limitation Overall	0 – 100 Higher score indicates better quality of life 50-75 good QOL, > 75 excellent QOL

Table 2

Sample Characteristics by Level of Perceived Stress

	Perceived Stress			T-test or chi ² p-value
	N=62 n (%)	Low (n = 31) n (%)	Moderate to High (n = 31) n (%)	
Gender				
Male	48 (77)	24 (50)	24 (50)	1.00
Female	14 (23)	7 (50)	7 (50)	
Age				
Mean ± SD	56.7 ± 13.0	58.2 ± 12.6	55.3 ± 13.2	0.38
Median	58.8	60.6	56.5	
Race				
Black	29(47)	16 (55)	13 (45)	0.65
White	25 (40)	12 (48)	13 (52)	
Other	8 (13)	3 (38)	5 (62)	
Marital Status				
Married or Living with Partner	40 (66)	19 (48)	21 (52)	0.72
Other	21 (34)	11 (52)	10 (48)	
Annual Household Income				
< \$30,000	16 (25)	9 (56)	7 (44)	0.53
\$30, 000-60,000	9 (15)	3 (33)	6 (67)	
>\$60,000	37 (60)	19 (51)	18 (49)	
Highest Level of Education				
<= high school	14 (23)	8 (57)	6 (43)	0.52
technical school or some college	18 (30)	7 (39)	11 (61)	
graduated college or beyond	28 (47)	15 (54)	13 (46)	
Co-morbidities				
Diabetes	20 (32)	9 (45)	11 (55)	0.59
Chronic Renal Disease	19 (31)	11 (58)	8 (42)	0.41
Depression	6 (10)	0 (0)	6 (100)	0.01
Right heart failure	5 (8)	3 (60)	2 (40)	0.64

Table 3

LVAD and Individual Characteristics by Level of Perceived Stress

	Perceived Stress			T-test or chi ² p-value
	Overall N = 62 n (%)	Low (n = 31) n (%)	Moderate to High (n = 31) n (%)	
Device				
Heartware	23 (37)	12 (52)	11 (48)	0.97
Heartmate II	37 (60)	18 (49)	19 (51)	
Heartmate III	2 (3)	1 (50)	1 (50)	
Implant Strategy				
Bridge to Transplant	31 (49)	15 (48)	16 (52)	0.80
Destination Therapy	32 (51)	16 (52)	15 (48)	
Emergent Implant				
Intermacs Profile 1 or 2	30 (49)	14 (47)	16 (53)	0.61
Intermacs Profile > 2	32 (51)	17 (57)	15 (43)	
Stressful Life events				
Mean ± SD	111.9 ± 91.8	90.9 ± 79.8	133 ± 99.3	0.07
Median	97.5	82	128	
Months since initial implant				
Mean ± SD	25.3 ± 24.5	25.3 ± 4.4	25.2 ± 4.5	0.98
Median	18.5			
Complications				
Gastrointestinal bleed	16 (27)	6 (38)	10 (62)	0.25
Stroke	13 (21)	7 (54)	6 (46)	0.76
Driveline Infection	10 (16)	5 (50)	5 (50)	1.00
Right Heart Failure	4 (7)	2 (50)	2 (50)	1.00
Pump replaced	4 (7)	2 (50)	2 (50)	1.00
Sepsis	4 (7)	1 (25)	3 (75)	0.30
Tracheostomy	3 (5)	1 (33)	2 (67)	0.55

Notes: Higher total Stressful Life Events score indicates higher stress.

Table 4

Indicators of Psychosocial Stress, Social Support and Outcomes by Level of Perceived Stress

	Perceived Stress			T-test p-value
	Overall N = 62 Mean ± SD	Low (n = 31) Mean ± SD	Moderate to High (n = 31) Mean ± SD	
Indicators of Psychosocial Stress and Social Support				
Perceived Stress	11.7 ± 7.0	5.9 ± 2.1	17.6 ± 4.4	-
Depressive symptoms	3.2 ± 3.9	1.2 ± 1.6	5.2 ± 4.5	<0.01
Fatigue	14.3 ± 9.1	8.4 ± 8	18.8 ± 7.4	<0.01
Coping				
Adaptive Strategies	37.4 ± 11.9	35.2 ± 13.4	39.6 ± 10.0	0.14
Mal-adaptive Strategies	15.5 ± 4.4	13.6 ± 3.8	17.4 ± 4.1	<0.01
Social Support	19.9 ± 5.4	21.9 ± 4.8	18 ± 5.3	<0.01
Outcomes				
Quality of Life				
Physical limitation	66.4 ± 16.0	70.4 ± 14.8	62.5 ± 16.3	0.05
Symptom frequency	88 ± 14.7	91.8 ± 11.8	84.4 ± 16.5	0.05
QOL	73.7 ± 23.8	83.5 ± 19.1	63.9 ± 24.3	<0.01
Social Limitation	64.4 ± 20.3	74.6 ± 11.8	54.5 ± 22.0	<0.01
Overall	73 ± 14.6	80.1 ± 9.5	66.3 ± 15.2	<0.01
Six Minute Walk Test Distance (meters)	287 ± 193	270 ± 187	306 ± 200	0.46
Healthcare Utilization*				
Days of Outpatient Visits	6.5 ± 4.6	5.4 ± 3.5	7.5 ± 5.2	0.08
Days Hospitalized	9.9 ± 14.2	10.9 ± 16.4	9 ± 12.0	0.60
Total healthcare days	16.8 ± 15.7	15.8 ± 17.5	17.8 ± 14.0	0.62
#days hospitalized/#days with LVAD	0.08 ± 0.13	0.09 ± 0.16	0.07 ± 0.11	0.59

Higher Scores indicate worse perceived stress, depression, fatigue and utilization of coping strategies. Higher scores indicate better social support, HRQOL and exercise capacity.

* Healthcare utilization was calculated for the 6 months prior to study date or in the time since LVAD implant.

Table 5Social Support Moderation Model, $R^2 = 0.49$, $df = 59$, $p < 0.001$

	Beta Coefficient	Standard Error	P-value
Perceived Stress	-0.99	0.33	<0.01
Fatigue	-0.62	0.19	<0.01
Social Support (Dichotomized at median = 21.5)	-4.54	5.5	0.41
Perceived Stress * Social Support	0.86	0.42	0.04

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