

ABSTRACT OF DISSERTATION

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The Graduate School

University of Kentucky

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requirements for the degree of Doctor of Philosophy in the
College of Nursing
at the University of Kentucky

By
Marla J. De Jong

Lexington, Kentucky

Director: Dr. Debra K. Moser, Professor of Nursing

Lexington, Kentucky

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Anxiety may cause adverse outcomes through physiologic pathways in patients with cardiac disease. The purpose of this dissertation was to investigate anxiety and its correlates in persons with acute myocardial infarction (AMI) and heart failure (HF). The specific aims were to: 1) evaluate whether anxiety levels early after AMI differ across five countries, and to determine whether an interaction between country, and sociodemographic and clinical variables contributes to variations in reporting anxiety; 2) review and analyze the measurement of anxiety for cardiac patients; 3) determine whether heart rate (HR) and blood pressure (BP) are related to anxiety in patients with HF, patients with AMI, and healthy individuals; 4) determine whether the single-item Anxiety Level Index (ALI) is a valid alternative to the State Anxiety Inventory (SAI) or the anxiety subscale of the Brief Symptom Inventory (BSI) for assessing state anxiety in patients with AMI; 5) determine the best predictive model of health status, given sociodemographic, clinical, health perception, and emotional variables for patients with HF; and 6) review neural control of HR, describe heart rate variability (HRV), and summarize research findings regarding HRV of HF patients.

Four studies were conducted using existing data from four samples of patients with either AMI or HF. The first was a prospective, comparative study of 912 patients from five countries regarding anxiety after AMI. In the second study, a cross-sectional design was used to examine the relationships of anxiety with and HR and BP in 54 patients with AMI, 32 patients with HF, and 31 healthy individuals. Next, cross-sectional data on three measures of anxiety were analyzed in 243 patients with AMI. Finally, cross-sectional data from 87 patients with HF were evaluated to determine predictors of health status.

Patients from each country experienced high anxiety. Culture did not account for variations in anxiety. Heart rate and BP did not accurately reflect level of anxiety. ALI scores were moderately correlated with SAI and BSI anxiety subscale scores, but the Bland-Altman method indicated the ALI lacked construct validity. The strongest predictors of health status were New York Heart Association class, anxiety, and depression.

KEYWORDS: Anxiety, Heart Failure, Acute Myocardial Infarction, Health Status, Heart Rate Variability

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CHAPTER ONE

Introduction

Anxiety is a complex and distressing emotion with psychological, physiological, behavioral, and cognitive manifestations.^{1,2} As a normal reaction to a real or perceived danger, anxiety can be protective.¹ Persistent anxiety, however, is often counterproductive or even harmful.¹ Anxiety may impede psychosocial adaptation to cardiovascular disorders, hinder physical rehabilitation, contribute to nonadherence, worsen health-related quality of life, cause greater symptom burden and disability, and interfere with patients' self-care, work, and leisure activities.³⁻⁷ In addition, patients who are overly anxious may be unable to learn or act upon new information about necessary life-style changes.⁸

The prevalence of anxiety is 69-70% for patients with AMI.^{9,10} Symptoms of anxiety persisted at least 1 year for 16-35% of acute myocardial infarction (AMI) patients who were anxious while hospitalized.^{10,11} Among others with AMI, anxiety peaked 1-2 weeks post-discharge and remained stable for 3-5 years.⁴

Up to 70% of patients with heart failure (HF) have high levels of anxiety.¹² Three months after hospitalization, patients with either AMI or HF had higher levels of anxiety than healthy elders.¹³ In one study, patients with HF reported anxiety levels that were nearly as high as for patients with neuropsychiatric disorders.¹⁴ Women with HF had higher anxiety than a normative group of women, elderly women, and women with either hypertension or cancer.¹⁵ Van Jaarsveld and colleagues reported that patients were more anxious 6 weeks after diagnosis with HF than at baseline.¹⁶ In the same study, anxiety levels were even higher 12 months after diagnosis.

In many respects, it is not surprising that patients with HF or AMI are anxious. Potential sources of anxiety include progressive and debilitating physical symptoms, multifaceted treatment regimens, recurring hospitalization, perceived hopelessness and loss of control, failure of accustomed coping mechanisms, isolation from family and friends, frustrations with a complicated healthcare system, financial worries, and fear of death.^{12,17-19}

Anxiety exists on a continuum from normal transient emotion^{2,20} to pathological psychiatric conditions such as generalized anxiety disorder, panic disorder, posttraumatic stress disorder, and obsessive-compulsive disorder.^{21,22} Many patients with HF or AMI are anxious but do not meet diagnostic criteria for an anxiety disorder.²³ Nonetheless, research to date strongly suggests that anxiety reactions along this continuum have comparable cognitive, neurobiological, and behavioral components,²⁴ and that clinical anxiety and subsyndromal⁷ anxiety are not fundamentally different phenomena.²⁵

Importantly, anxiety is associated with adverse outcomes such as poor functional status, recurrent ischemia, reinfarction, dysrhythmias, and increased mortality for patients with cardiovascular disorders.^{3,9,26-28} Yet, clinicians and researchers alike have virtually ignored the impact of this risk factor,^{23,29-31} as evidenced by their failure to routinely assess for anxiety.^{32,33} Among the minority of clinicians who do assess anxiety, no standardized approach to the measurement of anxiety is evident. Similarly, it is difficult to compare findings across studies because researchers use dissimilar instruments to measure anxiety. Consequently, anxiety is poorly understood for patients with HF or AMI.

It is necessary to implement interventions to reduce high levels of patient anxiety and thwart its detrimental consequences. There is, however, no agreement about how best to treat anxious patients, and clinicians are frustrated by the lack of interventions for anxiety in patients with HF or AMI. It is essential that researchers further characterize anxiety for patients with HF or AMI so that effective interventions can be designed and applied.

In chapter two of this dissertation, the results of cross-cultural comparisons of anxiety among patients with AMI are presented. Anxiety is a universal phenomenon; nevertheless, culture affects interactional processes that underlie emotions.³⁴ This study fulfilled a need to explore the effect of culture on anxiety, as findings may provide insight into the scope and nature of anxiety. In this study, patients with AMI from five countries were assessed for anxiety. Multifactorial analysis of covariance (ANCOVA) was used to evaluate whether there were differences in anxiety scores among the five countries while controlling for sociodemographic characteristics upon which the countries differed. Furthermore, multifactorial ANCOVA was used to determine whether sociodemographic and clinical characteristics interacted with country to produce a differential impact on anxiety.

In chapter three, a critical review and analysis regarding the measurement of anxiety illustrated the problems of inadequate conceptualization of anxiety and inconsistent measurement of anxiety in HF and AMI patients. Definitions of anxiety were reviewed and three anxiety assessment instruments, the State-Trait Anxiety Inventory, the Anxiety Subscale of the Brief Symptom Inventory (BSI), and the Hospital Anxiety and Depression Scale, were described in detail, compared, and contrasted. A

concluding focus was to summarize major findings from previous studies regarding anxiety for patients with HF or AMI.

In chapter four, the results of a study to determine whether heart rate and blood pressure were related to level of anxiety in patients with chronic advanced HF, patients with AMI, and healthy individuals are presented. Critical care nurses frequently use changes in heart rate and blood pressure as indicators of anxiety.^{35,36} However, this practice may be misguided as changes in physiologic signs are challenging to interpret in acutely ill patients because there are usually several plausible explanations for such changes.³⁷ In the current study, mean anxiety levels were calculated and reported for each group. Correlation coefficients were computed between the mean anxiety level of each group and heart rate, systolic blood pressure, and diastolic blood pressure. In addition, each of the three groups were subdivided into a "high anxiety group" and a "low anxiety group." Two-tailed t tests were used to evaluate whether the high and low anxiety groups manifested differences in mean heart rate, systolic blood pressure, and diastolic blood pressure.

In chapter five, results are presented from a study that was conducted to determine whether a single-item anxiety assessment instrument, the Anxiety Level Index (ALI), is a valid alternative to the State Anxiety Inventory (SAI) or the anxiety subscale of the BSI in assessing state anxiety for patients with AMI. Clinicians have not adopted an anxiety assessment instrument for widespread use, due in part to the unavailability of an easy-to-administer anxiety instrument that is not burdensome to either clinicians or critically ill patients. Others identified the need for a simple method of assessing anxiety in acutely ill patients^{38,39} and suggested that a single-item anxiety assessment instrument may be the

solution.³⁹ In this study, ALI scores were compared to SAI and BSI anxiety subscale scores using Spearman's rho test and the Bland-Altman method.

In chapter six, the results of a study to determine the best model of health status from among relevant sociodemographic, clinical, health perception, and emotional variables are presented. Anxiety may adversely affect all three facets of health status: health-related quality of life, functional status, and symptom burden. Previous data have shown little relationship between clinical variables and components of health status;^{40,41} therefore, this research was needed to evaluate the effects of health perception and emotional variables on health status. Hierarchical multiple regression analyses were conducted to determine the best predictors of health status. The sociodemographic and clinical variables were entered first in separate steps, followed by health perception and then emotional variables to determine their additive impact.

In chapter seven, neural control of heart rate and heart rate variability are described. Moreover, the work of previous investigators who examined heart rate variability for patients with HF is summarized and analyzed. Although the mechanisms whereby anxiety is associated with cardiac outcomes are not entirely clear,⁴² evidence suggests that a physiologic pathway links anxiety with adverse outcomes. Proposed models of the relationship between psychological influences and heart disease generally emphasize the role of the autonomic nervous system.^{43,44} According to the pathophysiologic model,^{43,44} psychological factors stimulate sympathetic nervous system activity, thus releasing catecholamines that, in time, produce harmful consequences. Heart rate variability analysis is one approach that has been used to detect, quantify, and trend changes in autonomic activity for patients with HF.

In chapter eight, summary and concluding remarks based on all chapters are presented. Recommendations for practice and future research are outlined.

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CHAPTER TWO

A Five-Country Comparison of Anxiety Early after Acute Myocardial Infarction

Synopsis

Objectives: The purposes of this study were to evaluate whether anxiety after acute myocardial infarction (AMI) differs across five diverse countries, and to determine whether an interaction between country, and sociodemographic and clinical variables contributes to variations in reporting anxiety.

Background: Anxiety is common after AMI and has the potential to negatively affect physical and psychosocial recovery. There have been no cross-cultural comparisons of anxiety among AMI patients.

Methods and Results: A total of 912 individuals with confirmed AMI were enrolled in this prospective, comparative, cross-cultural study. Anxiety was assessed within 72 hours of hospital admission using the Brief Symptom Inventory. The mean level of anxiety in the entire sample was 0.62 ± 0.76 , which is 77% higher than the normal mean level. Anxiety levels were not significantly different among the countries, with the exception that patients in England reported lower levels of anxiety than those in the U.S. ($P = .03$). However, this difference disappeared after controlling for sociodemographic variables on which the countries differed.

Conclusions: Patients from each country studied experienced high anxiety after AMI. Even though various cultures were represented in this study, culture itself did not account for variations in anxiety after AMI. It appears that anxiety after AMI is a universal phenomenon.

Key Words: Acute Myocardial Infarction, Anxiety, International

Introduction

Ischemic heart disease affects people worldwide without regard to geographic location, socioeconomic status, or gender. According to the World Health Organization, over 7.1 million people die from ischemic heart disease each year.¹ Although it is well established that ischemic heart disease is the leading cause of mortality in Western countries, there has been an alarming increase in deaths from ischemic heart disease in developing countries. Therefore, experts predict that by the year 2020, over 11.8 million persons will die of ischemic heart disease annually,² which will make it the leading cause of death worldwide.³

Numerous investigators have studied the physiologic and emotional responses of patients from Western countries following acute myocardial infarction (AMI).⁴⁻⁸ One such emotional response is anxiety, which has been defined as a "psychophysiological phenomenon experienced as a foreboding dread or threat to a human organism whether the threat is generated by internal, real or imagined dangers."^{9, p. 1} Investigators from North America reported that 10% to 26% of patients with AMI had higher levels of anxiety than patients with a psychiatric disorder.^{6,10} However, the prevalence of anxiety after AMI has not been studied extensively among international populations. In addition, to our knowledge, no investigators have evaluated whether the psychosocial or physiologic factors that are related to anxiety interact with the unique culture within each country to produce a differential impact on anxiety.

Understanding anxiety from an international perspective is important because anxiety poses a significant risk to patients after AMI. This risk may result from activation of the sympathetic nervous system and hypothalamic-pituitary-adrenal axis.¹¹

Anxiety after AMI is associated with increased in-hospital complications such as lethal dysrhythmias, continued ischemia, and reinfarction.⁶ Furthermore, anxiety has been shown to predict future coronary events and mortality survival after AMI.^{5,7,8} However, individuals from different ethnic and cultural backgrounds may vary in their biological response to anxiety.¹²

People from all cultures and countries experience anxiety.¹³ Moreover, culture influences the perception of a stress-producing situation, symptoms of stress, and the expression of emotions.¹⁴ Accordingly, the purposes of this study were to evaluate whether anxiety after AMI differed across five countries and to determine whether an interaction between country, and sociodemographic and clinical variables contributed to variations in the expression of anxiety. We previously reported that women had higher levels of anxiety than men in an international sample of AMI patients.¹⁵ In addition, we noted that there were no differences in anxiety level across countries.¹⁵ We conducted this secondary analysis to further explore the effect of culture on anxiety.

Methods

Design

This prospective, comparative, cross-cultural study was a substudy of a large international investigation of anxiety early after AMI.¹⁵ In the current study we compared anxiety levels of participants with a diagnosis of AMI in five countries. The participants' state anxiety was assessed within the first 72 hours of hospital admission.

Sample and Settings

Participants were recruited from community hospitals and academic medical centers from five countries – Australia, England, Japan, South Korea, and the United States (U.S.). Eligibility criteria for participation in this study included: 1) AMI documented by elevated cardiac isoenzymes and typical ECG changes; 2) onset of AMI outside of the hospital or other institutional setting, such as an extended care facility; 3) hemodynamic stability and absence of pain at the time of interview; and 4) intact cognitive function that allowed the participant to answer questions concerning their emotional status. Participants with life-threatening or currently debilitating co-morbidities were excluded from the study. These criteria were selected in order to minimize psychological and hemodynamic factors, other than the AMI experience, that affect anxiety.

Measurement

Sociodemographic and clinical characteristics. Research assistants interviewed participants and evaluated their medical records to obtain the following sociodemographic and clinical data: age, education, gender, marital status, Killip classification, systolic and diastolic blood pressure on admission, pulse on admission, participant estimate of greatest intensity of chest pain prior to admission on a scale of 0 to 10 (0 = none; 10 = worst pain ever felt), medications used during hospitalization; and history of hypertension, diabetes, myocardial infarction, smoking, coronary artery bypass grafting, and percutaneous coronary intervention.

Anxiety. We used the Anxiety Subscale of the Brief Symptom Inventory to measure patients' perception of their current level of anxiety. Although concise, the 6-

item subscale is a sensitive, reliable, and valid measure of state anxiety in acutely ill persons.¹⁶ The Anxiety Subscale of the Brief Symptom Inventory was selected because it minimizes participant burden, is reliable and valid, was conceptually relatively easy to translate from English to Korean and Japanese, and does not include physical indicators of anxiety. This instrument has been used successfully in a number of studies of anxiety among cardiac patients.^{6,15} Using a scale of 0 to 4 (0 = “not at all” and 4 = “extremely”), participants rate their level of emotional distress related to six symptoms of anxiety such as restlessness, nervousness, and tension. The values for the six items are averaged, with the averaged score representing the participant’s overall level of state anxiety. Thus, mean scores can range from 0 to 4. High standard deviations are common and reflect variability in the samples studied.¹⁶

Native speaking researchers translated the Sociodemographic and Clinical Data Form and the Anxiety Subscale of the Brief Symptom Inventory from English into Korean and Japanese to ensure linguistic and cultural equivalence. A second native speaking researcher translated the instruments back into English to ensure that the translation process did not distort the meaning of the instruments. There was 100% agreement on the items.

Research conducted during instrument development supported the construct, convergent, and discriminant validity of the Anxiety Subscale of the Brief Symptom Inventory.¹⁶ In previous research with cardiac patients, internal consistency as reflected by Cronbach’s alpha ranged from 0.85-.87.^{6,17} In the current study, reliability of the Anxiety Subscale was tested using Cronbach’s alpha and was 0.88 for the Australian

participants, 0.90 for participants from England, 0.87 for the Japanese participants, 0.90 for the South Korean participants, and 0.85 for the U.S. participants.

Procedures

The Institutional Review Board or its equivalent at each site granted permission to conduct this study, and this investigation conformed with the principles outlined in the Declaration of Helsinki. All participants gave written informed consent after trained research assistants from each country explained the study to them. The research assistants were experienced cardiovascular nurses who collected data from each participant within 72 hours (mean 53 ± 38 hours) of admission to the hospital. During the interview, participants completed the Sociodemographic and Clinical Data Form and the Anxiety Subscale of the Brief Symptom Inventory. Some participants completed the instruments independently; however, most requested that the research assistants read the information to them. In addition, clinical data were abstracted from each participant's medical record.

Statistical Analyses

All data were entered into a personal computer and analyzed using SPSS software, version 11.5. Data are presented as frequencies and means $\pm$ standard deviations. To compare baseline differences in sociodemographic and clinical characteristics among countries, one-way analysis of variance (ANOVA) or chi-square were used, as appropriate to the level of measurement. Multifactorial analysis of covariance (ANCOVA) was used to evaluate whether there were differences in mean anxiety scores among the five countries while correcting for sociodemographic characteristics upon which the countries differed. Furthermore, multifactorial ANCOVA

was used to evaluate whether sociodemographic and clinical characteristics interacted with country to produce a differential impact on anxiety. A P-value of $< .05$ was considered statistically significant.

Results

Characteristics of Sample

A total of 912 patients with AMI participated in this study; 127 from Australia, 144 from England, 136 from Japan, 128 from South Korea, and 377 from the U.S. Sociodemographic characteristics of the sample, by country, are presented in Table 2.1. Patients' mean age at presentation with AMI in this study was similar among the countries, with the exception that patients from South Korea were younger ($P < .02$). Patients from England and South Korea reported fewer years of education than patients from the remaining countries ($P < .004$). Substantially more patients in Japan and South Korea were married than patients from other countries ($P < .001$). Comparison of clinical characteristics among countries is reported in Table 2.2.

Anxiety Levels Among the Countries

The mean level of anxiety in the entire sample was 0.62 ± 0.76 (range 0-3.83), which is 77% higher than the normal mean level of 0.35 reported in a sample of healthy adults.¹⁶ Levels in each country are illustrated in Figure 2.1. The mean levels of anxiety in each country were as follows: 0.54 in Australia (this anxiety level is 54% higher than normal); 0.47 in England (34% higher than normal); 0.66 in Japan (89% higher than normal); 0.64 in South Korea (83% higher than normal); and 0.69 in the U.S. (97% higher than normal).

In all countries, patients reported high anxiety levels. A total of 46%, 35%, 43%, 52%, and 50% of patients in Australia, England, Japan, South Korea and the U.S., respectively, reported anxiety levels higher than the norm reference mean. A total of 7%, 7%, 15%, 5%, and 10% of patients in Australia, England, Japan, South Korea and the U.S., respectively, reported anxiety levels higher than the mean of 1.7 reported for psychiatric in-patients.¹⁶

Although there was a significant difference in anxiety level among the countries ($P = .03$) on the overall ANOVA, post hoc testing to discover where the countries differed, using the Bonferroni test, revealed that only England and the U.S. ($P = .03$) differed. Patients in England reported lower levels of anxiety than patients in the U.S. This difference in anxiety level disappeared after correction for sociodemographic variables on which the countries differed.

Interactions Between Country and Sociodemographic and Clinical Variables on Anxiety

The following sociodemographic and clinical characteristics were examined to determine if they interacted with country to influence anxiety: age, gender, marital status, education level, medical history, Killip classification on admission, use of various therapies in the emergency department, and pain level. None of these variables interacted with country to affect anxiety. There was a main effect seen for sex and age, as we have previously reported.¹⁵ Women and younger patients in each country reported higher levels of anxiety than men and patients older than 60 years.

Discussion

The principal findings from this study were that anxiety level early after AMI was high among patients from five diverse countries on four continents and did not differ substantially by country. Although patients from England reported anxiety levels lower than those from the U.S., there were no differences among any of the other countries, and the difference between English and American patients disappeared after correction for sociodemographic variables on which the countries differed.

To our knowledge, this is the first cross-cultural comparison of anxiety levels in AMI patients early after the acute event. These findings demonstrate that, despite the potential influence of culture on emotion,^{14,18,19} patients suffering AMI display a similar emotional response to this potentially life-threatening event. If culture influences the experience, expression, and communication of emotion,²⁰ why did we fail to find a difference in the expression of anxiety among patients from these five culturally diverse countries? Anxiety is thought to be a universal emotion found in all societies, but the expression and communication of anxiety are believed to be culturally different. However, Mesquita and Frijda, in a comprehensive review of cultural variation in emotions,²¹ argue that there are few data from which one can conclusively argue that there are cultural variations in emotion. Depending on the theoretical framework from which one's view arises, there are data to support the notion that emotions are universal and data to support the notion that emotions are social constructs.²¹ They further note that most of the research on cross-cultural comparisons of emotions considered only abstract representations of emotions and not concrete representations, such as the specific

threat of physical illness. Thus, the expectation that there are cultural differences in the expression of anxiety may be unfounded.

Little cross-cultural research has been conducted to examine the emotions of patients after AMI. Scherer reported that among European, Japanese, and American university students, Japanese students were less fearful and more reserved about expressing their fear and exhibited a diminished physiological response to fear.²² In contrast, others found that Chinese men who underwent cardiac catheterization and Taiwanese patients with AMI reported similar levels of anxiety as American patients.^{19,23} In an epidemiologic review, Lepine pointed out that anxiety disorders are found in all countries that were studied.¹³ In addition, somatization of anxiety appears to be a common reaction across a variety of cultures.¹⁴ Anticipation of physical danger has been reported as a precursor of anxiety in both non-Western and Western cultures.²¹ Therefore, our finding that patients with AMI from five diverse countries expressed similar levels of anxiety suggests that the threatening nature of AMI produces anxiety regardless of the patient's culture.

The high anxiety level seen among patients in all countries is of concern for a number of reasons. The level of anxiety seen, even in patients from the country with the lowest mean anxiety level, is substantially higher than that seen in healthy individuals.¹⁶ For both humanistic and clinical reasons, it is essential to address this level of anxiety. Anxiety in cardiac patients is associated independently with higher short- and long-term morbidity and mortality.^{5,6} Patients with higher anxiety early after AMI have a longer stay in the cardiac care unit and hospital,^{24,25} report sustained anxiety and long-term distress,²⁶ suffer more symptoms irrespective of the severity of their physical condition,²⁶

consume more health care resources,²⁶ and report a lower quality of life²⁵⁻²⁷ than patients with lower anxiety.

We investigated the possibility that a number of clinical or sociodemographic factors that might affect anxiety level would interact with country to affect anxiety level. None of the multiple factors examined produced a differential effect on anxiety. This finding suggests that, among AMI patients, anxiety is common regardless of clinical presentation, presence of co-morbidities, or severity of AMI, and that it cannot be predicted by typical sociodemographic or clinical characteristics. Further research is warranted to determine factors that may moderate anxiety, in order to better understand the phenomenon among AMI patients and develop effective interventions.

In summary, patients from each country studied experienced high anxiety after AMI. Even though various cultures were represented in this study, culture itself did not account for variations in anxiety after AMI. It appears that anxiety after AMI is a universal phenomenon. Given the potentially negative impact of anxiety on mortality and quality of life after AMI, clinicians and researchers should continue to explore interventions to treat anxiety and minimize its untoward effects.

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Table 2.1: Sample Sociodemographic Characteristics

Characteristic	Entire Sample	Australia	England	Japan	South Korea	United States
	$N = 912$	$n = 127$	$n = 144$	$n = 136$	$n = 128$	$n = 377$
Age; mean $\pm$ SD, years*	61 ± 13	62 ± 13	61 ± 13	61 ± 11	57 ± 11	62 ± 14
Education; mean $\pm$ SD, years [†]	12 ± 4	13 ± 4	10 ± 4	13 ± 3	11 ± 5	13 ± 3
Male; n (%) [‡]	658 (72.1)	101 (79.5)	111 (77.1)	109 (80.1)	99 (77.3)	238 (63.1)
Marital status; n (%)						
Married [§]	684 (75)	87 (68.5)	108 (75)	117 (86)	117 (91.4)	255 (67.6)
Single/divorced/widowed	220 (24.1)	40 (31.5)	33 (22.9)	19 (14)	10 (7.8)	118 (31.3)

* $P = .02$, South Korea less than every other country

[†] $P = .004$, England and South Korea less than every other country

[‡] $P = .001$, United States less than every other country

[§] $P = .001$, Japan and South Korea greater than every other country

Table 2.2: Patient Clinical Characteristics

Characteristic	Entire Sample	Australia	England	Japan	South Korea	United States
	<u>N</u> = 912	<u>n</u> = 127	<u>n</u> = 144	<u>n</u> = 136	<u>n</u> = 128	<u>n</u> = 377
	N (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Current smoker [*]	419 (45.9)	39 (30.7)	64 (44.4)	93 (68.4)	87 (68.0)	136 (36.1)
Hypertension [#]	482 (52.9)	48 (37.8)	59 (41.0)	74 (54.4)	62 (48.4)	239 (63.4)
Diabetes mellitus [§]	225 (24.7)	12 (9.4)	37 (25.7)	47 (34.6)	31 (24.2)	98 (26.0)
Previous AMI [#]	192 (21.1)	17 (13.4)	29 (20.1)	21 (15.4)	10 (7.8)	115 (30.5)
Killip class						
I [†]	604 (66.2)	99 (78.0)	104 (72.2)	116 (85.3)	78 (60.9)	207 (54.9)
II	229 (25.1)	21 (16.5)	29 (20.1)	13 (9.6)	37 (28.9)	129 (34.2)
III-IV	72 (7.9)	7 (5.5)	10 (6.9)	6 (4.4)	13 (10.2)	36 (9.5)
Treatment in ED						
Fibrinolytic [†]	310 (34.0)	34 (26.8)	99 (68.8)	20 (14.7)	36 (28.1)	121 (32.1)
Beta blocker ^{**}	320 (35.1)	28 (22.0)	72 (50.0)	11 (8.1)	10 (7.8)	199 (52.8)
Aspirin ^{##}	715 (78.4)	103 (81.1)	138 (95.8)	71 (52.2)	103 (80.5)	300 (79.6)
Anxiolytic [#]	270 (29.6)	30 (23.6)	43 (29.9)	28 (20.6)	33 (25.8)	136 (36.1)

AMI = acute myocardial infarction; ED = emergency department

Table 2.2 (Continued)

- * $P = .001$, Japan and South Korea greater than every other country
- # $P = .001$, US greater than every other country
- § $P = .001$, Australia less than every other country
- † $P = .001$, Japan greater than every other country
- ‡ $P = .001$, England greater than every other country
- ** $P = .001$, US and England greater than Australia; Australia greater than Japan and South Korea
- ## $P = .001$, England greater than US; Australia and South Korea greater than Japan

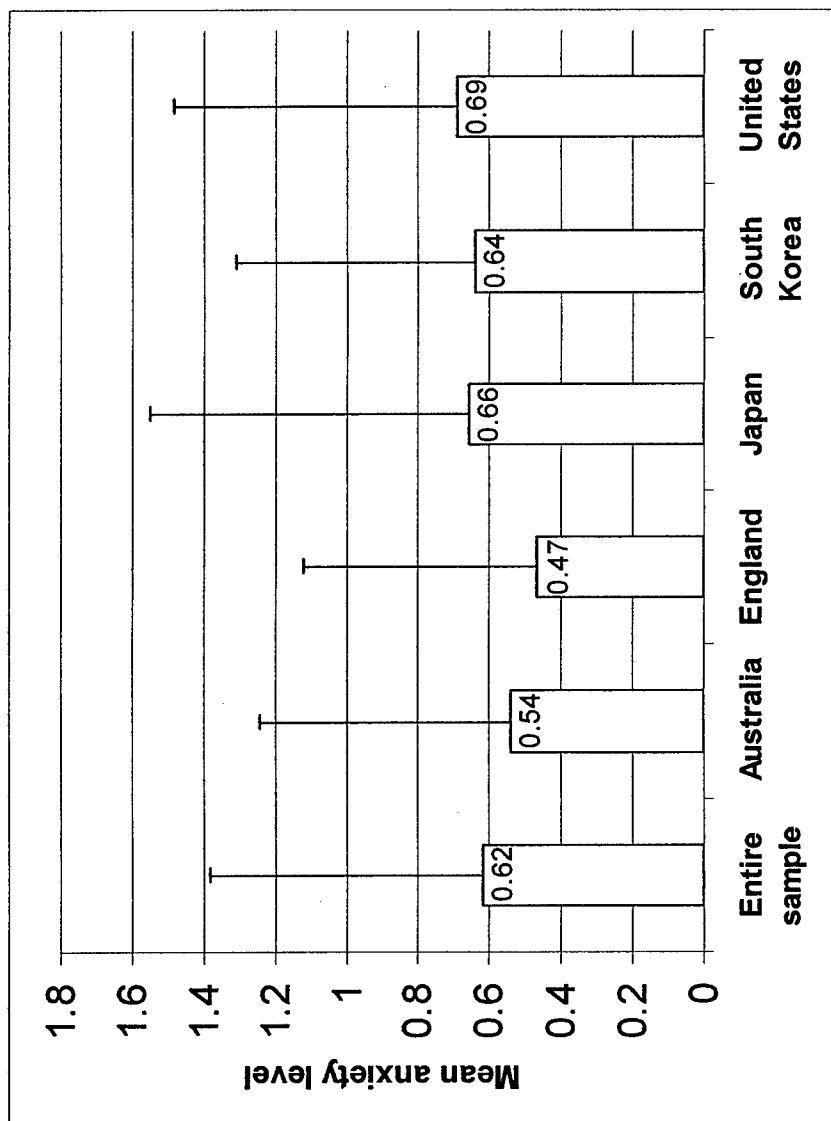


Figure 2.1: Mean Anxiety Level Among Countries

Overall F test, $P = .03$; post hoc Bonferroni tests revealed mean anxiety levels were significantly different between England and United States ($P = .03$)

CHAPTER THREE

Measurement of Anxiety for Patients with Cardiac Disease: A Critical

Review and Analysis

Synopsis

Objective: The purpose of this paper was to critically review and analyze the measurement of anxiety for patients with cardiac disease.

Background: Anxiety is a universal and distressing emotion that is prevalent among patients with cardiac disease. Accumulating evidence suggests that anxiety contributes to risk of rehospitalization, myocardial ischemia, reinfarction, dysrhythmias, quality of life, and mortality for these patients. Careful assessment and measurement of anxiety are needed to first determine whether interventions are indicated to treat anxiety and then to evaluate the effect of interventions.

Methods and Results: This was a critical review and analysis of literature regarding measurement of anxiety. Anxiety was defined in numerous ways; there was no consensus in the literature about the conceptual definition of anxiety. In many studies, clinicians and researchers neither defined nor described anxiety, making it difficult to determine whether the anxiety instrument that they administered satisfactorily measured their conceptualization of anxiety. No one instrument was used consistently; however, clinicians and researchers often used the State-Trait Anxiety Inventory, the anxiety subscale of the Brief Symptom Inventory, and the anxiety subscale of the Hospital Anxiety and Depression Scale to measure anxiety in patients with cardiac disease. These three instruments differ in scope, length, and availability of normative data; nonetheless, a consistent finding was that patients with cardiac disease experienced high levels of

anxiety. Although the instruments possess several strengths, more study is needed to further advance the measurement of anxiety.

Conclusions: The prevalence of anxiety is high in patients with cardiac disease.

Clinicians and researchers need to work together to develop a common conceptualization of anxiety and then repeatedly measure anxiety in the same manner. The resultant data will facilitate comparison of findings across studies, provide indications for empirically-based interventions to treat anxiety, and promote evaluation of treatment modalities.

Key Words: Anxiety, Assessment, Measurement, Cardiac Disease

Introduction

Although it is well-known that patients with cardiac disease experience psychological impairments, historically, clinicians have used physiologic measures such as ejection fraction, myocardial infarction size, blood pressure, and end-diastolic volume as prognostic indicators. More recently, cardiology experts have expanded their focus to consider how psychological status may contribute to poor outcomes. Specifically, a growing body of research literature contains reports about the relationship between anxiety and risk of rehospitalization, myocardial ischemia, reinfarction, dysrhythmias, quality of life, and mortality for patients with cardiac disease.¹⁻⁶

Despite recent increased interest in anxiety, it remains a somewhat nebulous phenomenon due, in part, to the term's common and imprecise use among the general public, professionals, and researchers.⁷ Even clinicians and researchers often fail to conceptually define anxiety, and some use the terms anxiety, mental stress, and depression interchangeably. Furthermore, the term anxiety is used to describe not only a normal transient emotion,^{8,9} but also psychiatric conditions such as generalized anxiety disorder, panic disorder, posttraumatic stress disorder, and obsessive-compulsive disorder.¹⁰ Although anxiety has been defined in numerous ways (Table 3.1), common to many definitions is the conceptualization of anxiety as an emotional response to a perceived threat.⁸⁻¹³

The purpose of this paper is to present a critical review and analysis regarding measurement of anxiety for patients with cardiac disease. The focus, however, is neither the underlying presence nor diagnosis of anxiety *disorders*, but rather measurement of acute anxiety.

Overview of Anxiety Measurement

The value of anxiety data depend on their careful measurement. Clinicians and researchers who conduct studies regarding the effects of anxiety for patients with cardiac disease usually assess anxiety using self-report anxiety instruments. Although clinician-rated instruments and/or direct observation may also be used to assess anxiety, the focus of this paper concerns self-report anxiety instruments.

Using paper-and-pencil or computerized self-report instruments, patients or research participants answer questions about their behaviors, thoughts, and emotions. Self-report data also may be obtained during a structured interview. In either case, self-report measures are dependent on the respondent's awareness of his or her emotions.¹⁴

The self-report method confers several advantages. The self-report approach has been used to study many facets of emotions and may be the only way to obtain information about subjective aspects of anxiety.¹⁵ "This approach is particularly important when dealing with inner reactions, such as emotions, for which the subject has to be the final authority."^{16, p. 277} Persons without formal psychiatric training can administer and score self-report instruments, saving time and money.¹⁷ Self-report results are amenable to analysis and interpretation using common statistical procedures.¹⁸ Finally, use of self-report instruments allows clinicians and researchers to evaluate whether interventions improve emotional health.¹⁹

Disadvantages of the self-report method are that respondents may misunderstand statements or questions and thus provide inappropriate answers. Others may either refuse to answer or answer in ways that they deem either socially desirable or acceptable to

clinicians and researchers. Finally, some individuals may lack the physical or mental capacity to complete self-report instruments.

Description of Three Existing Self-Report Measures of Anxiety

There are over 200 instruments that measure anxiety. Of these, many instruments are not relevant to patients with cardiac disease. Formal psychiatric training is a prerequisite to use of the many instruments used to diagnose specific anxiety disorders such as panic or posttraumatic stress disorders. Other instruments are used to assess anxiety of persons with a specific diagnosis, like Acquired Immune Deficiency Syndrome. In addition, some instruments pertain only to children or are used to assess performance anxiety of students, athletes, and other healthy persons.

Three self-report instruments that non-psychiatric clinicians can use to assess for anxiety include the State-Trait Anxiety Inventory (STAI), the anxiety subscale of the Brief Symptom Inventory™ (BSI), and the anxiety subscale of Hospital Anxiety and Depression Scale (HADS). These three instruments are described below and compared in Table 3.2. The STAI is included because investigators use the STAI the most often to assess cardiac patients for anxiety. Furthermore, its distinction between state and trait anxiety may be relevant to acutely ill cardiac patients. The anxiety subscale of the BSI is addressed because it is a short instrument with substantial evidence of validity and reliability that has been used successfully with cardiac patients. Finally, the anxiety subscale of the HADS is included because it was specifically developed for medical and surgical outpatients without a psychiatric disorder. Patients with cardiac disease

commonly receive treatment in outpatient settings and often do not meet criteria for a formally diagnosed anxiety disorder.

State-Trait Anxiety Inventory

The STAI is a unidimensional, self-report instrument that was designed to provide reliable, relatively brief, and homogeneous measures of both state and trait anxiety.²⁰ As shown in Table 3.2, the STAI consists of two distinct 20-item subscales. The state subscale reflects how the individual feels at the present time. In contrast, the trait subscale reflects how the individual generally feels.

The STAI is the instrument used the most often to assess anxiety²¹ and has been translated into 58 languages and dialects. Clinicians and researchers from nursing, medicine, dentistry, psychology, and other social sciences have used the STAI.

When constructing the STAI, Spielberger and colleagues²² used several methods to validate it. To identify potential items for their instrument, these authors initially administered three widely-used anxiety instruments to psychology students. Based on correlation analysis, 177 items from the three instruments were retained and rewritten, creating one scale that, depending on how it was administered, measured either state or trait anxiety.²² However, validity analysis revealed problems with this approach, leading the authors to devise separate state and trait anxiety scales. Next, the developers modified the items, making distinctions between state and trait anxiety. To evaluate face validity, psychology majors examined the modified items for clarity and ability to measure state and trait anxiety. The authors continued to test their instrument with college students and made revisions based on concurrent validity analyses.

Form X of the STAI was published in 1970. For college students, the trait scale was highly correlated with three existing anxiety instruments, a finding that lent support to its convergent validity.²² Results of known-groups construct validation were also favorable. For example, the STAI discriminated between trait anxiety levels of neuropsychiatric patients and healthy individuals. Likewise, college students reported higher state anxiety during an examination than during a regular class period.

In 1979, Spielberger and colleagues began revising Form X to meet three goals: 1) develop an anxiety measure that would distinguish between anxiety and depression, 2) replace items that possessed weak psychometric properties, and 3) improve the factor structure of the trait scale.²² Spielberger and associates published Form Y in 1983. Correlations between Form X, the original STAI, and Form Y, the revised STAI, ranged from .96 to .98. The main advantage of form Y is its "purer" measure of anxiety and its better differentiation between anxiety and depression.²² Factor analysis of the revised STAI supported its two dimensions, namely state and trait anxiety.

The STAI is a reliable measure of anxiety. Thirty-day test-retest reliability coefficients of trait anxiety for male and female high school students were .71 and .75, respectively.²² Sixty-day test-retest reliabilities were slightly lower; .68 for males and .65 for females. Considering the transient nature of state anxiety, test-retest reliability analysis is not appropriate.

Evidence supports the internal consistency reliability for both state and trait anxiety. For working adults, Cronbach's alpha coefficients for the state anxiety and trait anxiety subscales were .93 and .91, respectively.²² Investigators often use the STAI to

measure anxiety in patients with cardiac disease and have reported Cronbach's α coefficients ranging from .93 to .94.²³⁻²⁷

Anxiety Subscale of the Brief Symptom Inventory

The BSI was developed from its longer parent instrument, the SCL-90-R[®], in response to the need for a shorter, less time-consuming instrument.¹⁷ The SCL-90-R[®] is a 90-item self-report symptom inventory with nine symptom dimensions. For each dimension of the SCL-90-R[®], Derogatis¹⁷ selected the items with the highest loadings and used these items to create the BSI. Composed of 53 items that encompass nine primary symptom dimensions, the BSI was designed to assess psychological symptoms not only for psychiatric and medical patients, but also for other persons.¹⁸ When completing the BSI, individuals are to base their answers on how each problem has affected them during the past 7 days.¹⁷

The BSI has been used with a variety of populations, in both clinical and research situations. The BSI has been translated into at least 26 languages.

The 6-item subscale for the anxiety dimension includes general symptoms that are commonly associated with high anxiety levels. Physiologic indices, such as heart rate and diaphoresis, are not included in this subscale.

Evidence supporting the validity of each subscale of the BSI has been reported.¹⁷ Strong evidence of convergent validity was found when comparing the results of the BSI with scores from the clinical and content scales of the Minnesota Multiphasic Personality Inventory.¹⁸ Likewise, the correlation between the anxiety subscales of the BSI and the SCL-90-R[®] was .95. The results of factor analysis further contributed to the construct

validity of the BSI. Lastly, the BSI has been shown to have predictive validity for persons with cancer, chronic pain, psychopathology, and other illnesses.

Formal analyses have supported the reliability of the anxiety subscale of the BSI. Derogatis reported an internal consistency α coefficient of .81 for psychiatric outpatients.¹⁷ Similarly, the two-week test-retest coefficient was .79 for nonpatients.¹⁷ Investigators have reported Cronbach's α ranging from .85 to .90 when studying patients with cardiac disease.^{4,26,28}

Anxiety Subscale of Hospital Anxiety and Depression Scale

The HADS was created to detect anxiety and depression for general medical and surgical outpatients because non-psychiatric hospital departments needed a shorter instrument concerning the nature of psychiatric disorders.²⁹ The HADS consists of a 7-item anxiety subscale and a 7-item depression subscale. The anxiety subscale items were derived from the Present State Examination and the authors' previous research. Its authors purposefully avoided emphasizing somatic symptoms so that general anxiety and depression could be assessed independently of physiologic symptoms.²⁹ Respondents select answers based on their feelings during the past week.

Although the HADS was developed for general outpatient departments, it has been used in a variety of inpatient, primary care, community, and research settings. The HADS has been translated into over 20 languages.

Limited validity and reliability data were available when the HADS was first introduced. Initially, positive and significant correlations ($r = .54$) between self-report data and formal psychiatric interview data supported construct validity of the HADS.²⁹ There was also a significant positive relationship ($r = .74$) between anxiety severity and

psychiatric ratings of anxiety. During instrument development, reliability testing with 100 outpatients supported the internal consistency of the HADS.²⁹ Furthermore, the authors identified cut-off scores that were designed to distinguish between cases, doubtful cases, and non-cases (see Table 3.2). These cut-off scores were applied to data from 50 patients and demonstrated sensitivity and specificity for detecting psychiatric cases.

More recently, investigators have reexamined the validity and reliability of the HADS. In a review paper, Herrmann³⁰ reported Cronbach's α of .80 to .93 and retest reliabilities ranging from .70 to .84 for the anxiety subscale. Others administered the HADS to healthy and ill men and women of wide-ranging ages, reporting Cronbach's α ranging from .77 to .89.³¹⁻³³

Regarding validity, the HADS usually has acceptable sensitivity and specificity in finding cases of anxiety.^{30,34} Convergent validity is supported by medium to strong correlations with existing anxiety instruments such as the STAI.³⁴

Newer evidence regarding factorial validity of the HADS is less convincing. Although some investigators^{31,35,36} have found evidence supporting the HADS' bifactorial structure of anxiety and depression, results from seven of 19 studies indicated that the HADS has either a three- or four-factor structure.³⁴ Data from at least three additional studies also have provided evidence for a three-factor HADS structure.^{32,37,38} Using confirmatory factor analyses, Johnston and colleagues found that the HADS failed to consistently distinguish between anxiety and depression for patients with AMI and stroke.³³

Comparison of the Strengths and Weaknesses of Three Existing Self-Report

Measures of Anxiety

The STAI, the anxiety subscale of the BSI, and the anxiety subscale of the HADS possess inherent strengths and weaknesses. The STAI measures anxiety from a unidimensional perspective. In contrast, the anxiety subscales of the BSI and the HADS measure additional emotions such as depression and hostility. Therefore, when clinicians and researchers are interested in exclusively measuring anxiety, they must take care to administer only anxiety items from a multidimensional instrument.

As previously described, there is solid evidence supporting the reliability of the STAI, the anxiety subscale of the BSI, and the anxiety subscale of the HADS. However, factorial validity of the HADS is more questionable as compared to the STAI and the anxiety subscale of the BSI.

The STAI, the anxiety subscale of the BSI, and the anxiety subscale of the HADS have been used with numerous populations, including patients with cardiac disease (see Table 3.3). For international studies, the STAI is valuable because it has been translated into more languages. Nonetheless, the anxiety subscales of the BSI and the HADS are available in numerous languages.

Ideally, clinicians will deliver therapeutic interventions to cardiac patients who are anxious. In these cases, anxiety instruments must be able to measure fluctuations in anxiety intensity over time. The STAI, the anxiety subscale of the BSI, and the anxiety subscale of the HADS have been successfully used to evaluate the effects of an intervention.^{17,22,30,37}

Clinicians and researchers rely on normative data to help interpret findings from an anxiety instrument. Normative data are available for the STAI and the anxiety subscale of the BSI but not for the anxiety subscale of the HADS. Although cut-off scores are available for the HADS, its focus is to define cases.

A major weakness of the STAI is its length. Acutely ill and older persons are easily burdened by long instruments and thus may provide incomplete or inaccurate data. Furthermore, clinicians often lack the time needed to administer or score the STAI. From patient and clinician perspectives, the anxiety subscales of the BSI and the HADS are easy to administer and more time-efficient.

Summary of Measurement of Anxiety

In summary, anxiety is a complex human emotion. There are over 200 instruments that measure the various types and attributes of anxiety. For that reason, it is especially important for clinicians and researchers to understand the empirical evidence regarding these instruments.

An unresolved matter regarding anxiety measurement is the lack of consensus among clinicians and researchers regarding the vague phenomenon termed anxiety. Many researchers omit their conceptual definition of anxiety in research reports (see Table 3.3). Consequently, it is difficult to assess whether the anxiety instrument that they administered can satisfactorily measure their conceptualization of anxiety. For example, Luskin and colleagues³⁹ used the STAI to assess whether stress management training reduced anxiety for patients with heart failure. One would expect interventions to have

the greatest impact on state anxiety; however, these investigators reported a single state-trait anxiety score.

The measurement of anxiety has been problematic in other ways. First, one surmises that investigators are more interested in state anxiety than trait anxiety for patients with cardiac disease. Yet, various instruments are used to measure anxiety, some of which were not created to measure state anxiety. For example, researchers who use the Profile of Mood States or the anxiety subscale of either the BSI or the HADS sometimes modify the instructions, directing participants to report current feelings rather than feelings during the past week. It is not known whether these altered directions adversely affect the psychometric properties of these instruments. Second, as shown in Table 3.3, the majority of investigators did not report Cronbach's α coefficients, making it difficult to evaluate the internal consistency of the anxiety instrument for a specific sample. Finally, as previously alluded to, it is difficult to compare anxiety data for patients with cardiac disease because researchers have not consistently used the same anxiety instruments.

Although evidence suggests that the STAI, the anxiety subscales of the BSI, and the HADS all have acceptable reliability and validity when used with cardiac patients, future decisions regarding the best instrument for clinical and research use awaits results of direct comparison studies among these three instruments. Meanwhile, clinicians should consider using a shorter instrument, such as the anxiety subscale of the BSI, for acutely ill patients who are easily overburdened by longer instruments. When

caring for patients with physical symptoms of anxiety, clinicians are advised to avoid instruments that include physical indicators of anxiety, as this may artificially inflate anxiety scores.

Recommendations for New Directions in Measurement of Anxiety

Thousands of research studies pertain to anxiety; however, plenty of unanswered questions remain and thus provide the basis for new directions regarding anxiety measurement. Since the inception of these instruments, much has been learned about anxiety, including its unique attributes, assessment, treatment, and adverse effects. As a result, some have reported that the STAI and the anxiety subscale of the HADS measure concepts such as depression and psychomotor agitation.^{32,37,40} Further research is needed to reexamine the factor structures of the STAI and the anxiety subscale of the HADS.

Most anxiety instruments were constructed for use with adults, but not older persons; therefore, limited psychometric data are available for these individuals.⁴¹ Accordingly, it is important that research efforts result in normative data for older adults.

It is well-known that inpatients with cardiac disease are anxious. Yet, results of recent studies reveal that clinicians assess anxiety in an infrequent and inconsistent manner,^{24,25} partly because they believe that anxiety instruments are time-consuming,^{42,43} clinically irrelevant, and difficult to administer. In addition, rather than using an anxiety instrument, clinicians commonly diagnose anxiety using their clinical judgment.²⁵ These findings are alarming because investigators have not found a relationship between patient-generated and clinician-generated ratings of patient anxiety.^{24,25} Clinicians need

data about which anxiety instrument(s) is the most reliable and efficient for cardiac patients.

New research also is needed to ascertain how best to assess anxiety for cardiac patients who cannot complete self-report instruments. In recent studies, critical care nurses reported that they rely on changes in physiologic parameters, such as blood pressure and heart rate, to denote anxiety.^{44,45} Of concern, though, is that elevated heart rate and blood pressure do not accurately reflect anxiety in patients with cardiac disease.⁴⁶

Researchers commonly administer a battery of instruments to persons with cardiac disease. For example, respondents may complete instruments that are designed to measure anxiety, depression, quality of life, adherence, and activity status. Future study is needed to determine if the sequence of the questionnaires influences results.³³ Similarly, another issue that deserves more consideration is the frequency with which clinicians should measure anxiety for both inpatients and outpatients. It is possible that some patients may become frustrated with repeated anxiety assessments and thus not report worthy data. In contrast, sporadic assessments may not reveal the true nature of patients' anxiety, placing them at risk for complications. These timing data are critical so that the assessment of anxiety can be integrated into routine and recurring patient assessment processes.

Conclusion

In conclusion, patients with cardiac disease are often anxious. There is no consensus about the conceptual definition of anxiety; yet, many instruments have been

designed to measure anxiety. The STAI, the anxiety subscale of the BSI, and the anxiety subscale of the HADS have been used to assess anxiety for patients with cardiac disease. Although these instruments possess several strengths, more study is needed to further advance the measurement of anxiety.

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Table 3.1: Conceptual Definitions of Anxiety

Author	Date	Conceptual Definition of Anxiety
Goldstein ¹¹	1940	"...the phenomenon of anxiety belongs to the catastrophic condition. That is, anxiety corresponds on the subjective side to a condition in which the organism's existence is in danger. Anxiety is <i>the subjective experience of that danger to existence</i> ." ¹¹ , p. 91
Martin and Sroufe ⁴⁷	1970	"...a neurophysiological response that has especially strong manifestations in the hypothalamic-sympathetic-adrenal medullary system, and in the hypothalamic-pituitary-adrenal cortical system, and in the reticular systems. Pathological intensity and persistence of anxiety reflects chronic over-reaction in some aspect of these neurophysiological systems." ⁴⁷ , p. 216-217

Table 3.1 (Continued)

Author	Date	Conceptual Definition of Anxiety
Spielberger ^{20,48}	1966;	"State anxiety...refers to an empirical process or reaction which is taking place <i>now</i> at a given level of
	1972	intensity." ⁴⁸ , p. 16 "State anxiety...may be conceptualized as a transitory emotional state or condition of the human organism that varies in intensity and fluctuates over time. This condition is characterized by subjective, consciously perceived feelings of tension and apprehension, and activation of the autonomic nervous system." ²⁰ , p. 39 State anxiety is "the subjective feelings of tension, apprehension, nervousness, and worry that are experienced by an individual at a particular moment, and by heightened activity of the autonomic nervous system that accompanies these feelings." ⁴⁹ , p. 5
		"Trait anxiety...indicates a latent disposition for a reaction of a certain type to occur if it is triggered by appropriate (sufficiently stressful) stimuli." ⁴⁸ , p. 16 "Trait anxiety...refers to relatively stable individual differences in anxiety proneness, that is, to differences in the disposition to perceive a wide range of stimulus situations as dangerous or threatening, and in the tendency to respond to such threats with A-state reactions." ²⁰ , p. 39
McReynolds ⁵⁰	1976	Primary anxiety: "...anxiety that inevitably occurs under certain limited and prescribed conditions, simply because the organism is made that way..." ⁵⁰ , p. 38 Secondary anxiety: "...anxiety which arises through the adventitious association of previously neutral cues with states of primary anxiety." ⁵⁰ , p. 38

Table 3.1 (Continued)

Author	Date	Conceptual Definition of Anxiety
May ¹²	1977	"Anxiety is the apprehension cued off by a threat to some value that the individual holds essential to his existence as a personality."¹², p. 205 "Normal anxiety is that reaction which (1) is not disproportionate to the objective threat, (2) does not involve repression or other mechanisms of intrapsychic conflict,...(3) does not require neurotic defense mechanisms for its management. It (4) can be confronted constructively on the level of conscious awareness <i>or</i> can be relieved if the objective situation is altered."¹², p. 209 "Neurotic anxiety...is a reaction to threat which is (1) disproportionate to the objective danger, (2) involves repression (dissociation) and other forms of intrapsychic conflict, and...(3) is managed by means of various forms of retrenchment of activity and awareness, such as inhibitions, the development of symptoms, and the varied neurotic defense mechanisms."¹², p. 214
Sims and Snaith ⁹	1988	"Anxiety is the emotion of fearful apprehension. Cognitively, it is the emotion associated with the anticipation of an unpleasant event involving either severe discomfort, or loss, or both."⁹, p. 4
Diagnostic Manual of Mental Disorders (DSM-IV) ¹⁰	2000	"The apprehensive anticipation of future danger or misfortune accompanied by a feeling of dysphoria or somatic symptoms of tension."¹⁰, p. 820

Table 3.1 (Continued)

Author	Date	Conceptual Definition of Anxiety
Emilien, Durlach, Lepola, and Dinan ⁸	2002	"...a psychophysiological phenomenon experienced as a foreboding dread or threat to a human organism whether the threat is generated by internal, real or imagined dangers." ⁸ , p. 1

Table 3.2: Comparison of Three Self-Report Measures of Anxiety

Instrument; Year	Number of Items	Response Options for Each Item	Scoring and Range	Time Required to Complete	Grade Level	Normative Values
State-Trait Anxiety Inventory; 1970 (Form X) with revision in 1983 (Form Y)	State anxiety subscale = 20 Trait anxiety subscale = 20	1 (not at all) to 4 (very much so)	Responses for the items are summed; scores for each subscale range from 20-80	10-20 minutes	6	State anxiety Working adults aged 50-69 Males: 34.51 ± 10.34 Females: 32.20 ± 8.67 Neuropsychiatric patients: $47.74 \pm 13.24^*$ Medical-surgical patients: $42.38 \pm 13.79^*$ Trait anxiety Working adults aged 50-69 Males: 33.86 ± 8.86 Females: 31.79 ± 7.78 Neuropsychiatric patients: $46.62 \pm 12.41^*$ Medical-surgical patients: $41.91 \pm 12.70^*$

Table 3.2 (Continued)

Instrument; Year	Number of Items	Response Options for Each Item	Scoring and Range	Time Required to Complete	Grade Level	Normative Values
Anxiety subscale of the Brief Symptom Inventory; 1975	Anxiety subscale = 6	0 (not at all) to 4 (extremely)	Responses for the items are averaged; scores range from 0 to 4	2-5 minutes	6	Healthy adults: 0.35 ± 0.45 Psychiatric outpatients: 1.70 ± 1.00 Psychiatric inpatients: 1.70 ± 1.15
Anxiety subscale of the Hospital Anxiety and Depression Scale; 1983	Anxiety subscale = 7	0 to 3 (response options vary)	Responses for the items are summed; scores range from 0-21	3-4 min	NR	Normative values are not available. Cutoff scores: 0-7 = non-cases, 8-10 = doubtful cases, 11-21 = definite cases

* Based on State-Trait Anxiety Inventory, Form X

NR = Not reported

Table 3.3: Summary of Anxiety Research for Patients with Cardiac Disease

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Thompson et al., 1987 ⁵¹	Describe the pattern of anxiety during the first year after AMI; identify sources of anxiety	76 male inpatients with AMI	Not defined	State-Trait Anxiety Inventory; seven-point anxiety rating scale that the authors created to assess seven AMI-specific sources of anxiety, Cronbach's α = 0.76	Trait anxiety was lower 1 year after AMI than 24 hours, 5 days, or 6 weeks post-AMI; state anxiety and anxiety rating scale scores were highest one day after admission and lowest 1 year post AMI but were higher 6 weeks post-discharge than 5 days post-admission; sources of anxiety included the AMI itself, return to work, the future, potential complications, and leisure activities

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Sykes et al., 1989 ⁵²	Assess how the timing of discharge from the CCU affects anxiety for patients with AMI	569 inpatients with AMI; based on illness severity, patients were assigned to either a good or poor prognosis group; next, patients were randomly assigned to either an early or late discharge from the CCU	"...an emotional reaction to the trauma which in its extreme form may have a disorganizing effect on behaviour, inhibiting recovery and the adaptive process" (p. 477). Also summarized Spielberger's definitions of state and trait anxiety (see Table 3.1).	State-Trait Anxiety Inventory	Women had higher levels of trait and state anxiety than men; when patients with a poor prognosis were discharged early, their anxiety levels increased post-discharge; patients with a poor prognosis who did not survive 3 months reported lower initial state anxiety levels than survivors; for patients with a good prognosis, day 6 and 3 month state anxiety scores were higher for those who had not returned to a normal way of life 3 months post-AMI

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Buchanan et al., 1993 ⁵³	Describe HRV and psychological emotions after AMI	21 inpatient men with AMI	Briefly differentiated between state and trait anxiety when describing the State-Trait Anxiety Inventory	State-Trait Anxiety Inventory	State anxiety was elevated the first 4 days post-AMI but did not correlate significantly with HRV; state anxiety scores were lower 6 months after AMI; trait anxiety levels did not vary by time
Rose et al., 1994 ⁵⁴	Study the relationship between trait and state anxiety for patients with AMI	62 inpatients with AMI	"Anxiety is a common response found among hospitalized MI survivors ^a ...and may affect both hospital and post-discharge experiences among these persons..." ^b	State-Trait Anxiety Inventory	Older patients had lower state anxiety than younger patients; state and trait anxiety scores did not differ by gender; patients with higher state anxiety were more likely to smoke 3 months post-AMI

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Crowe et al., 1996 ¹⁴	Investigate numerous aspects of anxiety and depression for patients with AMI	785 inpatients with AMI	"...feeling of fear, tension, or panic or an expectancy that something unpleasant is going to happen and is almost invariably accompanied by physical signs and symptoms." ¹⁵	State-Trait Anxiety Inventory	69% of patients were anxious; compared with psychiatric patients, 10% had higher state anxiety scores and 14% had higher trait anxiety scores; state and trait anxiety levels remained elevated during the year after AMI

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Thomas et al., 1997 ¹	Assess the effects of psychosocial variables on survival for patients with AMI who developed ventricular dysrhythmias	348 patients with AMI and ventricular dysrhythmias; of these, 308 received a nonactive medication	Briefly differentiated between state and trait anxiety when describing the State-Trait Anxiety Inventory	State-Trait Anxiety Inventory	In a logistic regression model, high state anxiety independently predicted mortality even after controlling for the effects of physiological variables

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Lane et al., 2001 ²	Evaluate the effect of anxiety on mortality and QOL for patients with AMI	288 inpatients with AMI	Not defined	State-Trait Anxiety Inventory	State and trait anxiety predicted neither cardiac nor all-cause 12-month mortality after AMI; in a multiple regression model, state anxiety predicted 12-month QOL
Luskin et al., 2002 ³⁹	Investigate the effect of stress management training on QOL, physical function, and HRV for patients with HF	Treatment group = 16 outpatients with HF; control group = 17 outpatients with HF	Briefly differentiated between state and trait anxiety when describing the State-Trait Anxiety Inventory	State-Trait Anxiety Inventory	Patients in the treatment group had lower anxiety 1-2 weeks post-training; however, the decrease was not statistically significant

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
An et al., 2004 ²⁷	Explore the evolution of anxiety early after AMI; assess for gender differences in anxiety early after AMI	486 inpatients with AMI	"...a feeling of fear, tension, panic or the expectancy that something unpleasant is going to happen." ^d	State-Trait Anxiety Inventory, Cronbach's α = 0.94	Patients were most anxious during the first 12 hours after AMI; in general, women reported higher anxiety than men

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Frasure-Smith et al., 1995 ³	Examine whether psychological variables predict future cardiac events for patients with AMI	222 inpatients with AMI	Not defined	State portion of the State-Trait Anxiety Inventory	In a multivariate model containing physiological and psychological factors, high anxiety and the prescription of ACE inhibitors at discharge were the only significant independent predictors of recurrent cardiac events during the first year after AMI; although the model contained depression, it was not an independent predictor

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
O'Brien et al., 2001 ²⁵	Measure how frequently clinicians assess patients for anxiety; compare patient-generated ratings with clinician-generated ratings of state anxiety for patients with AMI	101 inpatients with AMI	"...a natural response to the threats associated with AMI..." (p. 97).	State portion of the State-Trait Anxiety Inventory, Cronbach's α = 0.94	45% of patient medical records contained an anxiety assessment; there was no relationship between patient-generated and clinician-generated ratings of patient anxiety

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Frazier et al., 2002 ²⁴	Describe how anxiety is managed and examine the relationships among patient reported anxiety, clinician anxiety assessment, and subsequent treatment of anxiety for patients with AMI	101 inpatients with AMI	"Anxiety, the psychological and physiological responses of an individual to a perceived threat, usually generates feelings of apprehension, dread, or uneasiness." ^d	State portion of the State-Trait Anxiety Inventory, Cronbach's $\alpha = 0.94$	47% of patients reported moderate to severe anxiety; clinicians assessed anxiety for 45% of patients; there was no relationship between clinician-generated and patient-generated anxiety ratings; patients with higher anxiety received significantly more anxiolytic medications; there was no relationship between clinician-generated anxiety ratings and treatment of anxiety

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Watkins et al., 2002 ⁵⁵	Assess the relationship between anxiety and baroreflex sensitivity for patients with AMI	204 inpatients with AMI	Not defined	State portion of the State-Trait Anxiety Inventory	The addition of state anxiety scores to physiological variables significantly improved ability of a multiple regression model to predict lower baroreflex sensitivity; more patients with high anxiety had a history of cardiac dysrhythmias

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Frasure-Smith & Lesperance, 2003 ²³	Assess the importance of psychological variables as long-term prognostic indicators for patients with AMI	896 inpatients with AMI	Not defined	State portion of the State-Trait Anxiety Inventory, Cronbach's α = 0.93; Modified Somatic Perception Questionnaire, Cronbach's α = 0.81	High state anxiety predicted 5-year cardiac mortality but did not remain significant when adjusting for cardiac disease severity

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Welin et al., 2000 ⁵⁶	Assess the relationship between psychosocial variables and 10-year prognosis for patients with AMI	275 outpatients with recent AMI	Not defined	Trait portion of the State-Trait Anxiety Inventory	Neither all-cause mortality nor prognosis were associated with anxiety

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Moser & Dracup, 1996 ⁴	Examine the relationship between anxiety and in-hospital complications for patients with AMI	86 inpatients with AMI	"Anxiety is one of the earliest and most intense psychological responses to AMI." ^c	Anxiety subscale of the Brief Symptom Inventory, Cronbach's α = 0.85	Patients with high anxiety were 4.9 times more likely to experience ischemia, reinfarction, and ventricular fibrillation than patients with low anxiety; in a multiple regression model, anxiety independently predicted complications

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Kim et al., 2000 ²⁶	Assess gender differences in anxiety for patients with AMI	424 inpatients with AMI	"State anxiety is characterized by current feelings of tension, apprehension, nervousness, and worry and by activation of the autonomic nervous system." ^d	Anxiety subscale of the Brief Symptom Inventory, Cronbach's α = 0.87; state portion of the State-Trait Anxiety Inventory, Cronbach's α = 0.94	Women were more anxious than men; single men were more anxious than married or widowed men; married women were more anxious than single or widowed women; women with lower income were more anxious than women with higher income

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Moser et al., 2003 ²⁸	Assess gender differences in anxiety for patients with AMI from five countries	912 inpatients with AMI from five countries	"Anxiety is defined as the emotional response to 'anticipation of threats to safety or integrity of body or self.'" ^f	Anxiety subscale of the Brief Symptom Inventory, Cronbach's α = 0.85-0.90 among the five countries	Women in each country had higher anxiety than men; anxiety did not differ by country; patients less than 60 years old were more anxious than patients greater than 60 years old

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
De Jong et al., 2004 ⁴⁶	Explore whether anxiety post-AMI differs across five countries	912 inpatients with AMI from 5 countries	"...psychophysiological phenomenon experienced as a foreboding dread or threat to a human organism whether the threat is generated by internal, real or imagined dangers." ^g	Anxiety subscale of the Brief Symptom Inventory, Cronbach's α = 0.85-0.90 among the five countries	Patients from all countries reported higher anxiety than the normal reference mean; after controlling for sociodemographic variables, anxiety levels did not differ significantly by country

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Chiou et al., 1997 ⁵⁷	Describe anxiety, depression, and coping styles of Taiwanese patients with AMI	40 inpatients with AMI	Not defined	Hospital Anxiety and Depression Scale, Cronbach's $\alpha = 0.91$ for anxiety subscale	25% of patients had high levels of anxiety; positive and significant correlations were found between anxiety and social class and between anxiety and perceived severity of AMI

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Mayou et al., 2000 ⁵	Evaluate the impact of emotional distress as a predictor of outcomes for patients with AMI	344 inpatients with rule-in or possible AMI	Not defined	Hospital Anxiety and Depression Scale	18.5% of patients were identified as probable cases of anxiety; anxiety levels decreased by 3 months post-AMI but remained steady 12 months post-AMI; anxiety predicted worse QOL and higher use of primary care and surgical health resources at 3 and 12 months post-AMI

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Herrmann-Lingen, et al., 2003 ⁵⁸	Evaluate the relationship between pro-ANP and anxiety for patients with HF	46 patients with HF; 73 individuals with cardiovascular risk factors (controls)	Not defined	Hospital Anxiety and Depression Scale	Anxiety and pro-ANP were significantly and negatively correlated for patients with HF, but not for controls; for all patients, vital exhaustion, age, depression, and pro-ANP levels were multivariate predictors of anxiety

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Dellipiani et al., 1976 ⁵⁹	Describe anxiety after AMI and relate it to treatment regimens	Group A = 203 inpatients with AMI or myocardial ischemia; Group B = 83 patients with definite, possible, or ruled out AMI who were treated either at home or in the hospital	Not defined	Cattell 8-Parallel-Form Anxiety Battery	For group A, anxiety was first measured after transfer from CCU and was highest immediately after transfer; anxiety levels decreased over the following week but rose when hospital discharge was imminent; anxiety levels 4 months post-discharge were lower than normal; patients in group B reported a similar pattern in anxiety, but were more anxious

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Moser & Dracup, 1995 ⁶⁰	Assess the relationship between perceived control and psychosocial recovery for patients with AMI, CABG, or both	176 outpatients with recent AMI, CABG, or both	Not defined	Multiple Affect Adjective Checklist	Patients with low levels of perceived control were more anxious than patients with high levels of perceived control

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Dracup et al., 2003 ⁶¹	Evaluate whether perceived control reduces emotional distress, such as anxiety, in patients with HF	222 outpatients with HF	Not defined	Multiple Affect Adjective Checklist	Patients with high levels of perceived control were less anxious than those with low levels of perceived control

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Kohn et al., 1983 ⁶	Examine the relationship between stress and norepinephrine for patients with AMI and healthy participants	21 patients with history of AMI; 27 healthy individuals (controls)	Not defined	Affect Adjective Checklist for anxiety	Anxiety was moderately and positively correlated with norepinephrine levels for patients with AMI; for both groups, anxiety was significantly and positively correlated with depression, stress at home, duration of stress, and duration of stress accompanying major life changes occurring within the previous 3 years

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Havik & Maeland, 1990 ⁶²	Describe the pattern of emotions in the 5 years after AMI	283 inpatients with AMI	Not defined	Semantic differential type of questionnaire, Cronbach's $\alpha = 0.80-0.90$ among the testing times	Anxiety levels were stable during hospitalization; 1-2 weeks post-discharge, anxiety levels were significantly higher and remained so for the subsequent 3-5 years; six patterns of long-term emotional reactions were identified

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Conn et al., 1991 ⁶³	Examine whether there are gender and age differences in psychosocial condition, health state, and adherence for patients with AMI	197 outpatients with a history of AMI	"...heightened musculoskeletal tension, including somatic tension, which may not be overtly observable, as well as observable psychomotor manifestations." ^h	Profile of Mood States	No association between age and anxiety was found; women were more anxious than men*

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Riegel & Gocka, 1995 ⁶⁴	Compare psychosocial adjustment for men and women with AMI	64 outpatients with recent AMI	Not defined	Profile of Mood States, Cronbach's α = 0.97	Men and women were more anxious 1 month post-AMI than 4 months after AMI
Oldridge et al., 1995 ⁶⁵	Assess the efficacy of an 8 week cardiac rehabilitation program for patients with AMI who were anxious and/or depressed before discharge	Rehabilitation group = 93 patients; usual care group = 94 patients	Not defined	Profile of Mood States	Upon completing cardiac rehabilitation, patients in the rehabilitation group whose initial anxiety scores were higher than the mean had lower anxiety scores than the usual care patients; 12 months after AMI, both groups of patients reported similar and significant improvements in anxiety

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Riedinger et al., 2002 ⁶⁶	Compare aspects of QOL, including emotional distress, in women with HF with that of a normative group and with groups of women with other chronic diseases	691 women with HF	Not defined	Anxiety subscale of Profile of Mood States, Cronbach's $\alpha > 0.70$	Women with HF had higher anxiety than a normative group of women, geriatric women, and women with either HTN or cancer; women with recent AMI and patients with COPD had higher anxiety than women with HF

Table 3.3 (Continued)

Author/Date	Major Purpose of Study	Sample	Authors' Conceptual Definition of Anxiety	Anxiety Instrument with Cronbach's α (if reported)	Major Findings Related to Anxiety
Uuskula, 1996 ⁶⁷	Assess psychological differences between young men and young women after AMI	64 inpatients with AMI	Not defined	Present Affect Reactions Questionnaire	Women had higher state anxiety than men during the first week after AMI
Winefield & Martin, 1981 ⁶⁸	Identify variables that predict recovery after AMI	28 inpatient men with AMI	Not defined	The S-R Inventory of General Trait Anxiousness	High in-hospital trait anxiety and manual occupation predicted poor recovery; anxiety predicted rehospitalization for cardiac indications

Table 3.3 (Continued)

AMI = acute myocardial infarction; CABG = coronary artery bypass grafting; CCU = coronary care unit; COPD = chronic obstructive pulmonary disease; HF = heart failure; HRV = heart rate variability; HTN = hypertension; pro-ANP = atrial natriuretic pro-peptide; QOL = quality of life

*Data from table but conflict with the text

^aBuchanan L, Cowan M, Burr R, Waldron C, Kogan H. Measurement of recovery from myocardial infarction using heart rate variability and psychological outcomes. *Nurs Res.* 1993;42:74-78. Carney RN, Freedland KE, Clark KA, et al. (1992). Psychosocial adjustment of patients arriving early at the emergency department after acute myocardial infarction. *Am J Cardiol.* 1992;69:160-162. Hackett TP, Cassem, NH. White and blue collar responses to heart attack. *J Psychosom Res.* 1976;20:80-85.

^bCay E, Vetter N, Philip A. Psychological status during recovery from an acute heart attack. *J Psychosom Res.* 1972;16:422-435.

Malan, SS. Psychosocial adjustment following MI: current views and nursing implications. *J Cardiovasc Nurs.* 1992;6(4):57-70.

^cMedalie JH, Goldbourt U. Angina pectoris among 10,000 men: psychosocial and other risk factors as evidenced by a multivariate analysis of a five year incidence study. *Am J Med.* 1976;60:910-921.

^dSpielberger CD, Gorsuch RL, Lushene R, Vagg PR, Jacobs GA. Manual for the State Trait Anxiety Inventory (Form Y). Palo Alto, CA: Consulting Psychologists Press; 1983.

^eMalan, SS. Psychosocial adjustment following MI: current views and nursing implications. *J Cardiovasc Nurs.* 1992;6(4):57-70.

Ben-Sira Z, Eliezer R. (1990). The structure of readjustment after heart attack. *Soc Sci Med.* 1990;30:523-536. Buchanan L, Cowan M, Burr R, Waldron C, Kogan H. Measurement of recovery from myocardial infarction using heart rate variability and psychological outcomes. *Nurs Res.* 1993;42:74-78.

^fKirmayer LJ. Cultural variations in the clinical presentation of depression and anxiety: implications for diagnosis and treatment. *J Clin Psychiatry.* 2001;62(Supp):22-28.

^g Emilien G, Durlach C, Lepola U, Dinan T. *Anxiety Disorders: Pathophysiology and Pharmacological Treatment*. Basel, Switzerland: Birkhauser Verlag; 2002.

^h McNair D, Lorr M, Droppleman L. *Profile of Mood States Manual*. San Diego: Education and Industrial Testing Service; 1971.

CHAPTER FOUR

Anxiety is Not Manifested by Elevated Heart Rate and Blood Pressure in Acutely Ill Cardiac Patients

Synopsis

Objective: The purpose of this study was to determine whether heart rate and blood pressure are related to level of anxiety in patients with chronic advanced heart failure (HF), patients with acute myocardial infarction (AMI), and healthy individuals.

Background: Accurate assessment of anxiety in cardiac patients is important because anxiety is associated with adverse outcomes. Clinicians often use heart rate and blood pressure as indicators of anxiety; however, little is known about whether these measures accurately reflect anxiety in acutely ill patients.

Methods and Results: In this descriptive, correlational study, anxiety, heart rate, and blood pressure were measured at the same time in three groups of individuals: 1) 54 patients hospitalized for AMI; 2) 32 patients with chronic advanced HF; and 3) 31 healthy individuals. State anxiety was measured using the anxiety subscale of the Brief Symptom Inventory. Heart rate and blood pressure data were collected immediately prior to the anxiety assessment. Data were collected in the outpatient setting for patients with HF and healthy individuals. For patients with AMI, data were collected a mean of 48 ± 33 hours after admission. There were no correlations between anxiety and heart rate or diastolic blood pressure. Higher anxiety was associated with lower systolic blood pressure in patients with AMI ($r = -.23$, $P < .05$) and in healthy individuals ($r = -.27$, $P < .05$).

Conclusions: Elevated heart rate and blood pressure do not accurately reflect level of anxiety as reported by patients with AMI or HF and healthy individuals, and thus cannot be used to assess anxiety in acutely ill patients. Clinicians who use changes in heart rate or blood pressure as indicators of anxiety may fail to recognize and treat anxiety, placing their patients at high risk for both immediate and long-term complications.

Key Words: Acute Myocardial Infarction, Heart Failure, Heart Rate, Blood Pressure, Anxiety

Introduction

Historically, healthcare providers focused on how physiologic parameters, such as dysrhythmias, Killip class, and infarct size and location, affected recurrent cardiac events and mortality for patients with coronary heart disease (CHD). More recently, researchers have examined whether psychological factors, such as anxiety and depression, impact the pathogenesis of CHD and the morbidity and mortality for persons diagnosed with CHD.

Anxiety is a “psychophysiological phenomenon experienced as a foreboding dread or threat to a human organism whether the threat is generated by internal, real or imagined dangers.”^{1, p. 1} Anxiety is manifested by a variety of psychological and somatic symptoms.^{1,2} Understandably, patients with acute myocardial infarction (AMI) or heart failure (HF) are often anxious.³⁻⁵ This anxiety stems from concerns such as physical symptoms, diagnostic or therapeutic procedures, the healthcare environment, risk of death, cost of treatment, and their ability to resume self-care, work or recreational activities. Ten to twenty-six percent of hospitalized persons with AMI are more anxious than individuals with a psychiatric disorder.^{4,5} Anxiety is more prevalent than depression for patients with AMI.⁵⁻⁷

Most, but not all,^{6,8} investigators have demonstrated that anxiety is associated with adverse outcomes. For example, Moser and Dracup⁴ demonstrated that patients with higher levels of state anxiety were 4.9 times more likely to develop in-hospital complications. Thomas and colleagues⁹ followed 348 patients from the Cardiac Arrhythmia Suppression Trial to study the effects of psychosocial factors on survival and demonstrated that level of state anxiety independently predicted 3 month survival after AMI. In a study by Frasur-Smith and associates,¹⁰ patients with AMI who had higher

anxiety scores on the state portion of the State-Trait Anxiety Inventory experienced more frequent recurrent cardiac events during the first post-AMI year. Remarkably, anxiety was the only variable from among several cardiac and psychological variables that predicted recurrent AMI.

The prevalence of anxiety is high in patients with HF,¹¹ but few investigators have evaluated how anxiety affects patients with HF.¹²⁻¹⁴ The results of these few investigations have been mixed; anxiety predicted functional status at 1 year in patients with HF,¹⁴ but not rehospitalization or mortality.¹⁵ However, in a study of patients with recent AMI and depressed left ventricular function, anxiety was associated with a higher incidence of adverse cardiac events and cardiac death in the subsequent 6-10 years.¹⁶

The above findings emphasize that it is essential for clinicians to accurately assess and promptly manage anxiety in patients with AMI or HF. Yet, healthcare professionals often fail to consider anxiety and other psychosocial factors when caring for their patients.^{17,18} Furthermore, clinicians often diagnose anxiety by using their clinical judgment instead of a reliable or valid instrument that is designed to measure anxiety.¹⁸ Results from a recent study indicated that the majority of critical care nurses believed that anxiety could be life threatening or harmful.¹⁹ Yet, in another study, critical care nurses documented an anxiety assessment in only 39% of patients with AMI, while physicians assessed only 6% of patients for anxiety.^{18,20} In addition, clinicians did not use objective indicators to describe anxiety and documented a follow-up anxiety assessment in only 24% of patients that they had identified as being anxious. The most striking finding from this study was that there was no relationship between clinician-generated and patient-generated anxiety ratings.

In a recent survey, critical care nurses indicated that agitation, increased blood pressure, increased heart rate, patients' verbalization of anxiety, and restlessness are the most important indicators of anxiety.²¹ In the qualitative arm of the same study, nurses reported that they most frequently used restlessness, increased heart rate, agitation, increased blood pressure, increased respiratory rate, and increased diaphoresis as signs of anxiety.²² Indeed, under 5% of nurses considered a patient's verbalization of anxiety as an important element of their anxiety assessment. These findings are concerning because physiologic symptoms of anxiety may not be as useful when assessing acutely ill patients for anxiety.² It can be difficult to differentiate between signs and symptoms of anxiety and indicators that reflect deteriorations in the patient's physiologic status. Furthermore, cardiac patients often receive beta-blockers and other interventions that influence heart rate and blood pressure. Clinicians who rely on changes in heart rate or blood pressure to diagnose anxiety may underestimate the presence of anxiety in their patients.²¹ Clinicians may more accurately recognize anxiety by actively listening to patient reports of anxiety²¹ and by assessing psychological symptoms that are associated with anxiety.²

Although critical care nurses use heart rate and blood pressure as indicators of anxiety, little is known about whether these measures accurately reflect anxiety in acutely ill cardiac patients. The purpose of this study was to determine whether heart rate and blood pressure were related to level of anxiety at the time of measurement in three groups of participants: 1) patients with chronic advanced HF; 2) patients with AMI; and 3) healthy individuals.

Methods

Design

In this descriptive study we determined the relationship between anxiety, and heart rate and blood pressure in three groups of individuals. Blood pressure and heart rate were assessed at the same time as anxiety level. Data from two separate studies^{23,24} are presented in this paper.

Sample and Settings

For purposes of this study, we combined data from two studies: 1) study of anxiety among patients experiencing AMI,^{23,25} and 2) study of the impact of a biofeedback-relaxation intervention in patients with HF.²⁴ In the AMI study, patients were enrolled based on the following criteria: 1) diagnosis of AMI using typical electrocardiogram changes and enzyme levels to confirm AMI; 2) pain free and hemodynamically stable at the time of interview; 3) AMI not experienced in an institutional setting; 4) cognitively able to participate in a short interview; 5) free of serious debilitating co-morbidities such as cancer or renal failure; and 6) able to speak English. The study was conducted in patients' hospital rooms, which were typically in the critical care unit or telemetry unit.

In the biofeedback-relaxation study, patients with HF and healthy individuals were enrolled. Inclusion criteria for the patients included the following: 1) diagnosis of advanced chronic HF with New York Heart Association (NYHA) functional classification II to IV, and left ventricular ejection fraction < 30%; 2) have undergone evaluation of HF and optimization of medical therapy, and have not been referred for heart transplantation; 3) no history of cerebral vascular accident; 4) no history of major

extremity vascular problems; 5) no recent (within 6 months) myocardial infarction; and 6) not receiving sedatives, narcotics, or hypnotics. Healthy individuals were included if they had no history of CHD, diabetes, or other major illnesses. No healthy participants were taking beta-adrenergic blocking agents. Healthy individuals could have been diagnosed with hypertension, but could not have been receiving antihypertensive medications. Participants from the biofeedback-relaxation study were assessed in an outpatient clinical research center of a major academic medical center.

Measurement

Anxiety, heart rate, and blood pressure were measured in the same manner in each group of participants. The following sociodemographic and clinical data were collected: age, gender, ethnicity, marital status, education level, smoking status, NYHA classification, heart rate, blood pressure, and history of AMI, coronary artery bypass grafting, percutaneous coronary intervention, diabetes, or hypertension.

Anxiety. State anxiety was measured using the anxiety subscale of the Brief Symptom Inventory.^{26,27} This six-item anxiety subscale is especially useful when studying acutely ill patients because it is sensitive, brief, reliable, and valid, and does not rely on clinical symptoms to indicate feelings of anxiety.^{26,27} Instruments that include clinical indicators of emotions have been criticized for overestimating the level of emotion in acutely ill patients. For each of the six items on the scale, patients rate their level of distress from 0 ("not at all") to 4 ("extremely"). The scores are summed and averaged. The averaged score reflects the patient's overall level of state anxiety.

Heart rate and blood pressure. Heart rate and blood pressure data were collected using two methods to establish the validity of the measurement. The same methods were

used for participants from both studies. Trained research assistants assessed heart rate by auscultating the apical pulse for a full minute, and determined blood pressure using the technique outlined by the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure.²⁸ Heart rate and blood pressure were also measured using a calibrated noninvasive blood pressure monitor.

Procedures

The appropriate Institutional Review Boards approved this study and the investigation conforms with the principles outlined in the Declaration of Helsinki. All participants gave informed, written consent. Healthcare providers referred their patients to the respective studies. We used flyers to recruit healthy participants. Trained research assistants who were all cardiovascular nurses explained the study requirements to potential participants and collected all data.

Data in the AMI study were collected within 72 hours (mean 48 ± 33 hours) of patients' admission to the hospital with AMI symptoms. The AMI study included no intervention and a one-time assessment of anxiety during a patient interview. Heart rate and blood pressure data were collected immediately prior to the anxiety assessment. In the biofeedback-relaxation study, anxiety, heart rate, and blood pressure measurements were collected in an outpatient setting during a data collection session. Data used in the present analyses were collected at baseline, before the intervention was instituted.

Statistical Analyses

All data were entered into a personal computer and analyzed with SPSS software, version 11.5. Data are presented as frequencies and means $\pm$ standard deviations. Using Kendall's tau-b, correlation coefficients were computed between the mean anxiety level

of each group and heart rate, systolic blood pressure, and diastolic blood pressure. We also subdivided each of the three groups into a “high anxiety group” and a “low anxiety group” based on the median split of the anxiety scores. We performed two-tailed t tests to evaluate whether the high and low anxiety groups manifested differences in mean heart rate, systolic blood pressure, and diastolic blood pressure at the time of measurement. A P-value of $< .05$ was considered statistically significant.

Results

Characteristics of Sample

The sample of 117 patients was composed of 32 (27.4%) patients with HF, 54 (46.2%) patients with AMI, and 31 (26.5%) healthy individuals. The sociodemographic and clinical characteristics of the sample are summarized in Table 4.1. The mean age of the sample was 56.8 ± 13.9 years. Patients in the AMI group were older than patients in the HF and normal groups ($P < .05$). Over half (56.4%) of the participants were married, 59.8% were female, and the majority (79.5%) were Caucasian.

Anxiety Level

The mean anxiety scores for the HF, AMI, and healthy groups were 0.98, 0.52, and 0.58, respectively, which in each group is substantially greater than the norm reference anxiety level of 0.35 ± 0.45 .²⁷ In this study, 62.5% of patients with HF, 38.8% of patients with AMI, and 54.9% of healthy individuals reported higher anxiety than the norm reference.

Relationship Between Anxiety and Physiologic Variables

The results of the correlational analyses presented in Table 4.2 show that there were no significant correlations between anxiety and heart rate or diastolic blood pressure. There were only two significant correlations. Interestingly, higher anxiety was associated with lower systolic blood pressure in healthy individuals ($r = -.27$, $P < .05$) and patients with AMI ($r = -.23$, $P < .05$).

As previously described, the patients were divided into high and low anxiety subgroups. As shown in Table 4.3, mean systolic blood pressure, diastolic blood pressure, and heart rate were not statistically different for patients in the high and low anxiety subgroups, regardless of the presence or absence of cardiac disease. There was a tendency for patients with HF to have a higher heart rate and diastolic blood pressure.

Discussion

Results from this study show that heart rate and blood pressure do not accurately reflect level of anxiety as reported by patients with AMI or HF and healthy individuals. This study is unique because its investigators call into question the long-standing practice of assuming that anxiety is associated with elevated heart rate and blood pressure. Little research has been done to examine the relationship between heart rate and blood pressure for patients with cardiac disease. Traditionally, clinicians have assessed acutely ill patients for high anxiety by detecting changes in heart rate and blood pressure; however, findings from this study do not support this practice. From a physiologic perspective, it would seem that increased anxiety should be associated with elevated heart rate and blood pressure. Although the purpose of this study was not to test the mechanisms

linking anxiety with poor outcomes, we found that heart rate and blood pressure were not elevated in this sample of participants, regardless of their anxiety level. In fact, an unexpected finding was that higher anxiety was associated with *lower* systolic blood pressure in healthy individuals and in patients with AMI. We propose several explanations for our findings.

First, although it is a long-held belief²⁹⁻³⁵ that anxiety is associated with increased heart rate and blood pressure, examination of the existing evidence reveals several points that counter this belief: 1) individuals with even extreme anxiety do not respond in a homogenous manner, given that some persons exhibit an increase in heart rate and blood pressure while others show no heart rate or blood pressure response;³⁶⁻³⁸ 2) when investigators reported that anxiety was associated with increased heart rate and blood pressure, the increases often were minimal and not clinically important;^{29,36,37,39,40} 3) many investigators failed to show any change in heart rate or blood pressure in response to acute anxiety;^{38,41-43} and 4) the physiologic response to anxiety is far more complex than originally thought and involves differential responses depending on which brain hemisphere is activated.^{29,44}

Second, patients with AMI or HF who are anxious and on beta-adrenergic blockers may not manifest a rapid heart rate or elevated blood pressure.² In this sample, 93% of the AMI patients were on beta-adrenergic blockers. Beta-adrenergic blockers are recommended as standard therapy for patients with AMI;⁴⁵ realistically, most patients with AMI will receive a beta-adrenergic blocker. Aside from this, however, no relationship was found between anxiety and either blood pressure or heart rate in patients with HF or in healthy participants who did not receive beta-adrenergic blockers,

indicating that regardless of beta-adrenergic blocker use, anxiety is not associated with heart rate and blood pressure changes. Yet, clinicians continue to use heart rate and blood pressure changes as indicators of anxiety. Our findings are consistent with a recent report that also demonstrated no relationship between anxiety level and either blood pressure or heart rate for ICU patients with various diagnoses.⁴⁶

Third, heart rate and blood pressure are gross indicators of sympathetic tone and therefore may not be accurate indicators of anxiety, especially when it is sustained. Particularly among cardiac patients, whose autonomic nervous system tone is altered acutely and chronically,⁴⁷ adaptation to sustained sympathetic nervous system activation may include blunting of the heart rate and blood pressure response. For example, among patients with HF, baroreceptor function is altered early and contributes to the development and progression of HF.⁴⁷ Consequently, heart rate and blood pressure responses to changes in autonomic nervous tone may be distorted.

Fourth, acutely ill patients who are anxious may exhibit anxiety in a variety of ways and either they may not be able to mount an overt physiologic response to anxiety or the response may be masked by the complex pathophysiologic responses of the presenting illness.²¹ For example, volume status abnormalities, pain, or changes in patient activity all affect heart rate and blood pressure. In addition, while some healthy or ill individuals who initially experience intense, acute anxiety may exhibit tachycardia and hypertension,²⁹ this physiological response may not persist as the individual experiences chronic anxiety that persists for hours or days.²

We recommend that clinicians assess anxiety using an instrument designed for that purpose. Although clinicians have reported using heart rate and blood pressure as

signs of anxiety, the principal finding of this study indicates that heart rate and blood pressure are not reliable indicators of anxiety for patients with AMI or HF. One could argue that heart rate tended to be higher in the high anxiety groups; however, the difference in heart rate was neither statistically nor clinically significant. Clinicians are unlikely to attribute such small variations in heart rate to anxiety. As a result, clinicians who rely on changes in heart rate and blood pressure as indicators of patient anxiety may fail to recognize and treat anxiety.

Further prospective research is needed to identify the most efficient and effective method of assessing anxiety in acutely ill patients. Clinicians need a brief, valid, and reliable instrument that is easy to administer. However, some critically ill patients are not capable of either completing such an instrument or subjectively reporting anxiety. Therefore, future research is needed to explore whether any physiologic measures are reliable indicators of patient anxiety.

A limitation of this study is that we measured anxiety at one time point. More research is needed to evaluate whether our findings would persist over time and whether we would find similar results if AMI patients were assessed during the early acute phase (< 24 hours after admission) or if patients with HF were assessed during an acute exacerbation. A second limitation is that healthy individuals had higher than expected levels of anxiety. Interestingly, even healthy individuals with anxiety did not manifest an elevated heart rate or blood pressure. Finally, although our sample size was somewhat limited, the sample size was large enough to detect relationships that existed (i.e., higher anxiety was associated with lower systolic blood pressure in patients with AMI and in healthy individuals).

In summary, elevated heart rate and blood pressure do not accurately reflect level of anxiety as reported by patients with either AMI or HF and healthy individuals. These findings constitute an important contribution to cardiac nursing research literature because clinicians report using heart rate and blood pressure as indicators of anxiety. Results of this study indicate that use of an anxiety assessment instrument will enable clinicians to more accurately assess patient anxiety.

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Table 4.1: Comparison of Baseline Characteristics

Variable	Entire Sample ($N = 117$)	HF Group ($n = 32$)	AMI Group ($n = 54$)	Healthy Group ($n = 31$)
Age (years)	56.8 ± 13.9	53.5 ± 13.3	62.8 ± 14.4	49.3 ± 8.3
Heart rate (beats/min)	72.8 ± 12.9	69.5 ± 13.6	76.7 ± 13.2	69.8 ± 9.9
Systolic BP (mm Hg)	122.2 ± 19.2	114.4 ± 16.9	121.1 ± 17.2	131.6 ± 21.2
Diastolic BP (mm Hg)	70.4 ± 16.0	74.3 ± 14.2	60.5 ± 10.4	83.6 ± 14.8
Education (years)	13.7 ± 3.1	13.8 ± 1.9	12.4 ± 2.6	16.0 ± 3.8
	N(%)	N(%)	N(%)	N(%)
Gender				
Male	47 (40.2)	22 (68.8)	12 (22.2)	13 (41.9)
Female	70 (59.8)	10 (31.2)	42 (77.8)	18 (58.1)
Marital status				
Single	14 (12.0)	4 (12.5)	3 (5.6)	7 (22.6)
Married	66 (56.4)	21 (65.6)	32 (59.2)	13 (41.9)
Divorced/separated	21 (17.9)	5 (15.6)	8 (14.8)	8 (25.8)
Widowed	15 (12.8)	1 (3.1)	11 (20.4)	3 (9.7)
Cohabitate	1 (0.9)	1 (3.1)	0 (0.0)	0 (0.0)

Table 4.1 (Continued)

Variable	Entire Sample ($N = 117$)	HF Group ($n = 32$)	AMI Group ($n = 54$)	Healthy Group ($n = 31$)
Ethnicity				
Nonhispanic White	93 (79.5)	27 (84.4)	43 (79.6)	23 (74.2)
Black	20 (17.1)	4 (12.5)	10 (18.5)	6 (19.4)
American Indian	1 (0.9)	1 (3.1)	0 (0.0)	0 (0.0)
Asian	1 (0.9)	0 (0.0)	0 (0.0)	1 (3.2)
Other	1 (0.9)	0 (0.0)	0 (0.0)	1 (3.2)
Current smoker	25 (21.4)	6 (18.8)	17 (31.5)	1 (3.2)
History of AMI	31 (26.5)	15 (46.9)	16 (29.6)	0 (0.0)
History of CABG	15 (12.8)	8 (25.0)	7 (13.0)	0 (0.0)
History of PCI/stent	14 (12.0)	5 (15.6)	9 (16.7)	0 (0.0)
History of HTN	50 (42.7)	12 (37.5)	34 (63.0)	4 (12.9)
History of diabetes	23 (19.7)	6 (18.8)	17 (31.5)	0 (0.0)

Values in table are means $\pm$ standard deviation or actual number of patients followed by percentage in parentheses; column percentages may not total 100%, due to missing data

AMI = acute myocardial infarction; BP = blood pressure; CABG = coronary artery bypass grafting; HF = heart failure; HTN = hypertension; PCI = percutaneous coronary intervention

Table 4.2: Correlations Between Anxiety, and Heart Rate and Blood Pressure

Variable	HF Group Total Anxiety	AMI Group Total Anxiety	Healthy Group Total Anxiety
Heart rate	.26	.11	.07
Systolic blood pressure	.10	-.23*	-.27*
Diastolic blood pressure	.24	-.10	-.25

Anxiety assessed by the anxiety subscale of the Brief Symptom Inventory

*P < .05 by Kendall's tau

AMI = acute myocardial infarction; HF = heart failure

Table 4.3: Comparison of Mean Systolic Blood Pressure, Diastolic Blood Pressure, and Heart Rate Between High Anxiety and Low Anxiety Groups

	High Anxiety Group	Low Anxiety Group	P
HF Group			
Heart rate (beats per minute)	73.9 ± 13.2	65.7 ± 13.2	.09
Systolic blood pressure (mm Hg)	117.9 ± 21.1	111.4 ± 11.8	.28
Diastolic blood pressure (mm Hg)	79.1 ± 13.9	70.0 ± 13.5	.07
AMI Group			
Heart rate (beats per minute)	79.5 ± 13.9	73.4 ± 12.1	.09
Systolic blood pressure (mm Hg)	116.8 ± 14.5	125.1 ± 18.8	.08
Diastolic blood pressure (mm Hg)	59.3 ± 8.7	61.6 ± 11.9	.42
Healthy Group			
Heart rate (beats per minute)	69.9 ± 10.8	69.6 ± 9.0	.95
Systolic blood pressure (mm Hg)	126.0 ± 21.0	138.5 ± 19.9	.10
Diastolic blood pressure (mm Hg)	80.5 ± 16.0	87.4 ± 12.8	.19

AMI = acute myocardial infarction; HF = heart failure

CHAPTER FIVE

Using a 0-10 Scale for Assessment of Anxiety in Patients with Acute Myocardial Infarction

Synopsis

Objective: The purpose of this study was to determine whether a single-item anxiety assessment instrument, the Anxiety Level Index (ALI), is a valid alternative to the State Anxiety Index (SAI) or the anxiety subscale of the Brief Symptom Inventory (BSI) for assessing state anxiety for patients with AMI.

Background: Patients with acute myocardial infarction (AMI) often experience anxiety, an emotion that predicts adverse physiologic outcomes. Critical care clinicians have not adopted an anxiety assessment instrument for widespread use, due in part to the unavailability of an easy-to-administer anxiety instrument that is not burdensome to either clinicians or critically ill patients.

Methods and Results: In this prospective multi-center study, 243 inpatients with AMI rated their anxiety using the SAI, the anxiety subscale of the BSI, and the ALI. Anxiety Level Index scores were compared to SAI and BSI anxiety subscale scores using Spearman's rho test and the Bland-Altman method. There were moderate, positive correlations between the ALI and the SAI ($r_s = .52$, $P < .001$) and between the ALI and the anxiety subscale of the BSI ($r_s = .45$, $P < .001$). However, the Bland-Altman method revealed a moderate bias between the ALI and the SAI and between the ALI and the anxiety subscale of the BSI. As anxiety scores increased, the level of disagreement became more pronounced in both comparisons.

Conclusions: Although ALI scores were moderately and significantly correlated with scores on the SAI and the BSI anxiety subscale, the results of the Bland-Altman method indicate a lack of construct validity of the single-item measure. The quest continues to construct a simple self-report measure of anxiety that is appropriate for critically ill patients with AMI.

Key Words: Anxiety, myocardial infarction, nursing assessment

Introduction

Anxiety is an inherent human emotion and a common psychological response to acute myocardial infarction (AMI). In fact, 10-26% of hospitalized persons with AMI are more anxious than persons who have been diagnosed with a psychiatric disorder.^{1,2} Anxiety associated with AMI is not unique to the United States; patients throughout the world experience anxiety after AMI.³

Anxiety associated with AMI can be a dangerous phenomenon. Moser and Dracup¹ reported that patients with higher state anxiety after AMI had a 4.9 times higher incidence of in-hospital ventricular fibrillation, ischemia, and reinfarction than patients with lower anxiety. High state anxiety has been shown to predict 3-month survival following AMI.⁴ Similarly, Frasure-Smith and colleagues⁵ reported that high state anxiety predicted recurrent cardiac events during the first year after AMI. Finally, for patients with recent AMI and a left ventricular ejection fraction $\leq 50\%$, elevated anxiety was associated with more frequent cardiac events and higher mortality 6-10 years after the acute event.⁶

Given the above findings, it is easy to find nursing literature that emphasizes the need for clinicians to assess, document, and manage anxiety in patients with AMI.⁷⁻¹² What is missing, however, are specific guidelines for *how* clinicians should assess anxiety. Instead, recommendations for assessing anxiety are vague. For example, clinicians are instructed to "assess for verbal and nonverbal signs of anxiety and when level of anxiety changes..."^{13, p. 826} perform active listening, and encourage patients to verbalize their emotions.⁹ The assessment of anxiety after AMI is not standardized and no anxiety assessment tool has been recognized as the gold standard. Consequently,

although reliable and valid anxiety instruments are available, clinicians often neither complete nor document a formal anxiety assessment. When nurses do assess anxiety, they do so using a subjective approach.¹⁴ For example, nurses documented that patients were anxious, restless, or shaky, but did not use objective measures to assess anxiety.¹⁴ Nurses also use tachycardia, tachypnea, elevated blood pressure, and increased diaphoresis as indicators of anxiety.^{15,16} However, interpretation of altered physiologic parameters is difficult because many factors other than anxiety influence them.¹⁷

The Spielberger State Anxiety Index (SAI)¹⁸ and the anxiety subscale of the Brief Symptom Inventory (BSI)¹⁹ are two valid and reliable anxiety instruments that investigators have used to assess anxiety in patients with AMI. Clinicians often perceive that such anxiety instruments are too lengthy,^{20,21} burdensome to acutely ill patients,²² clinically irrelevant, and difficult to administer. O'Brien and associates¹⁴ reported that clinicians never used an objective instrument to assess anxiety for 101 patients with AMI. Although 45 of these patients' medical records contained a brief subjective anxiety assessment, there was no association between clinicians' assessment of their patients' anxiety and patients' assessment of their own anxiety. Furthermore, clinician assessments of the same patient during the same time period differed.

Others documented the need for a simple method of assessing anxiety in acutely ill patients^{14,17} and suggested that a single-item anxiety assessment instrument may be the solution.¹⁴ Some investigators asked non-cardiac patients to report anxiety using a 0 to 10 numeric rating scale; however, no psychometric data were reported.^{23,24} Clinicians who care for patients with cardiac disease are familiar with numeric rating scales because they routinely assess chest pain using a 0 to 10 pain scale. Advantages of a 0 to 10 scale

are that clinicians require minimal training regarding its use, it is time efficient, and cardiac patients are familiar with it. If clinicians had a straightforward 0 to 10 numeric anxiety scale, they might assess and document anxiety more consistently. Furthermore, a 0 to 10 anxiety scale could eliminate difficulties with translating currently available anxiety instruments to non-English languages. Accordingly, the purpose of this study was to determine whether a single-item numeric rating scale for anxiety, the Anxiety Level Index (ALI), is a valid alternative to the SAI or the anxiety subscale of the BSI for assessing state anxiety for patients with AMI.

Methods

Design

In this prospective multi-center study, we assessed the state anxiety level of patients with AMI using the SAI, the anxiety subscale of the BSI, and the ALI. Subsequently, we compared the ALI scores with the SAI and BSI scores. The anxiety assessment was completed within 48 hours of the patient's admission for AMI.

Sample and Settings

The study was conducted in the cardiac care units of three large urban university medical centers located in the Midwestern United States. Adult male and female patients were invited to participate in the study if they met the following inclusion criteria: 1) diagnosis of AMI confirmed by elevated cardiac enzymes and typical electrocardiogram changes; 2) pain free and hemodynamically stable at the time of assessment; 3) free of cognitive impairment; 4) free of non-cardiac serious or life threatening co-morbidities; and 5) able to speak English. A total of 243 patients were enrolled.

Measurement

Sociodemographic and Clinical Data. Prior to the anxiety assessment, each patient provided his or her age, educational level, ethnicity, and marital status. Trained research assistants reviewed each patient's medical record to collect the following clinical data: peak cardiac enzyme levels, Killip classification, type of AMI, smoking status; and history of AMI, coronary artery bypass grafting, hypertension, and diabetes.

Anxiety. For purposes of this study, we measured state anxiety, which has been defined as a "transitory emotional state or condition of the human organism...that is characterized by subjective, consciously perceived feelings of tension and apprehension, and activation of the autonomic nervous system."^{25, p. 39} Each patient completed three self-report instruments that reflect state anxiety: the SAI, the anxiety subscale of the BSI, and the ALI. The SAI is a 20-item instrument that enables persons to rate their anxiety at the present time. For each item, respondents indicate their agreement using a scale of 1 ("not at all") to 4 ("very much so"); thus, total scores range from 20 to 80. It takes 5-10 minutes to complete this instrument. The SAI has been used to assess anxiety in patients with AMI^{2,5,10,12,14,26-28} and previous research has supported its reliability and validity.¹⁸ The Cronbach's alpha reliability coefficient for our sample was .93. Table 5.1 contains normative values for the SAI.

The 6-item anxiety subscale of the BSI instrument includes brief descriptions of psychological symptoms that are associated with anxiety. Using a 0 ("not at all") to 4 ("extremely") scale, participants rate their level of distress concerning these symptoms. The six scores are totaled and averaged. The averaged score quantifies the patient's level of anxiety and can range from 0 to 4. Like the other two instruments, higher scores

denote higher anxiety. This anxiety subscale is reliable and valid,¹⁹ and investigators have used this instrument for patients with AMI.^{3,12,29} For this sample, the Cronbach's alpha reliability coefficient was .84. Normative values are found in Table 5.1.

The ALI is a 1-item, verbal, numeric rating instrument. The investigator read the following statement to patients: "We are interested in how anxious you feel now. On a scale of 0 to 10, where 0 is no anxiety and 10 is the most anxiety you have ever experienced, please rate your current anxiety level." The reported score reflects the patient's state anxiety; no further calculations are necessary. The investigators designed this instrument to resemble the 0 to 10 pain level scale that clinicians commonly use to assess pain in patients with AMI. It is impossible to calculate Cronbach's alpha on this 1-item instrument. Given the nature of state anxiety, it is also inappropriate to measure reliability of any state anxiety instrument using test-retest reliability analysis.

Procedures

The Institutional Review Boards at the three sites approved the study. Prior to data collection, all participants gave informed, written consent. During their scheduled rounds, trained research assistants with cardiovascular nursing experience approached all patients who met inclusion criteria. Prior to meeting the patient, the research assistants had no knowledge of the patient's anxiety status. The research assistants explained the study to potential participants, administered the anxiety assessment instruments, and obtained the patient's sociodemographic and clinical data. Data were collected within 48 hours of the patient's arrival at the emergency department for symptoms of AMI. The anxiety assessments took place in the patient's cardiac care unit room. Some participants completed the SAI and the anxiety subscale of the BSI independently; however, most

requested that the research assistants read the information to them. Research assistants administered the ALI as described above.

Statistical Analyses

Sociodemographic and clinical data are presented as frequencies and means $\pm$ standard deviations. Because the anxiety data were skewed towards low scores, the nonparametric Spearman's rho test was used to examine the association between the SAI and the ALI, and the association between the BSI anxiety subscale and the ALI. A P-value of $< .05$ was considered statistically significant. Correlations only measure the association between two instruments. Correlations may be high even when two measurement techniques are in poor agreement.³⁰ Therefore, we also used the Bland-Altman method to assess the degree of agreement between the instruments.³⁰⁻³² Although not endorsed by all,³³ the Bland-Altman method is the preferred method for evaluating whether a new instrument provides equivalent information to an existing instrument.^{30,31} In summary, this method provides an assessment of bias and precision between new and existing instruments. Bland-Altman plots are useful when comparing two measurement techniques. The bias (difference between the two measures) is plotted on the y axis; the mean of the two measures is plotted on the x axis. There is no statistical test to determine whether the amount of bias seen is acceptable; instead, clinical judgment is used to decide.^{30,32} Each scale had different metrics; therefore, before conducting Bland-Altman statistical analyses, we transformed the SAI and anxiety subscale of the BSI scores to a 0 to 10 scale.

Results

Characteristics of Sample

A total of 243 patients with AMI agreed to participate in this study. Table 5.2 contains a summary of the sociodemographic and clinical characteristics of the sample. The mean age of the participants was 62.3 ± 13.5 years. Female patients accounted for nearly half (47.3%) of the sample. Nearly all (92.6%) patients were Caucasian and the majority (69.1%) were married. The mean education level was 12.6 ± 3.1 years. The peak creatine phosphokinase-MB isoenzyme level was 110.1 ± 139.0 ng/mL.

Level of Anxiety

The mean anxiety scores for the SAI, the anxiety subscale of the BSI, and the ALI were 36.76 ± 12.01 , $0.56 \pm .75$, and 3.08 ± 2.62 , respectively. For the anxiety subscale of the BSI, 40.4% of patients reported higher anxiety than the normal reference mean, while 6.4% of patients were more anxious than the normal reference mean for patients with psychiatric disorders. In this sample, 42.2% of males and 72.1% of females reported anxiety levels that surpassed normal reference SAI values. Finally, 16.5% of patients had higher SAI anxiety scores than patients with neuropsychiatric disorders.

Correlations Among the Anxiety Instruments

As shown in Table 5.3, there was a moderate, positive correlation between the SAI and the ALI ($r_s = .52$, $P < .001$). Similarly, the anxiety subscale of the BSI and the ALI were moderately correlated ($r_s = .45$, $P < .001$).

Agreement Between SAI and ALI Anxiety Instruments

Figure 5.1 shows the Bland-Altman plots of the differences between the SAI and ALI anxiety instruments against the mean of these instruments. The mean difference was

1.5 ± 2.2 , indicating that there was a moderate degree of bias between the SAI and ALI anxiety instruments. The 95% confidence interval (CI) for the bias was 1.24 to 1.80. The limits of agreement ranged from -2.9 to 5.9, indicating poor agreement and imprecise measurement. The 95% CI for the lower limit of agreement was -3.38 to -2.42; the 95% CI for the upper limit of agreement was 5.42 to 6.38. Figure 5.1 shows that although most differences fall within two standard deviations of the mean difference, the bias was more pronounced for higher anxiety scores.

Agreement Between Anxiety Subscale of the BSI and ALI Anxiety Instruments

Figure 5.2 shows the Bland-Altman plots of the differences between the anxiety subscale of the BSI and the ALI anxiety instrument against the mean of these instruments. The mean difference was -1.7 ± 2.3 , indicating that there was a bias between the anxiety subscale of the BSI and the ALI anxiety instruments. The 95% confidence interval for the bias was -1.97 to -1.38. The limits of agreement ranged from -6.4 to 3.0, indicating widespread disagreement between the anxiety subscale of the BSI and ALI scores. The 95% confidence interval for the lower limit of agreement was -6.86 to -5.84; the 95% confidence interval for the upper limit of agreement was 2.50 to 3.51. Figure 5.2 shows that the bias was more pronounced for higher anxiety scores.

Discussion

The results of this study suggest that the ALI is not a valid alternative to either the SAI or the anxiety subscale of the BSI. The ALI may be convenient for clinicians and patients because it parallels a frequently used numeric pain instrument and takes less time to complete than the SAI or the anxiety subscale of the BSI. However, although ALI

scores were moderately and significantly correlated with the SAI and anxiety subscale of the BSI scores, results of the Bland-Altman method indicate a lack of construct validity for the single-item numeric rating scale as a measure of anxiety.

When comparing the ALI anxiety score with the SAI anxiety score, the mean difference of 1.5 ± 2.2 indicates a moderate systematic bias between these methods. If the ALI and SAI scores had agreed perfectly, the mean difference would have equaled zero. As shown in Figure 5.1, the mean difference of 1.5 is well above zero and values are scattered above and below the mean value. Furthermore, as the anxiety scores increase, more values fall outside the 95% confidence interval, indicating decreasing agreement. Importantly, the data indicate that a patient's ALI score may differ widely from his or her SAI score. For example, an ALI score of 5.0 may be as high as 9.4 or as low as 0.6, a large range that nearly encompasses the range of possible ALI scores and thus is clinically unacceptable.

The mean difference of -1.7 reveals a moderate systematic bias between ALI anxiety and BSI anxiety subscale scores. Figure 5.2 shows values scattered above and below the mean with more widespread disagreement for higher anxiety scores. One cannot be confident of ALI scores due to the wide limits of agreement found when comparing these scores with the BSI anxiety subscale scores. For example, an ALI score of 5.0 may be as high as 9.7 or as low as 0.3.

Although neither the SAI nor the anxiety subscale of the BSI has been designated as the "gold standard," investigators often use these instruments to assess anxiety for patients with AMI.^{1,3,12,14,26,27,29,34} Yet, clinicians rarely use published instruments to assess patients for anxiety. Clinicians who receive vague instructions for assessing

anxiety, who are unaware of published anxiety instruments, or who conclude that existing instruments are time-consuming, burdensome to patients, inaccessible, or clinically irrelevant may invent their own anxiety assessment instrument or adapt a similar scale to measure anxiety. For example, clinicians may assume that the ALI is a valid anxiety measure because data have supported the validity of a similarly designed verbal 0 to 10 numeric pain instrument.³⁵ However, results of invalidated instruments may be misleading, as illustrated by our data.

A limitation of this study is that we measured anxiety one time while the patient was in the cardiac care unit. Conceivably, patients would perform better on the ALI with repeated exposure to it. In addition, we did not control for how clinicians assessed patients for pain. Although patients were pain free at the time of anxiety assessment, it is possible that some patients had difficulty distinguishing between a 0 to 10 pain instrument and a 0 to 10 anxiety instrument. Finally, to promote ease of administration, we administered the ALI using a verbal approach. The ALI did not contain printed questions or statements; therefore, patients may have differed in their conceptions of anxiety. When patients completed the SAI they responded, for example, to statements about feeling calm, tense, nervous, content, and steady. When using a more nondescript instrument such as the ALI, perhaps patients are unsure how to discriminate feelings of anxiety from other emotions. McCormack and colleagues³⁶ pointed out that it is difficult to validate visual analogue scales for broad subjective concepts such as anxiety, and that not all patient groups respond alike to a particular anxiety scale.

Anxiety has been shown to adversely affect physiologic and psychologic outcomes for patients with AMI; therefore, it is essential that clinicians use a valid and

reliable instrument to assess anxiety. Further research is indicated to identify the instrument(s) most acceptable to clinicians and patients. Our analysis indicated that a verbal ALI instrument yielded unsatisfactory anxiety data. Future research using a printed ALI instrument with tic marks, numbers, or simple descriptors may yield more favorable results.

Recently, McKinley and colleagues²² introduced the Faces Anxiety Scale, a single-item anxiety instrument composed of five faces. The five faces range from a neutral face to a face showing extreme anxiety. Newly published data from a sample of intensive care unit patients support the validity of the Faces Anxiety Scale.¹⁷ However, the Faces Anxiety Scale instrument has not been specifically tested with patients with AMI. Further research is necessary to evaluate whether the Faces Anxiety Scale is suitable for patients with AMI.

In summary, it is well known that many patients with AMI are anxious and that anxiety contributes to unfavorable patient outcomes. Critical care clinicians have not adopted a published anxiety instrument for widespread use. Based on the construct validity data from this study, we cannot recommend that clinicians use the ALI to assess anxiety in patients with AMI. The quest continues to construct a simple and valid self-report measure of anxiety that is appropriate for critically ill patients with AMI.

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Table 5.1: Normative Values

Instrument	Normative Values
State Anxiety Index ¹⁸	Working adults aged 50-69 Males: 34.51 ± 10.34 Females: 32.20 ± 8.67 Neuropsychiatric patients: 47.74 ± 13.24 Medical-surgical patients: 42.38 ± 13.79
Anxiety Subscale of Brief Symptom Inventory ¹⁹	Healthy adults: 0.35 ± 0.45 Psychiatric outpatients: 1.70 ± 1.00 Psychiatric inpatients: 1.70 ± 1.15

Table 5.2: Sample Baseline Characteristics (N = 243)

Characteristic	<u>n</u>	%
Male gender	128	(52.7)
Ethnicity		
Caucasian	225	(92.6)
Black	14	(5.8)
Other	3	(1.2)
Marital status		
Married/cohabitate	169	(69.5)
Widowed/divorced/separated	28	(11.5)
Single	11	(4.5)
History of AMI	71	(29.2)
History of CABG	24	(9.9)
History of HTN	132	(54.3)
History of diabetes	60	(24.7)
Current smoker	63	(25.9)
Location of myocardial infarction [‡]		
Inferior	111	(45.7)
Anterior	90	(37.0)
Lateral	48	(19.8)
Posterior	35	(14.4)
Apical	6	(2.5)
Killip classification on admission		
I	169	(69.5)
II	56	(23.0)
III/IV	15	(6.2)

AMI = acute myocardial infarction; CABG = coronary artery bypass grafting; HTN = hypertension

Columns may not add to 100% because of missing data

‡ Some patients had more than one type of myocardial infarction

Table 5.3: Correlations Among the Spielberger State Anxiety Index, the Anxiety Subscale of the Brief Symptom Inventory, and the Anxiety Level Index

	Anxiety Level Index	Anxiety Subscale of the Brief Symptom Inventory
Spielberger State Anxiety Index	.52*	.56*
Anxiety Subscale of the Brief Symptom Inventory	.45*	—

*P < .001 by Spearman's rho

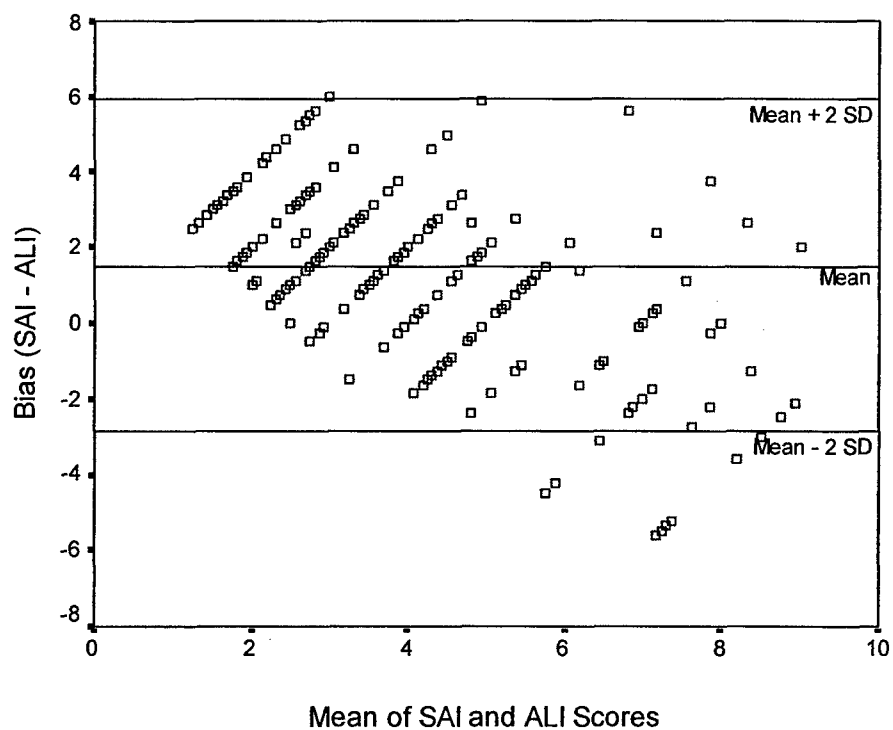


Figure 5.1: Bland-Altman Plot of the Differences Against the Mean Responses for the State Anxiety Index and Anxiety Level Index

SAI = State Anxiety Index; ALI = Anxiety Level Index

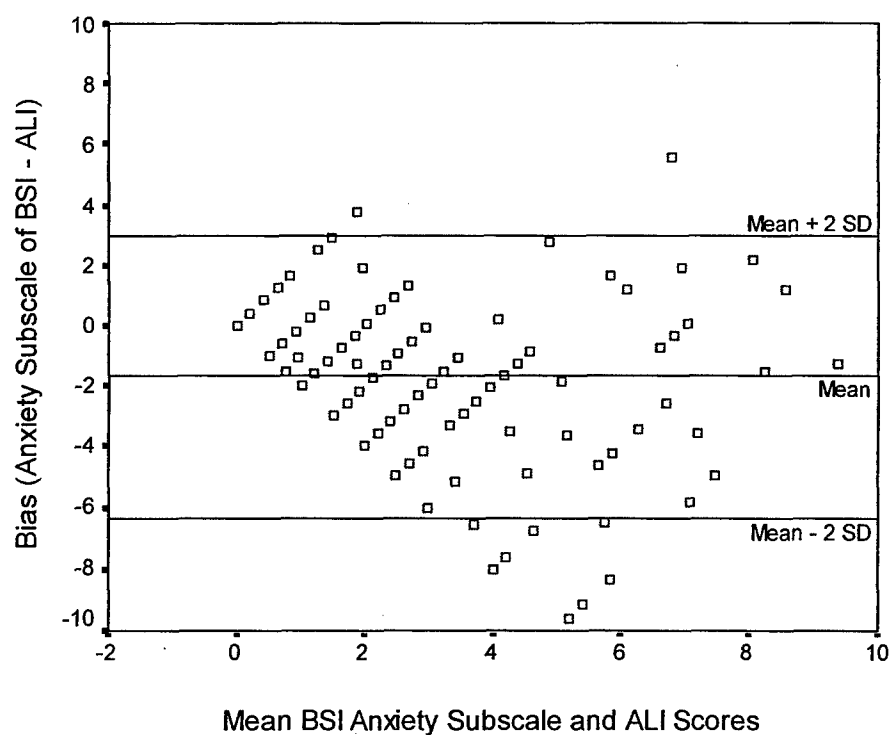


Figure 5.2: Bland-Altman Plot of the Differences Against the Mean Responses for the Brief Symptom Inventory Anxiety Subscale and Anxiety Level Index
 BSI = Brief Symptom Inventory; ALI = Anxiety Level Index

CHAPTER SIX

Predictors of Health Status for Heart Failure Patients

Synopsis

Objectives: To determine the best model of health status from among relevant sociodemographic, clinical, health perception, and emotional variables for patients with heart failure (HF).

Background: Health status is poorly understood for patients with HF. Earlier studies have shown little relationship between clinical variables and health status outcomes.

Methods: This was a descriptive, correlational study of 87 patients with HF. Health status was conceptualized as health-related quality of life [HRQL] (measured using the Minnesota Living with Heart Failure Questionnaire), actual physical activity level (measured over 24 hours using actigraphy), and level of symptom burden (measured using the Dyspnea-Fatigue Index). Hierarchical multiple regression techniques were used to determine sociodemographic (sex, age, living alone), clinical (comorbidities, New York Heart Association [NYHA] class, ejection fraction), health perception, and emotional (anxiety, depression, and hostility measured using the Brief Symptom Inventory) variables associated with health status.

Results: Worse NYHA class, higher anxiety, and higher depression predicted worse HRQL, explaining 37% of the variance. Better NYHA class and higher anxiety predicted higher levels of physical activity and explained 17% of the variance. Worse NYHA class and higher depression predicted greater symptom burden, explaining 52% of the variance.

Conclusions: The three strongest predictors of health status were NYHA class, anxiety, and depression. Traditional demographic and clinical variables assessed by clinicians are not associated with health status. Although not routinely assessed, emotional variables have a major impact on health status. Interventions to improve health status should target not only physical, but also emotional, well-being.

Key Words: Heart Failure, Health Status, Anxiety, Depression

Introduction

Worldwide, 15 million persons have heart failure (HF).¹ The prevalence of HF increases annually and has reached epidemic proportions.^{1,2} Nearly 4 million Americans live with symptomatic HF.³ Symptoms of HF progressively worsen and adversely affect patients' health status. Clinicians have concentrated on the sociodemographic and physiologic determinants of health status. This emphasis ignores the full breadth of the phenomenon of health status.

Health status is an increasingly important concept in the management of HF.^{4,5} In fact, symptomatic patients often are more concerned about their everyday health status than the length of their life.^{6,7} Yet, health status is poorly understood for patients with HF.⁸ Health status encompasses the concepts of health-related quality of life (HRQL), functional status, and symptom burden (Figure 6.1) and refers to how a disease manifests itself to patients.^{9,10} The patient's perception of health status is more than a simple reflection of their objective clinical status, and is influenced by subjective phenomena such as anxiety, depression, hostility, and perception of health.

The purpose of this study was to determine the best model of health status from among relevant sociodemographic, clinical, health perception, and emotional variables. Previous data have shown little relationship between clinical variables and health status outcomes.^{11,12} Therefore, we hypothesized that a combination of objective and subjective variables would predict health status better than objective variables alone. Knowledge of predictors will promote the design of new treatment strategies to combat the negative health status commonly seen in patients with HF.

Methods

Design

This was a descriptive, correlational sub-study of a prospective, randomized clinical trial designed to determine the optimum disease management strategy needed to improve outcomes in patients with HF.¹³ In the current study, only baseline data were included in the analyses.

Sample and Settings

Hospitalized patients with New York Heart Association (NYHA) functional classification II to IV HF from three urban and suburban community hospitals located in the Midwest were recruited for this study. Heart failure was diagnosed using either radiographic evidence of pulmonary congestion or presence of typical signs and symptoms of HF in conjunction with definite clinical improvement following diuresis.¹⁴ All patients were at risk for rehospitalization based on their history of one or more previous HF admissions or four or more prior hospitalizations for any reason in the previous 5 years.¹⁵ Patients were excluded if they were discharged to an extended care facility or referred for hospice services. Other exclusion criteria included dementia, serious cognitive impairment, and serious psychiatric illness. The Institutional Review Board at each site approved the study. All patients gave written informed consent.

Measurement

Primary end-point: health status. Health status was conceptualized as HRQL, functional status, and symptom burden. Health-related quality of life was measured using the Minnesota Living with Heart Failure Questionnaire (LHFQ).¹⁶ The LHFQ is a 21-item, disease-specific measure of HRQL that was designed to measure the effect of HF

symptoms on HRQL. Response options range from 0 (no) to 5 (very much); higher scores reflect worse HRQL. The LHFQ has been used extensively in HF research and its validity and reliability have been documented.^{16,17}

Physical activity level, a measure of functional status, was recorded using the Actiwatch 16 (Mini Mitter Co., Inc., Bend, OR). Patients wore this nonobstrusive, lightweight, wrist-watch type actigraph on their non-dominant arm for 24 hours after discharge. Investigators commonly use actigraphy to quantify physical activity.¹⁸⁻²⁰ The Actiwatch contains an omnidirectional accelerometer that senses motor activity in all directions and produces a variable electrical signal that is sampled by a microprocessor at set time intervals. These signals are digitally processed and sampled at a frequency of 32 Hz. The signal is expressed as "activity counts" and accordingly provides objective data regarding activity level. Accelerometers have well-documented reliability and validity and a high degree of participant acceptability.^{19,21}

Symptom burden was measured using the Dyspnea-Fatigue Index (DFI),²² which assesses the degree to which dyspnea and fatigue impact daily life. The DFI contains three domains, each rated on a 0 to 4 scale: 1) *magnitude of the task* that produces symptoms (0 = symptomatic at rest; 4 = symptomatic with extraordinary activity), 2) *magnitude of the pace*, (0 = symptomatic at rest; 4 = all physical activity performed at a normal pace), and 3) *level of functional impairment* (0 = very severe and has given up most or all usual activities; 4 = no restrictions on activities or occupation). Effort or pace is graded so that patients who improve their magnitude of task performance by decreasing the pace of their activity do not receive spuriously high scores. The scores for each domain are summed to obtain an aggregate score that ranges from 0 to 12. Lower

scores reflect greater symptom burden. Previous research has supported reliability and validity of the DFI for HF patients.²²

Sociodemographic and clinical variables. Nurses collected sociodemographic data when patients were stable and near discharge. Patients provided their age, gender, and living arrangement. We reviewed patients' medical records to ascertain NYHA functional classification and left ventricular ejection fraction (LVEF), measures of disease severity, and history of cardiac comorbidities (coronary artery disease, acute myocardial infarction, percutaneous coronary intervention, coronary artery bypass grafting).

Health perception and emotional variables. Health perception was measured using a single-item question from the Medical Outcomes Study Short Form (SF-36).²³ Patients rated their current health as excellent, good, fair, or poor.

Anxiety, depression, and hostility were measured using the Brief Symptom Inventory (BSI).²⁴ The anxiety, depression, and hostility subscales of the BSI contain six, seven, and five items, respectively. Patients rated their distress concerning these symptoms using a 0 (not at all) to 4 (extremely) scale. The items of each subscale are averaged; higher scores reflect greater emotional distress. The subscales contain no physiologic indices of anxiety which could spuriously overestimate measurement of emotions in patients with cardiac disease. Each subscale is reliable and valid.²⁴

Statistical Analyses

Data were analyzed with SPSS software, version 12.0. Because health status is a multidimensional variable, separate but parallel regression models were constructed for the three indicators of health status. Hierarchical multiple regression analyses were

conducted to determine the best predictors of health status. The sociodemographic and clinical variables were entered first in separate steps, followed by health perception and then emotional variables to determine their additive impact. Prior to regression analysis, we use published cutpoint scores to dichotomize patients into high and low groups for each emotion as follows: 1) low anxiety BSI ≤ 0.35 , high anxiety BSI > 0.35 ; 2) low depression BSI ≤ 0.28 , high depression BSI > 0.28 ; 3) low hostility BSI ≤ 0.35 , high hostility > 0.35 .²⁴ A P-value of .05 was considered statistically significant.

Results

Characteristics of Sample

Patient characteristics are summarized in Table 6.1. Over half (51.5%) of the 87 patients perceived their health as fair or poor. The mean anxiety, depression, and hostility scores were 0.90 ± 0.70 , 1.03 ± 0.83 , and 0.57 ± 0.50 , respectively. Compared to published norms, 72.3% of patients were above the norm for anxiety, 73.3% were above the norm for depression, and 66.3% were above the norm for hostility.

Health Status

Health-related quality of life. The mean score for HRQL was 51.62 ± 22.58 , indicating poor HRQL. Exploration of bivariate relationships between HRQL and each of the potential predictor variables revealed that age ($r_s = -.25$, $P = .02$), NYHA class ($r_s = .28$, $P = .01$), current health ($r_s = .36$, $P = .001$), anxiety ($r_s = .47$, $P < .001$), depression ($r_s = .49$, $P < .001$), and hostility ($r_s = .43$, $P < .001$) were associated with HRQL. In contrast, gender, living alone, comorbidities, and LVEF did not correlate with HRQL.

Results of the Mann-Whitney U test indicated that gender, living alone, and cardiac comorbidities were unrelated to HRQL.

Multivariate hierarchical regression analysis revealed that sociodemographic variables did not account for a significant amount of the variability in HRQL (Table 6.2). When the clinical variables were added in the second step, the model accounted for a significant amount of the variability in HRQL. However, only NYHA class (standardized beta = .43; $P < .001$ at step two) independently predicted HRQL. Specifically, worse NYHA class predicted worse HRQL. The addition of the health perception variable in the third step explained an additional 5% of the variance in HRQL. Patients' perception of current health (standardized beta = .26; $P = .02$ at step three) independently predicted HRQL. When added to the model in step four, the emotional variables explained an additional 14% of the variance in HRQL. Higher anxiety ($P = .03$) and greater depression ($P = .05$), but not hostility, independently predicted worse HRQL. The addition of the emotional variables in step four negated the contribution of the health perception variable. Thus, the final multivariate model for HRQL contained NYHA class, anxiety, and depression, explaining 37% of the variance.

Functional status. The mean activity count was $181,808 \pm 88,034$ which is substantially less than for elderly persons without HF. Age ($r_s = -.25$, $P = .02$) and NYHA class ($r_s = -.35$, $P = .001$) were the only predictor variables in bivariate analysis that correlated significantly with activity level.

When activity level was regressed on the sociodemographic variables in step one of the multivariate hierarchical regression model, the equation did not account for a significant amount of the variability in activity level (Table 6.3). With the addition of

clinical variables in step two and the health perception variable in step three, the models became significant; however, neither addition significantly improved the R^2 from the previous step. Nonetheless, NYHA class (standardized beta = $-.27$; $P = .02$ at step two) was an independent predictor of activity level. Patients with a worse NYHA class were less active. The only significant increase in R^2 occurred when the emotional variables were added in step four. Higher anxiety ($P = .02$) independently predicted greater physical activity. The independent variables that remained in the final multivariate model were NYHA class and anxiety and they explained 17% of the variance in physical activity.

Further analyses were conducted to explore whether the association between higher anxiety and greater activity level was a linear or higher-order relationship. Patients were divided into quartiles based on level of anxiety. Results of a Kruskal-Wallis test indicated differences in activity level among the four groups. Although patients with mild or moderate anxiety were more active, patients with the highest anxiety had a sharp decrease in physical activity ($P = .04$).

Symptom burden. The mean symptom burden score of 5.04 ± 2.29 reflected substantial symptom burden. Significant bivariate predictors of symptom burden included NYHA class ($r_s = -.70$, $P < .001$), current health ($r_s = -.27$, $P = .01$), anxiety ($r_s = -.41$, $P < .001$), depression ($r_s = -.51$, $P < .001$), and hostility ($r_s = -.28$, $P = .01$). Although NYHA class and symptom burden were strongly correlated, variable inflation factor and tolerance values for the symptom burden model and previously described models revealed no problems with multicollinearity.

As with HRQL and activity level, no sociodemographic variables accounted for a significant amount of variability in symptom burden (Table 6.4). When the clinical variables were added in step two, the model explained a significant amount of variability in symptom burden, and NYHA class (standardized beta = $-.68$; $P < .001$ at step two) independently predicted symptom burden. Patients with a worse NYHA class reported a higher magnitude of symptom burden. The health perception variable was entered in the third step but did not contribute significantly to the model. Emotional variables were entered in step four with depression ($P = .05$) independently predicting symptom burden. Furthermore, the addition of the emotional variables explained 7% more variability in symptom burden. Predictors retained in the multivariate model included NYHA class and depression, explaining 52% of the variance in symptom burden.

Discussion

Heart failure pervades all facets of health status – HRQL, functional status, and symptom burden. Health status is important because it predicts mortality and rehospitalization for patients with HF.⁹ The principal finding of our study was that NYHA class, anxiety, and depression strongly and independently predicted health status. Clinicians who seek to deliver patient-centered care and maximize health status for patients with HF must address not only sociodemographic and clinical measures, but also salient emotional variables. Failure to assess emotional variables provides an incomplete portrayal of health status.

The traditional biomedical model underscores the history, physical examination, diagnosis, and treatment to cure disease.^{25,26} Heart failure, however, is a debilitating and

chronic clinical syndrome with no cure. Patients with HF must learn to manage complex treatment regimens, adapt to physical and social limitations, and cope with psychological manifestations of the disorder. Even with optimal medical therapy, persons with HF often suffer disabling and progressive symptoms, are frequently hospitalized, and die prematurely. Not surprisingly, patients with HF report poor health,²⁷ impaired HRQL,^{4,28-30} impaired functional status,^{4,31,32} and persistent symptoms.^{32,33} The effects of these maladies seem particularly problematic for patients with HF. Compared to patients with other chronic conditions, patients with HF had the second worst scores for physical, role, and social functioning.²⁷ Likewise, mood disturbances were more commonly associated with HF than other cardiac disorders.¹² With the realization that HF is to be managed, not cured, health status is now considered an important assessment parameter and endpoint of treatment.²⁶

Health status, functional status, and HRQL have been used interchangeably,²⁶ but are not synonymous concepts. Meta-analysis results indicated that patients perceived quality of life and health status as distinct constructs.³⁴ Not all patients with impaired functional status reported poor HRQL.³¹ Similarly, particular symptoms do not affect HRQL uniformly for all patients.³⁵

Health-related quality of life is the difference between patients' expectations of health and their actual health.³⁶ As such, HRQL is a subjective concept unique to each person. In this study, worse NYHA class, anxiety, and depression independently predicted HRQL. As hypothesized, the addition of the subjective variables, health perception and emotions, explained significantly more variance in HRQL than sociodemographic and clinical variables. Our findings support previous data showing

that HRQL was lower in patients with either depression^{5,8,37} or worse NYHA class.^{11,28,31,38} Carels³⁰ recently reported that worse NYHA class, reduced LVEF, and depression predicted HRQL; however, like most investigators,^{11,28} we found that LVEF did not predict HRQL. Like others, we found a significant bivariate association between age and HRQL;²⁹ however, when adjusting for other variables, this relationship disappeared, indicating that age is not an independent predictor of HRQL.

Functional status, the second component of health status, reflects the patient's physical capability to perform daily activities that are important to them.^{31,39} Patients with HF have low physical activity levels, restricted ability to exercise, and limited stamina.⁴⁰ Most investigators use NYHA class, the 6-minute walk, or a self-report measure to measure functional status. Although the NYHA class integrates an assessment of symptoms and physical function, the clinician actually listens to patient input and makes a subjective assessment of patient function.⁹ The walk test may not accurately reflect the patient's full typical activity level at home.^{33,41} Self-report activity data should be viewed with prudence as others reported no association between patients' perception of their physical condition and their actual physical ability.⁴⁰ To our knowledge, we are the first to use actigraphy to quantify actual physical activity in the HF patient's natural home setting. Actigraphy data differentiate between physical and sedentary activities and are significantly related to oxygen uptake and heart rate during both physical and sedentary activities.²⁰

We found that better NYHA class and higher anxiety predicted greater actual physical activity. Emotional variables explained more variance in functional status than the other predictor variables, thus supporting our hypothesis. The correlation between

NYHA class and activity level was only moderate, likely reflecting inadequacies in the assessment of actual physical activity ability based on patient perceptions and clinicians' interpretations of these perceptions. Results of earlier studies^{11,38,42} indicated that patients with more severe HF walked a shorter distance on the 6-minute walk. Similarly, our patients with a worse NYHA class were less active, likely due to fatigue, dyspnea, and diaphragmatic and skeletal muscle atrophy.⁴³ Although others^{5,8,37,44} reported an association between functional status and depression, our data did not confirm these findings. In agreement with previous results, LVEF did not predict functional status.^{12,45} Majani and colleagues⁴⁶ reported that NYHA class, pulmonary capillary resistance, and depression predicted patient satisfaction with their functional status; however, they did not report actual activity levels.

An intriguing finding is that higher anxiety predicted greater physical activity. Others reported that patients with lower anxiety reported greater physical condition.⁴⁰ Yet, our patients with mild or moderate anxiety were more active than nonanxious or severely anxious patients. It appears that limited anxiety might positively influence patients' illness behavior.⁴⁷

The final aspect of health status is symptom burden. Symptoms are the patient's perception of abnormal physical function. Such perceptions are influenced by preferences, values, and psychological factors; thus, symptom burden differs among patients.³⁵ Dyspnea seems especially bothersome as patients with respiratory distress expressed more willingness to trade shorter survival for better health.⁷ We found that NYHA class and depression predicted symptom burden. Data regarding this model

supported our hypothesis and again accentuated the importance of the subjective variables.

Given that symptom assessment is an integral component of NYHA classification, we expected and found that NYHA class predicted symptom burden. In addition, depression independently predicted symptoms of fatigue and dyspnea. Sullivan and colleagues reported significant and persistent associations between depression and symptoms of breathlessness, fatigue, and chest pain for patients with HF.⁸ In fact, depression predicted these symptoms better than LVEF, blood pressure, myocardial oxygen consumption, or jugular venous pressure. Others also reported that depressive symptoms were the strongest predictors of worsening symptoms of HF.⁵

This study provides strong evidence that anxiety and depression are major determinants of health status. Often, clinicians overestimate the impact of biological and physiologic parameters on symptoms and functioning.³⁵ Clinicians routinely collect the patients' sociodemographic data and assess clinical parameters. The Joint Commission on Accreditation of Healthcare Organizations requires the assessment and documentation of LVEF before, during, or soon after admission for HF. In contrast, although the prevalence of anxiety and depression for patients with HF is up to 70%³² and 78%,⁴⁴ respectively, most clinicians neither routinely assess patients for anxiety or depression nor document their findings. Those who do, typically use their own methods to assess anxiety and depression rather than using an instrument designed for that purpose.⁴⁸ Many clinicians do not have access to instruments such as BSI, State-Trait Anxiety Inventory, the Hamilton Rating Scales for Anxiety and Depression, the Beck Depression Inventory, or the Hospital Anxiety and Depression Scale, which can be used to assess patients for

anxiety and depression. These instruments are brief and lay healthcare providers without formal psychiatric training can administer and interpret them.

The goal of therapy for HF is to prevent disease progression, relieve symptoms, maximize functioning, and prolong survival. Practice guidelines emphasize pharmacologic therapy for HF but fail to address anxiety or depression.⁴⁹ This omission may be one reason why HF has increased to epidemic proportions.² Cognitive-behavioral interventions, stress management, biofeedback, and medication therapy can reduce anxiety and depression.^{50,51} However, in one study, only 44% of patients with depression received any treatment for depression.⁵² Our findings support the importance of assessing and treating psychosocial parameters, as this should improve health status and survival for patients with HF. Future research is needed to evaluate this supposition. In addition, investigators need to identify clinically important difference (CID) standards from the patient's perspective.⁵³ With availability of empirically-based CID standards, clinicians could use a health status assessment to detect disease and extent of dysfunction, facilitate communication, screen for hidden problems, facilitate shared clinical decision making, and evaluate outcomes of therapy.^{26,54}

The primary limitation of this study is the small sample size; therefore, we view our conclusions with caution and recommend replication with a larger sample. We did not measure other variables such as social support, pain, or perceived control that may have influenced health status. An important strength of this study, however, is our

conceptualization of health status as a broad phenomenon that encompasses HRQL, actual physical activity level, and symptom burden. We used a unique approach to objectively measure patients' actual physical activity over 24 hours in their familiar home environment.

Some may argue that the symptom burden and activity level are so closely related to NYHA class that NYHA class should not be included as a predictor. In fact, there are striking differences among the measures. NYHA is a subjective clinician-based functional status assessment. In our study, actigraphy monitoring enabled us to objectively measure actual physical activity in the patient's natural home setting. The Dyspnea Fatigue Index is an advantageous patient-based measure of symptom burden measure because it emphasizes magnitude of the task and pace, as well as level of functional impairment in evaluating how symptoms affect daily health status. Thus, these assessment strategies measure three distinct concepts that together provide new insight into health status.

In summary, health status is important for patients with HF. The three strongest predictors of health status were NYHA class, anxiety, and depression. Clinicians should assess not only clinical, but also emotional, factors and be prepared to intervene when indicated.

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Table 6.1: Sample Baseline Characteristics (N = 87)

Characteristic	
Age (yrs)	72 ± 11
Education (yrs)	12 ± 2
Women, n (%)	42 (48)
Ethnicity	
Caucasian, <u>n</u> (%)	77 (89)
Black, <u>n</u> (%)	10 (11)
Marital status	
Married/cohabitate, <u>n</u> (%)	41 (47)
Widowed, <u>n</u> (%)	27 (31)
Divorced/Separated, <u>n</u> (%)	10 (11)
Single, <u>n</u> (%)	9 (10)
Left ventricular ejection fraction (%)	38 ± 15
Lives alone, <u>n</u> (%)	44 (51)
Prior coronary artery disease, <u>n</u> (%)	61 (70)
Prior acute myocardial infarction, <u>n</u> (%)	33 (38)
Prior coronary artery bypass grafting, <u>n</u> (%)	30 (34)
Prior hypertension, <u>n</u> (%)	65 (75)
Killip classification	
II, <u>n</u> (%)	41 (47)
III, <u>n</u> (%)	41 (47)
IV, <u>n</u> (%)	5 (6)

Data are presented as number of patients (%) or mean ± SD

Table 6.2: Hierarchical Multiple Regression of Variables Associated With Health-Related Quality of Life

Predictor Variables	Step F	Step P Value	R ²	Adjusted R ²	F for R ² Change	P Value for R ² Change	Standardized Beta*	Beta P Value
Step 1 Demographic Variables	2.24	.09	.08	.04	2.24	.09		
Age							-.18	.08
Gender							.01	.89
Living alone							.08	.38
Step 2 Clinical Variables	4.59	<.001	.26	.20	6.50	.001		
NYHA classification							.21	.047
Ejection fraction							.15	.11
Comorbidity							.10	.29
Step 3 Health Perception	5.06	<.001	.31	.25	6.09	.02		
Current health							.13	.23
Step 4 Emotional Variables	6.09	<.001	.45	.37	6.18	.001		
Anxiety							.25	.03
Depression							.21	.05
Hostility							.09	.45

*Betas shown are for step 4; NYHA = New York Heart Association

Table 6.3: Hierarchical Multiple Regression of Variables Associated With Physical Activity Level

Predictor Variables	Step F	Step P Value	R ²	Adjusted R ²	F for R ² Change	P Value for R ² Change	Standardized Beta*	Beta P Value
Step 1 Demographic Variables	2.70	.051	.09	.06	2.70	.051		
Age							-.10	.42
Gender							.11	.32
Living alone							.11	.29
Step 2 Clinical Variables	2.54	.03	.16	.10	2.26	.09		
NYHA classification							.35	.005
Ejection fraction							-.04	.97
Comorbidity							.10	.35
Step 3 Health Perception	2.31	.03	.17	.10	.96	.33		
Current health							.08	.51
Step 4 Emotional Variables	2.75	.006	.27	.17	3.30	.03		
Anxiety							.30	.02
Depression							-.20	.11
Hostility							.11	.41

*Betas shown are for step 4; NYHA = New York Heart Association

Table 6.4: Hierarchical Multiple Regression of Variables Associated With Symptom Burden

Predictor Variables	Step F	Step P Value	R ²	Adjusted R ²	F for R ² Change	P Value for R ² Change	Standardized Beta*	Beta P Value
Step 1 Demographic Variables	2.20	.09	.07	.04	2.20	.09		
Age							-.12	.19
Gender							.12	.16
Living alone							.03	.67
Step 2 Clinical Variables	12.80	<.001	.49	.45	21.75	<.001		
NYHA classification							.52	<.001
Ejection fraction							-.05	.57
Comorbidity							.15	.07
Step 3 Health Perception	11.20	<.001	.50	.45	1.31	.26		
Current health							.02	.86
Step 4 Emotional Variables	10.24	<.001	.58	.52	4.51	.006		
Anxiety							-.07	.45
Depression							-.18	.05
Hostility							-.18	.09

*Betas shown are for step 4; NYHA = New York Heart Association



Date: April 20, 2005

Our Ref: DeJongLeJacqRDS4-05

Marla De Jong
mdejong@aol.com

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January 21, 2005

John A. Spertus, MD, MPH, FACC
Professor, School of Medicine
University of Missouri-Kansas City
MED SLH MAHI 5
5100 Rockhill Road
Kansas City, MO 64110-2499

Dear Dr. Spertus:

My name is Marla J. De Jong. I am completing a doctoral dissertation at the University of Kentucky College of Nursing. As part of my research, I am conducting a study entitled "Predictors of Health Status for Heart Failure Patients."

You published the following paper: Spertus JA, Tooley J, Jones P, et al. Expanding the outcomes in clinical trials of heart failure: the quality of life and economic components of EPHEUS (Eplerenone's neuroHormonal Efficacy and SURvival Study). Am Heart J 2002;143:636-42. I would like to use Figure 2 (Range of health status) as a conceptual framework showing that health status encompasses health-related quality of life, functional status, and symptom burden.

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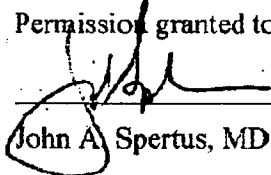
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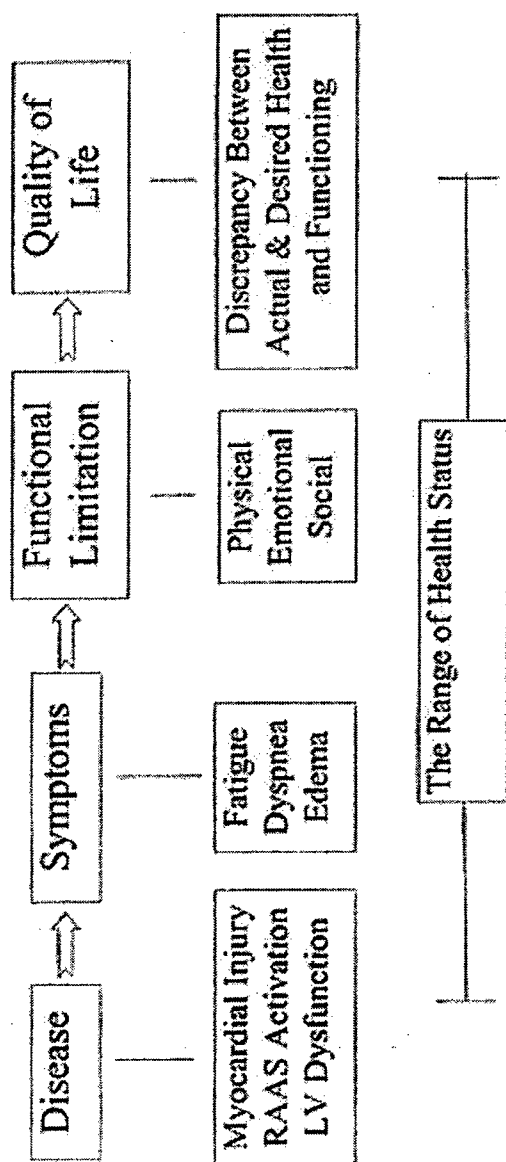


Figure 6.1: Range of Health Status. Reprinted with permission.¹⁰

LV = left ventricle; RAAS = renin-angiotensin-aldosterone system

CHAPTER SEVEN

Heart Rate Variability Analysis in the Assessment of Autonomic Function in Heart Failure

Synopsis

Objective: The purpose of this paper was to review neural control of heart rate, briefly describe heart rate variability, and summarize research findings regarding the heart rate variability of patients with heart failure (HF).

Background: Heart rate is not static, but rather changes continuously in response to physical and mental demands. In fact, an invariant heart rate is associated with disorders such as HF. Heart rate variability analysis is a noninvasive technique used to quantify fluctuations in heart rate.

Methods and Results: Literature about neural control of heart rate was reviewed. Respiration, reflexes, and the sympathetic, parasympathetic, and intrinsic cardiac nervous systems affect heart rate. Published research reports regarding heart rate variability of patients with HF were also appraised and summarized. Patients with HF had decreased heart rate variability in both the time and frequency domains. Decreased heart rate variability was related to excessive sympathetic activity, neuroendocrine dysfunction, elevated cytokine levels, and reduced vagal-cardiac activity. Decreased heart rate variability for patients with HF was associated with adverse cardiac events and higher mortality.

Conclusions: Heart rate fluctuates in response to neural intervention. Clinicians and researchers can use heart rate variability analysis to detect, quantify, and trend changes in autonomic activity for patients with HF. Patients with HF have altered nervous system

function that contributes to decreased heart rate variability. Decreased heart rate variability places patients at risk for future adverse cardiac events, need for heart transplantation, and death.

Key Words: Heart Failure, Heart Rate Variability, Autonomic Nervous System

Introduction

Clinicians often report that a patient's heart rate (HR) is "regular." Yet, as shown in Figure 7.1, HR is not a static hemodynamic parameter, but rather changes over time in response to physical and mental demands. Furthermore, an invariant, or nearly invariant, HR is often associated with disease processes such as heart failure (HF),¹⁻⁵ acute myocardial infarction (AMI),⁶⁻¹⁰ and diabetes.¹¹ Heart rate variability (HRV) analysis is a noninvasive technique used to quantify fluctuations in HR that reflect naturally occurring physiological processes.¹² The purpose of this paper is to review neural control of HR, briefly describe HRV, and summarize research findings about HRV for patients with HF.

Neural Control of Heart Rate

Heart rate is normally determined by spontaneous and periodic depolarizations of the sino-atrial node. Although neural innervation is not necessary to initiate the heart beat, the sympathetic and parasympathetic divisions of the autonomic nervous system (ANS), the intrinsic cardiac nervous system, reflexes, and respiration modulate the frequency of sino-atrial nodal depolarizations. These neural systems also influence cardiac contractility and conduction of electrical activity through the heart. Accordingly, cardiac chronotropism (HR), inotropism (contractility), and dromotropism (conduction, primarily through the AV node) are adjusted to meet the changing needs of the body.

Sympathetic Nervous System

Sympathetic nervous system fibers emerge from the cell bodies of preganglionic neurons within the intermediolateral column of the spinal cord located in the thoracic

through lumbar (T1-L2) regions. After passing through the white rami, most fibers synapse with postganglionic efferent neurons within the sympathetic paravertebral ganglia. The axons of these postganglionic neurons innervate blood vessels and the viscera.¹³

Parasympathetic Nervous System

Parasympathetic nervous system fibers emerge from cell bodies of the preganglionic neurons located in the brainstem and sacral area (S2-S4). Parasympathetic nerves travel to the head, thorax, and abdomen within cranial nerves. The vagus nerve (i.e., cranial nerve X) provides the parasympathetic innervation to the heart, lungs, and some abdominal regions. The majority of the axons within this nerve are sensory (i.e., visceral afferent); only about 20% of these axons are motor (i.e., parasympathetic efferent).

Like sympathetic nerves, the vagus nerve innervates the sinus and atrioventricular nodes and the atrial myocardium. The classical view that there is little to no parasympathetic innervation of ventricular myocardium neglects the well-established fact that parasympathetic nerves presynaptically inhibit the release of neurotransmitter from sympathetic nerves innervating the ventricular myocardium; this “indirect” effect can profoundly affect ventricular contractile function.¹³⁻¹⁵ Vagal stimulation promotes acetylcholine release, which decreases HR, myocardial conduction, atrial contractility, and through interaction with the sympathetic system, ventricular contractility.^{13,14}

Functional Connectivity Between the Sympathetic and Parasympathetic Systems

The heart and the majority of other organs are innervated by both sympathetic and parasympathetic nerves (i.e., reciprocal innervation). In resting man, parasympathetic

effects predominate sympathetic effects on HR. Whereas activity in the cardiac parasympathetic efferent nerves produces changes in HR on a beat to beat basis,¹⁶ typically, many seconds elapse before changes in cardiac sympathetic nervous activity achieve peak effects. Thus, as is explained below, these short latency effects of vagal activation ultimately explain the dominance of the parasympathetic nervous system within the “high frequency” range of the HR power spectrum. Conversely, alterations in sympathetic activity produce large amplitude, but slowly developing, or “low frequency,” changes in HR. In general, sympathetic stimulation is associated with diminished parasympathetic activity; the opposite is also true.¹⁷

Intrinsic Cardiac Nervous System

Recently, the anatomy of function of a nervous network within the heart itself has been extensively studied. Intrinsic cardiac ganglia have been described in five regions on the posterior surface of the atria and in five regions on the superior aspect of the ventricles.¹⁸ The “intrinsic cardiac network” (ICN) reportedly includes not only the classically described parasympathetic post-ganglionic neurons, but also sensory neurons, interneurons, and catecholaminergic (i.e., “sympathetic”) neurons. The ICN formed by these elements is effectually a localized component of the ANS analogous to the enteric nervous system in the gut. The ICN appears to be capable of mediating intracardiac reflexes.¹⁴ Canines with early-stage HF manifested altered intrinsic cardiac nervous function and a compromised ability to regulate HR and other hemodynamic variables.¹⁹ Thus, neural control of HR is likely a function of both the intrinsic cardiac and autonomic nervous systems.¹⁵

Autonomic Neuropharmacology

Norepinephrine is released from the sympathetic nerve varicosities; it interacts with β adrenergic receptors in the heart to produce positive chronotropic, dromotropic, or inotropic effects, depending upon the tissue under consideration. Newer evidence has shown that the heart itself synthesizes norepinephrine.^{20,21} Parasympathetic post-ganglionic fibers release acetylcholine that then interacts with muscarinic cholinergic receptors. Activation of these receptors, again depending upon the specific tissue, produces negative chronotropic, dromotropic, and, in the atria, inotropic effects. Although their function has not been fully elucidated, it is known that numerous putative neurotransmitters are co-released with these "classical" neurotransmitters. These include, for example, adenosine 5'-triphosphate, adenosine, 5-hydroxytryptamine, neuropeptide Y, vasoactive intestinal polypeptide, somatostatin, nitric oxide, carbon monoxide, and histamine.²²

Reflex Control of Cardiovascular Function

Receptors within the aortic arch and carotid sinus sense blood pressure changes and modify HR to maintain hemodynamic stability. For example, if blood pressure increases, the baroreceptors fire more rapidly and transmit impulses to the nucleus tractus solitarius (NTS) in the brainstem.²³ Neurons from the NTS project to the nucleus ambiguus and stimulate parasympathetic preganglionic neurons, which, in turn, project through the vagus nerve to parasympathetic ganglia at the heart.²³ At the same time, activity within the sympathetic nerves is decreased. As a result, HR, peripheral vascular resistance, and cardiac output decrease and blood pressure normalizes.

Increased right atrial pressure distends atrial mechanoreceptors, which transmit impulses to the brainstem via vagal afferent nerves. Unlike the baroreflex, this Bainbridge reflex is a “feed forward” mechanism whereby efferent sympathetic stimulation produces tachycardia and thus enables the heart to effectively pump the larger preload. However, the magnitude and direction of the HR response depend on the baseline HR and concomitant baroreceptor reflex activity.¹³

Respiratory Sinus Arrhythmia

Respiratory sinus arrhythmia (RSA) refers to the cyclical variation in HR interval associated with respiration and is primarily attributable to oscillations in efferent activity in the vagal fibers innervating the sino-atrial node (Figure 7.2).²⁴ During inspiration, lung distention stimulates vagal afferent nerves in the lungs. In the brainstem, these vagal sensory impulses ultimately inhibit vagal efferent activity, thereby increasing HR. With expiration, HR decreases secondary to increased cardiac vagal activity. This is one mechanism whereby breathing has a profound impact on HR fluctuations.²⁵ Other data suggest that sympathetic activity also influences RSA at both slow and rapid breathing rates.²⁶ Respiratory sinus arrhythmia may improve the efficiency of pulmonary gas exchange.²⁷

Heart Rate Variability

The RR interval on the electrocardiogram (ECG) is the time between two ventricular beats and thus can be used to calculate ventricular rate. For example, the RR interval is 0.8 sec when the HR is 75 beats/min. Heart rate variability refers to the increases and decreases over time in the RR interval.^{28,29} Very slowly occurring changes

in the RR interval have been attributed to alterations in vasomotor tone associated with thermoregulation.^{30,31} More rapid changes in the RR interval are produced by the baroreceptor reflex.²⁴ As has already been explained, rather rapid changes in RR interval are produced by respiration. Normal aging is associated with decreased HRV.³² Much of the current interest in HRV stems from reports that “power” within select frequency ranges provides evidence regarding the ANS and its effectors. Although HRV analysis does not directly measure autonomic nervous activity,³³ HRV data have prognostic value for patients with HF.^{1,4,34-36}

The first step of HRV analysis is to acquire a quality ECG recording; for typical applications, an artifact-free recording of five minutes’ duration is generally adequate, although longer data sets are required in more specialized circumstances.³⁷ Using a computer and commercial software, the ECG analog signal is then converted to a digital signal. The computer also generates the RR tachogram which is a series of time intervals between two consecutive R waves. Time-domain and frequency-domain analyses are the approaches most often used to quantify HRV. Nonlinear methods such as Poincaré plots have also been used to study patients with HF,^{38,39} though this methodology will not be considered here.

Time-Domain Analyses

Time-domain analyses are statistical calculations of RR intervals (also termed normal-to-normal [NN] intervals) and are relatively easy to compute. Using the RR tachogram, computer software calculates the sequential NN intervals of adjacent R waves produced by a sinus pacemaker; any ventricular ectopic beats are edited from the record. The software also computes the differences between NN intervals. Other time-domain

measures that can then be derived include: 1) standard deviation of all NN intervals for a selected time period (SDNN), 2) standard deviation of the mean of NN intervals in all 5-minute segments of the recording period (SDANN), 3) square root of the mean of the sum of the squares of differences between adjacent RR intervals (RMSSD), 4) the number of pairs of successive NN intervals differing by greater than 50 ms in the recording period (NN50 count), and 5) the proportion of differences in successive NN intervals greater than 50 ms (pNN50).²⁸ Although most investigators calculate pNN50 values, in one study NN12 values best differentiated between healthy persons and patients with HF.² In the same study, patients with New York Heart Association (NYHA) class I-II HF had higher pNN10, but not pNN50, values than patients with class III-IV HF. Numerically smaller time-domain values denote lower HRV.

Frequency-Domain Analyses

For frequency-domain (or spectral) analysis of the RR tachogram, computer software uses a mathematical algorithm, such as fast Fourier transformation, to apportion the HRV signal into its frequency components (Figure 7.3) and to quantify the power of these components. To understand this process more clearly, consider that any “signal” contains information that ranges from components that change very slowly (i.e., low frequency) to components that fluctuate rapidly. The relative admixture of the various frequency components is often of considerable importance. For example, the overall sound generated by a mixed choir of male and female voices includes the very-low frequencies of the base section, the somewhat higher frequencies of the tenors, as well as the much higher frequencies produced by the alto and soprano singers. The conductor, in analyzing the quality of the performance, can mentally perform a “frequency-domain

analysis” to discern the individual notes produced by each section (e.g., are the tenors “in tune?”), and assess the intensity of each part (e.g., is the mixture of the volume of sound from the bases and sopranos appropriately balanced?). Likewise, spectral, or frequency-domain analysis, precisely quantifies the power of fluctuations in HR over a designated range of frequencies.⁴⁰ Unlike time-domain measures, frequency-domain measures can quantitate rhythms and their frequencies.²⁵

Frequency-domain results are displayed by plotting the magnitude of HRV power against frequency. Three frequency bands are of clinical interest: 1) very-low frequency (VLF) band (0.003-0.04 Hz), 2) low frequency (LF) band (0.04-0.15 Hz), and 3) high frequency band (0.15-0.4 Hz).²⁸ In humans, VLF, LF, and high frequency peak frequencies are commonly centered around about 0.015 Hz, 0.1 Hz and 0.25 Hz, respectively. In some contexts an ultra-low frequency band (ULF; ≤ 0.003 Hz) is also of interest.^{41,42} Figure 7.3 is an illustrative heart rate power spectrum computed by a mathematical process known as “Fast Fourier Transform¹”; it shows concentrations of power within the three major bands. The area under the curve of each frequency band represents the power within that band. Normally, LF power exceeds high frequency power. Total power represents the variability of the entire signal and is obtained by summing the powers of each frequency band. Low frequency and high frequency power are often “normalized” (i.e., expressed as a percentage of total power) by dividing each

¹ The computations involved in the Fast Fourier Transform, or FFT, have been included in most of the commercial software that is now widely available for HRV analysis. It is important to bear in mind, however, that there are a number of important requirements for valid computations. For example, any signal subject to FFT must be “stationary,” meaning that the statistical characteristics of the signal (e.g., mean value, variance) are the same throughout the course of the recording. The algorithm assumes these conditions have been met, when, in fact, one or more may be violated by a given data set. One must assure him/herself that these requirements are satisfied before performing the computation if valid results are to be obtained.

by the total power minus VLF power,⁴³ although in Figure 7.3 power is given in absolute units of beats-per-minute squared.

Although some have cautioned that respiration itself may be responsible for observed changes in HRV,^{24,44,45} it is generally believed that specific physiological processes contribute differently to power within the various regions. For example, it is commonly accepted that respiratory mechanisms mediate high frequency components of HRV.^{12,27,46-48} Recall that HR responds very quickly to changes in the nervous activity in the parasympathetic nerves innervating the sino-atrial node. This rapid response characteristic ultimately assures that the high frequency peak of the HR power spectrum is mediated largely, probably exclusively, by the parasympathetic nervous system.⁴⁶ Conversely, the sympathetic system is unable to mediate high frequency components because the sino-atrial nodal response to changes in norepinephrine interaction with the β -adrenergic receptor is much slower than that of acetylcholine interacting with the muscarinic receptors.^{40,49} Thus, the high frequency component provides data about how the sino-atrial node responds to vagal activity at the respiratory frequency.

In contrast, a mixture of sympathetic and parasympathetic activities is generally thought to influence the LF components of HRV.^{12,46,47} As such, the LF component provides information about autonomic tone; however, evidence suggests that parasympathetic activity dominates at higher frequencies.⁵⁰ The circadian rhythm accounts for much of the variation in the ultra-low frequency band.⁵¹

Some^{17,28,49} investigators argue that the ratio of power within the low frequency vs. high frequency spectral regions (i.e., low frequency:high frequency ratio) distinguishes sympathetic effects from parasympathetic effects. However, this is

controversial^{48,52} and caution is warranted in drawing any conclusions in this regard.

Although the sympathetic and parasympathetic systems function on a reciprocal basis, these systems are not necessarily “balanced.”⁴⁸

Heart Rate Variability and Heart Failure

It is well known that a hallmark of HF is adverse changes in autonomic function that are manifested, in part, by altered HRV. Heart failure ensues following myocardial cell damage that impairs ventricular contractility. Neurohormonal systems are activated in an attempt to maintain cardiac output and tissue perfusion.⁵³ Nonetheless, chronic neurohormonal activation ultimately contributes to progressively deteriorating HF.⁵³ Fundamentally, HF is characterized by profoundly elevated sympathetic activity for an extended period. Although perhaps less well documented, parasympathetic withdrawal is also an important facet of HF.^{47,54}

Heart rate variability analysis enables clinicians and researchers to detect, quantify, and trend changes in autonomic activity for patients with HF. However, spectral analysis is difficult for patients with terminal HF because HR is often nearly invariant.⁴⁷

As shown in Table 7.1, patients with HF exhibit altered HRV in both the time and frequency domains. High sympathetic activity,⁵⁵⁻⁵⁷ neuroendocrine dysfunction,⁴⁰ elevated cytokine levels,⁵⁸ and reduced vagal-cardiac activity⁵² contribute to decreased HRV for patients with HF. Patients with decreased HRV have difficulty employing vagal mechanisms to counteract sympathetic activation.⁵⁹ Others^{60,61} have reported that patients with HF have decreased LF power, which seemingly contradicts the thought that

HF is associated with high sympathetic tone. It is possible, therefore, that HRV analysis may be difficult to interpret for certain groups of individuals, for example, patients with HF compared with healthy persons.

Importantly, decreased HRV is associated with adverse outcomes, as shown in Table 7.2. In summary, time-domain HRV parameters predict mortality^{1,4,36,62-65} and future cardiac events.³⁴ In addition, frequency-domain parameters reportedly predict mortality,^{1,35,64,66} sudden death,^{5,62} and need for heart transplantation.⁶⁷

Although HRV data are useful, they cannot be interpreted reliably without attention to comorbid conditions,⁴⁹ medication therapy,²¹ body position,⁶⁸ emotions,^{69,70} circadian rhythm,³² and other variables known to affect the ANS. For example, patients with HF had higher normalized high frequency power, lower normalized LF power, and lower LF:high frequency ratio values in the right lateral decubitus position than in supine or left lateral positions.⁶⁸ Moreover, beta-blockers, angiotensin-converting enzyme inhibitors, and aldosterone antagonists may exert their morbidity and mortality benefits by minimizing ANS and neurohormonal disturbances.²¹ Specifically, beta-blockers improve HRV for patients with HF^{71,72} but nonetheless remain underutilized. It is important for clinicians to prescribe and administer beta-blockers, as this treatment strategy may prevent the adverse outcomes described in Table 7.2.

In summary, the sympathetic and parasympathetic nervous systems, reflexes, and respiration influence HR. Heart rate variability analysis enables clinicians and researchers to examine the influences of autonomic activity on HR. A consistent finding for patients with HF is decreased HRV. Importantly, this decreased HRV is associated with adverse outcomes.

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Table 7.1: Research that Indicates Heart Failure is Associated With Decreased Heart Rate Variability

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Saul et al., 1988 ⁷³	Compare the pattern of HRV for patients with severe HF and healthy persons; determine if HRV correlates with hemodynamic and clinical status	25 patients with class III-IV HF; 21 healthy individuals	Patients with HF had a higher mean HR, lower standard deviation of HR, lower SDNN, and lower spectral power in all frequency bands than healthy individuals; in the 0.04-0.07 Hz band, there was a positive relationship between both absolute and fractional power and cardiac index and an inverse relationship between both absolute and fractional power and PCWP
Binkley et al., 1991 ⁵⁴	Describe the autonomic profile of patients with ventricular dysfunction; evaluate whether patients with ventricular failure have reduced parasympathetic tone	15 healthy men; 10 patients with congestive cardio-myopathy	Healthy men exhibited both HFP and LFP; patients with HF manifested very little HFP, but amplified LFP; after receiving atropine, healthy persons exhibited a significant decrease in HFP; patients with HF had a lower HF:LF ratio than healthy men; fundamentally, parasympathetic withdrawal is a feature of HF
Nolan et al., 1992 ⁷⁴	Investigate cardiac parasympathetic activity and its association with LV function for patients with HF	43 patients with class II-III HF	To evaluate parasympathetic activity, HRV was measured by counting the number of times that each RR interval was > 50 ms longer than the preceding RR interval; 60% of patients had lower than expected counts; 24 hour RR counts and LVEF were moderately correlated

Table 7.1 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Szabo et al., 1995 ⁷⁵	Assess the relationship between severity of HF and changes in HRV	79 patients with HF	NYHA class was inversely correlated with SDNN, SDANN, and LFP; peak VO_2 (ml/min/kg) was positively correlated with SDNN, SDANN, LFP, and HFP; patients with class III-IV HF had lower SDNN, SDANN, and LFP values than patients with class I-II HF; patients with peak $\text{VO}_2 < 15.9$ ml/min/kg had lower SDNN, SDANN, HFP, and LFP values than patients with peak $\text{VO}_2 > 15.9$ ml/min/kg
Guzzetti et al., 1995 ⁷⁶	Analyze neural activity of the cardiovascular system in patients with HF	30 patients with class II-IV HF; 15 healthy individuals	Patients with class III or IV HF had lower mean RR values than healthy patients and patients with class II HF; patients with class IV HF had higher HFP (nu) values than other patients and healthy persons; LFP (nu) decreased as HF class increased and was nearly absent in patients with class IV HF; when tilted, healthy persons, but not patients with HF, had decreased RR and HFP (nu) and increased LFP (nu) values; only healthy persons had decreased LFP (nu) with controlled respiration

Table 7.1 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Fei et al., 1996 ⁷⁷	Evaluate whether the autonomic nervous system contributes to CI in patients with HF	41 patients with IDC	24% of patients exhibited CI ("an inadequate sinus node response to exercise"); although mean HR was similar, patients with CI had lower SDNN, ln TP, and ln LFP values than patients without CI
van de Borne et al., 1997 ⁶⁰	Examine sympathetic nerve activity for patients with HF	21 patients with HF; 12 healthy individuals	At LFP, patients with HF had lower RR interval variability and MSNA activity than healthy persons; at HFP, patients with HF had higher RR interval variability and MSNA activity than healthy individuals; only four patients exhibited a LFP component detectable in both RR and MSNA
Atherton et al., 1998 ⁷⁸	Evaluate whether changes in LVEDV during application of lower-body negative pressure correlate with HRV measures for patients with HF	30 patients with class I-IV HF	During application of lower-body negative pressure, there was a significant negative correlation between change in LVEDV and SDNN, RMSSD, TP, LFP, and HFP

Table 7.1 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Scalvini et al., 1998 ⁶¹	Use HRV to assess autonomic modulation in patients with HF	30 patients with symptomatic class II-IV HF; 21 patients with asymptomatic LVD; 25 healthy individuals	At rest and during sympathetic and parasympathetic stimulation, patients with HF had lower SDNN and lower absolute and LFP (nu) values than healthy individuals and patients with LVD; at rest, patients with HF had higher HFP (nu) values than persons in the two other groups; patients with HF and asymptomatic LVD did not manifest HRV changes in response to sympathetic stimulation
Yoshikawa et al., 1999 ⁵⁶	Evaluate the relationship among clinical variables, HRV, and baroreceptor sensitivity	146 patients with class I-IV HF	Patients were divided into either a high or low norepinephrine group; patients in the high norepinephrine group had lower ln TP, ln LFP, and ln HFP than patients in the low norepinephrine group; TP and LFP were inversely correlated with norepinephrine level; TP was correlated with plasma renin activity; LFP was correlated with baroreceptor sensitivity

Table 7.1 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Aronson & Burger, 2000 ⁷⁹	Explore gender-related differences in HRV for patients with HF	131 men and 68 women with class III-IV HF	Women had higher SDNN, SDANN, ln ULFP, and ln TP values than men; for patients with nonischemic HF, women had higher SDNN, SDANN, RMSSD, ln TP, ln ULFP, ln VLFP, ln LFP, and ln HFP values than men
Soejima et al., 2000 ⁸⁰	Determine whether age-corrected HRV can be used as an index of HF severity and prognosis	90 patients with class I-IV HF	Patients with LVD had lower ln HFP and ln LFP values than normal controls; normal controls had greater circadian changes in ln HFP and LF:HF values than patients with LVD; for patients with LVD, ln LFP decreased as HF class increased but ln HFP did not decrease significantly beyond NYHA class II; after a mean follow-up of 1388 days, patients with worsened symptoms had greater decreases in ln LFP and ln HFP than patients with stable symptoms
Malfatto et al., 2001 ⁸¹	Evaluate whether the etiology of HF influences the sympathovagal balance and autonomic responsiveness of patients with HF	21 patients with ischemic HF; 21 patients with IDC	Patients with ischemic HF had higher LFP (nu) and LF:HF ratio values and lower HFP (nu) values than patients with IDC at rest and in response to parasympathetic and sympathetic stimuli; patients with ischemic HF had lower LFP (nu) and LF:HF ratio values during parasympathetic stimulation than at rest

Table 7.1 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Malave et al., 2003 ³	Investigate the relationship between HRV and circulating levels of TNF and norepinephrine	29 patients with class I-IIIa HF; 10 healthy individuals	Patients with class IIIa HF had lower SDNN, SDANN, ln LFP, and HFP values than healthy persons and lower SDNN values than patients with class I-II HF; TNF levels were inversely correlated with SDNN, SDANN, ln LFP, and ln HFP; norepinephrine levels were inversely correlated with SDNN, SDANN, and ln LFP; TNF and ln norepinephrine levels predicted SDNN and ln LFP values
Musialik- Lydka et al., 2003 ⁸²	Analyze HRV in patients with depressed LVEF; relate HRV to clinical parameters	105 patients with class II-IV HF; 30 healthy individuals	Patients with HF had lower SDNN, SDANN, and RMSSD values than healthy persons; patients with class III-IV HF had lower SDNN and SDANN values than patients with class II HF; NYNA class was negatively correlated with SDNN, SDANN, and RMSSD values; SDNN and SDANN were moderately correlated with LVEF but were stronger for patients with ischemic cardiomyopathy than patients with dilated cardiomyopathy

CI = chronotropic incompetence; HF = heart failure; HFP = high frequency power; HR = heart rate; HRV = heart rate variability; IDC = idiopathic dilated cardiomyopathy; LFP = low frequency power; ln = logarithmic units; nu = normalized units; LV = left ventricular;

Table 7.1 (Continued)

LVD = left ventricular dysfunction; LVEDV = left ventricular end-diastolic volume; LVEF = left ventricular ejection fraction; mean RR = mean duration of all normal (NN) RR intervals; MSNA = muscle sympathetic nerve activity; NYHA = New York Heart Association; PCWP = pulmonary capillary wedge pressure; peak VO_2 = peak oxygen consumption; RMSSD = square root of the mean of the sum of the squares of differences between adjacent RR intervals; SDNN = standard deviation of all normal RR intervals; SDANN = standard deviation of the averages of RR intervals in all 5-minute segments; TNF = tumor necrosis factor; TP = total power; ULFP = ultra-low frequency power; VLF = very-low frequency power

Table 7.2: Research That Indicates Decreased Heart Rate Variability is Associated With Poor Outcomes

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Brouwer et al., 1996 ⁸³	Determine the prognostic value of HRV for patients with mild to moderate HF	95 patients with chronic class II-III HF	No relationship between time and frequency HRV measures and <i>mortality</i> ; in a multivariate model, abnormal HRV Poincaré plots independently predicted <i>all-cause cardiac death</i> and <i>SCD</i>
Ponikow-ski et al., 1997 ³⁵	Evaluate the prognostic value of HRV for patients with moderate to severe HF	102 patients with class II-IV HF	In a multivariate model, SDNN, SDANN, and LFP predicted <i>cardiac mortality</i> independently of peak $\dot{V}O_2$, NYHA class, LVEF, and VT; patients with a SDNN < 100 ms had higher <i>1-year mortality</i> rates than patients with a SDNN > 100 ms
Fauchier et al., 1997 ³⁴	Assess the relationship between HRV, and hemodynamic variables and ventricular dysrhythmias for patients with IDC; investigate the prognostic value of HRV	93 patients with IDC; 63 healthy individuals	Patients with IDC had a lower mean RR, SDNN, RMSSD, and day HR:night HR ratio than healthy persons; patients with IDC and class II-IV HF had a lower mean RR, SDNN, and day HR:night HR ratio than patients with class I HF; mean RR, SDNN, and day HR:night HR ratio correlated with LV shortening fraction, PCWP, and LVEF; in multivariate analysis, decreased SDNN independently predicted <i>future cardiac events</i> ; SDNN < 100 was associated with <i>higher mortality</i> rates

Table 7.2 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Szabo et al., 1997 ⁶⁵	Assess the prognostic value of HRV for patients with HF	159 patients with class II-IV HF	In a multivariate model, SDNN < 108 ms and pNN50 < 2% predicted <i>all-cause cardiac mortality</i> ; pNN50 < 2% and LFP > 14 ms ² predicted <i>death from progressive pump failure</i>
Jiang et al., 1997 ⁸⁴	Assess the ability of HRV to predict mortality and life- threatening cardiac events for patients with HF	26 patients with ≥ IIIb HF	Patients who <i>died</i> or had a <i>life-threatening event</i> had lower SDNN and SDANN values than patients without events; SDNN ≤ 53.4 ms and SDANN ≤ 41.3 ms were associated with shorter <i>event-free survival</i> ; other clinical measures did not distinguish event-free patients from those who had cardiac events
Nolan et al., 1998 ³⁶	Assess the prognostic value of HRV for patients with HF	433 patients with class I-III HF	SDNN was a univariate and multivariate predictor of <i>all-cause mortality</i> ; patients with SDNN < 50 msec had highest mortality rates; SDNN was a stronger predictor of <i>death</i> related to progressive HF than other conventional clinical parameters
Wijbenga et al., 1998 ⁸⁵	Assess the clinical and prognostic value of HRV for patients with HF	64 patients with HF	HRVI was positively associated with LVEF and deceleration time; in a multivariate model that included several clinical parameters, HRVI index independently predicted <i>cardiac death</i> and <i>heart transplantation</i>

Table 7.2 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Bonaduce et al., 1999 ⁶⁶	Assess the predictive value of HRV for patients with HF	97 patients with HF	Patients with class III-IV HF had lower time-domain (mean RR, SDNN, SDANN index, SDNN index) and frequency domain (ln TP, ln ULFP, ln VLFP, ln LFP, LF:HF ratio) measures of HRV than patients with class II HF; SDNN, SDANN index, pNN50, and LF:HF ratio predicted <i>mortality</i> for patients regardless of etiology; the inclusion of HRV data improved the prognostic value of clinical and echocardiographic data
Guzzetti et al., 2000 ⁸⁶	Determine the prognostic value of spectral and non-linear analysis of HRV	30 patients with HF; 20 healthy individuals	Compared to healthy persons, patients with HF had lower LF (nu) and LF:HF values, higher HFP (nu) values, and a steeper 1/f slope; baseline LFP (absolute and nu) was higher and the 1/f slope less steep for patients who were <i>alive</i> at 15-month follow-up
Galinier et al., 2000 ⁶²	Assess the prognostic value of HRV for all-cause and sudden death	190 patients with class II-IV HF	Non-survivors had lower SDNN, SDANN, SD, ln day-time and ln night-time TP, ln day-time and ln night-time LFP, and ln night-time HFP values; in a multivariate model, SDNN < 67 ms predicted <i>all-cause death</i> while day-time ln LFP < 3.3 ms ² predicted <i>sudden death</i>

Table 7.2 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Lucreziotti et al., 2000 ⁶⁷	Assess the interaction between autonomic activity and RV function in severe HF and determine whether this predicts future cardiac events	75 patients with severe HF	The LF:HF ratio was inversely correlated with norepinephrine levels; in a multivariate model that included standard clinical variables, only low LF:HF ratio independently predicted <i>cardiac death</i> and <i>heart transplantation</i> ; TP and LFP were positively correlated with RVEF; HFP was inversely associated with RVEF
Makikallio et al., 2001 ¹	Evaluate whether HRV predicts mortality for patients with chronic HF with ventricular dysfunction	499 patients with class II-IV HF and ventricular dysfunction	Mean HR, SDNN, HRVI, ln VLFP, and short-term fractal exponent (α_1) were univariate predictors of <i>mortality</i> ; HRV indices were stronger univariate predictors of <i>mortality</i> for patients with class II HF than for those with class III or IV HF; after adjusting for other risks such as age and LV function, α_1 predicted <i>mortality</i> for patients with class II but not class III or IV HF
Boveda et al., 2001 ⁶³	Assess the prognostic value of time-domain measures of HRV for patients with HF	190 patients with class II-IV HF	Survivors had higher SDNN, SDANN, and SD values; in a multivariate model, SDNN < 67 ms independently predicted <i>all-cause death</i>

Table 7.2 (Continued)

Author/ Date	Major Purpose of the Study Regarding HRV	Sample	Major Findings Related to Heart Rate Variability for Patients with Heart Failure
Bilchick et al., 2002 ⁴	Evaluate whether HRV could predict SCD in patients with HF	127 patients with class II-IV HF	Patients with SDNN < 65.3 msec had a higher risk of <i>mortality</i> and SCD than patients with SDNN $\geq$ 65.3 msec; in a multivariate model containing demographic and clinical variables, only SDNN predicted overall <i>mortality</i>
La Rovere et al., 2003 ⁵	Determine whether HRV predicts SCD for patients with HF	Derivation and validation samples of 202 and 242 patients, respectively, with moderate to severe HF	For the derivation sample, LFP $\leq$ 13 ms ² during controlled breathing and LVEDD $\geq$ 77 mm independently predicted SCD; in the validation sample, LFP $\leq$ 11 ms ² during controlled breathing and $\geq$ 83 PVCs/hour predicted SCD
Aronson et al., 2004 ⁶⁴	Investigate whether HRV measures predict post-discharge survival for patients admitted with decompensated HF	199 patients with class III- IV HF	In a multivariate model, patients with SDNN, SDANN, TP, and ULFP values < 44 ms, < 37 ms, < 1,475 ms ² , and < 1,100 ms ² respectively, had higher all-cause <i>mortality</i> rates; ULFP power was the strongest predictor of all-cause <i>mortality</i>

Table 7.2 (Continued)

HF = heart failure; HFP = high frequency power; HR = heart rate; HRV = heart rate variability; HRVI = heart rate variability index; IDC = idiopathic dilated cardiomyopathy; LFP = low frequency power; ln = logarithmic units; nu = normalized units; LV = left ventricular; LVEDD = left ventricular end-diastolic diameter; LVEF = left ventricular ejection fraction; mean RR = mean duration of all normal to normal (NN) RR intervals; NYHA = New York Heart Association; PCWP = pulmonary capillary wedge pressure; peak VO_2 = peak oxygen consumption; pNN50 = percentage of adjacent normal RR intervals > 50 ms different; PVC = premature ventricular contraction; RMSSD = square root of the mean of the squares of differences between adjacent RR intervals; RV = right ventricular; RVEF = right ventricular ejection fraction; SCD = sudden cardiac death; SD = mean of the standard deviations of all RR intervals for all 5-minute segments; SDNN = standard deviation of all normal RR intervals; SDANN = standard deviation of the averages of RR intervals in all 5-minute segments; TP = total power; ULFP = ultra-low frequency power; VLFP = very-low frequency power; VT = ventricular tachycardia

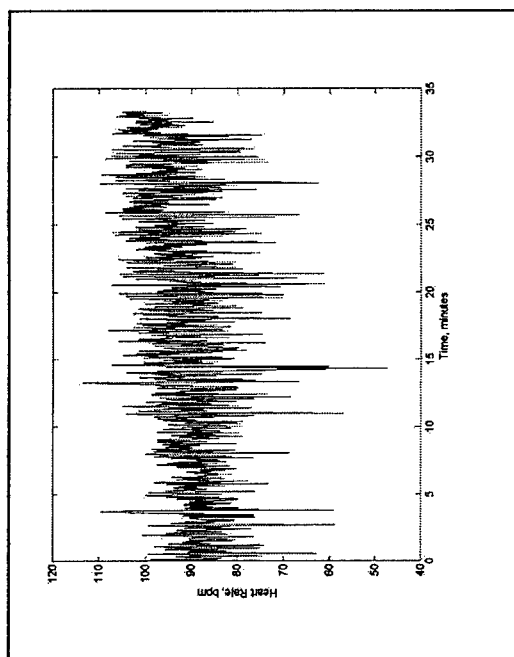


Figure 7.1: Beat-By-Beat Heart Rate Over Time From an Individual Patient. "Cardiotachometer" output shown here resulted from the computer detecting the interval between onset of successive individual heart beats and converting the resultant sequence of RR intervals into a visual display of heart rate. Heart rate fluctuated significantly from moment-to-moment. Power spectral analysis is a mathematical process that quantitatively summarizes these fluctuations in terms of frequency and amplitude.

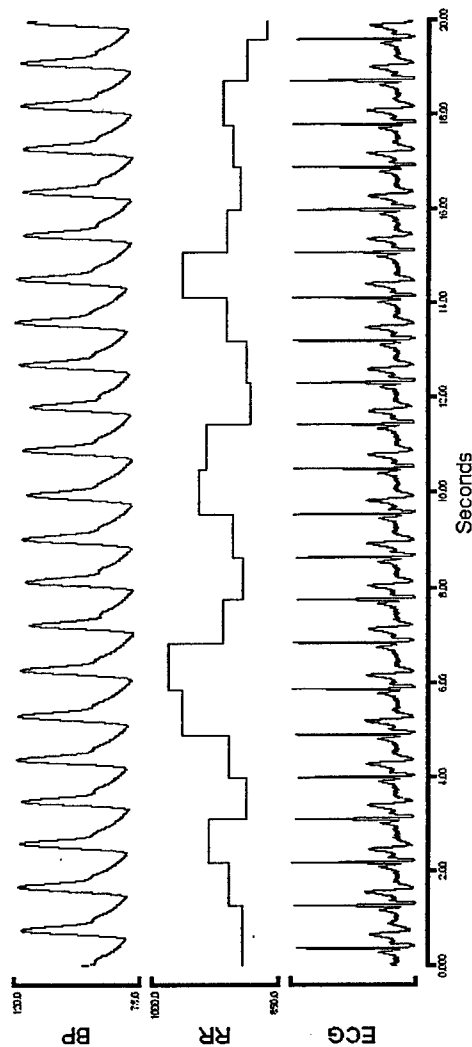


Figure 7.2: Arterial Blood Pressure (top, mm HG; recorded non-invasively), RR interval (middle, msec.), and Electrocardiogram (bottom) Show Waxing and Waning of Inter-Beat Interval Over Time in This Resting Subject. This arrhythmia, which originates in the sinus node (note P waves preceding each QRS complex) and is in phase with respiration, is known as respiratory sinus arrhythmia. This rhythm appears in the heart rate power spectrum within the “high frequency” region and is mediated by alterations in parasympathetic nervous activity to the sino-atrial node.

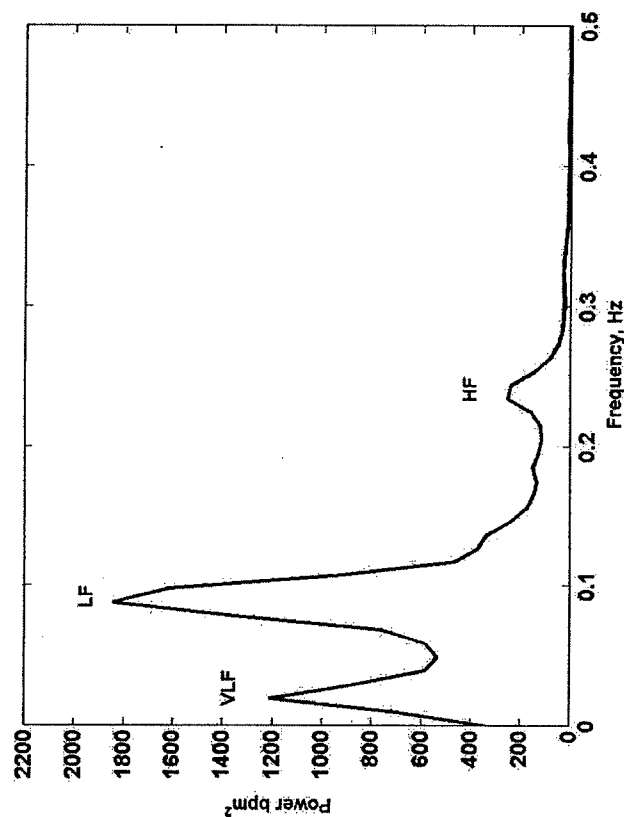


Figure 7.3: Illustrative Heart Rate Power Spectrum From an Individual Patient. Ordinate is power (mm Hg^2), shown here using a linear scale; abscissa is frequency (Hz). High frequency (HF) peak at respiratory rate is widely acknowledged to be under the control of the parasympathetic nervous system, though the precise relationship between changes in cardiac vagal nervous activity and changes in HF power has not been established. Low frequency (LF) peak typically occurs at about 0.1 Hz in the human; the power within the HF region in the heart rate spectrum appears to be jointly controlled by cardiac sympathetic and parasympathetic nervous activity. The very-low frequency (VLF) peak has been attributed to slowly varying changes in vasomotor tone, probably related to processes such as thermoregulation.

CHAPTER EIGHT

Conclusions and Discussion

In the United States, nearly 18 million individuals have coronary heart disease or heart failure (HF), and cardiovascular disease is the leading cause of death.¹ As many as 69-70% of patients with HF or acute myocardial infarction (AMI) are anxious.²⁻⁴ Yet, the fact is that clinicians infrequently assess patients with cardiac disease for anxiety.^{5,6} Sociodemographic and clinical variables do not fully explain untoward outcomes for cardiac patients, however, in general, investigators and clinicians have failed to consider how anxiety may contribute to poor outcomes. There is growing evidence, however, that anxiety contributes to dysrhythmias, reinfarction, recurrent ischemia, poor functional status, and increased mortality for patients with cardiac disease.^{3,7-13}

Several reasons may explain why investigators and clinicians seem apathetic about anxiety in patients with cardiac disease. First, some view studies of anxiety and other psychological constructs as “soft” or less scientific than biological measures. Second, many clinicians regard anxiety as “understandable” and without clinical importance, especially when it accompanies physical illness.¹⁴ Third, patients with repressive tendencies may not recognize or report anxiety and thus downplay the effects of anxiety.¹⁵ Clinicians who are inclined to repudiate anxiety and its impact are unlikely to further assess anxiety in these patients. Fourth, many nurses and physicians were not formally educated about the importance of anxiety. At best, nursing and medical schools devote a few hours of content to psychological topics. There are modest numbers of journal articles, research reports, and podium presentations at professional meetings that encompass anxiety. However, given that few investigators and clinicians attend podium

presentations about psychological topics, one wonders whether printed reports about these matters are read. Fifth, others assume that other emotions (e.g., depression) or factors (e.g., culture, values, beliefs) correlate highly with anxiety, making it difficult to directly isolate the effects of anxiety.

Chapter two of this dissertation addresses the assumption that culture is strongly related to anxiety. The study was a prospective, comparative, cross-cultural investigation to evaluate whether anxiety after AMI differed across five diverse countries. In all countries studied – Australia, England, Japan, South Korea, and the United States – patients experienced high anxiety after AMI. In fact, the mean anxiety level was 77% higher than the normal mean anxiety level. The level of anxiety remained similar in all countries even when controlling for sociodemographic variables on which the countries differed. The findings suggest that the threat of AMI is associated with high anxiety without regard to country of residence. Clinicians should abandon long-held stereotypes regarding cultural variations in the expression of anxiety.

Lack of interest by clinicians about anxiety may also stem from its subjective nature. Investigators and clinicians have voiced concerns that, unlike physiologic measures, it is difficult to assess subjective phenomenon. As a result, over 200 instruments have been developed and used to assess anxiety. Chapter three of this dissertation was a critical review and analysis of literature regarding measurement of anxiety. The literature review revealed no consensus about the conceptual definition of anxiety and that many investigators fail to define anxiety. Although self-report anxiety instruments differ by purpose, scope, length, and normative data, investigators commonly used the State-Trait Anxiety Inventory,¹⁶ the anxiety subscale of the Brief Symptom

Inventory,¹⁷ and the anxiety subscale of Hospital Anxiety and Depression Scale¹⁸ to assess anxiety for patients with cardiac disease. Nonetheless, various other instruments also are used to assess anxiety. Conceivably, the inadequate conceptualization of anxiety is related to investigators' inconsistent application of anxiety assessment instruments.

Nurses who care for cardiac patients favor physiologic measures of anxiety and use their clinical judgment to assess anxiety;^{6,19} however, evidence to support this practice for cardiac patients was lacking. Chapter four was a descriptive, correlational study that was conducted to determine whether heart rate and blood pressure were related to level of anxiety in patients with chronic advanced HF, patients with AMI, and healthy individuals. Substantial numbers of both patients and healthy individuals were more anxious than the norm reference anxiety level. Higher anxiety was associated with *lower* systolic blood pressure in patients with AMI and in healthy individuals. There were no significant correlations between anxiety and heart rate or diastolic blood pressure for any participants. In addition, regardless of the presence or absence of cardiac disease, mean systolic blood pressure, diastolic blood pressure, and heart rate did not differ significantly when comparing patients classified as nonanxious with patients classified as anxious. Although clinicians report a propensity to use changes in heart rate and blood pressure as indicators of anxiety, results of this study do not support this practice. Rather, clinicians should use a valid and reliable anxiety assessment instrument to assess anxiety because changes in heart rate and blood pressure are fallacious indicators of anxiety for cardiac patients. Unfortunately, some critically ill patients with AMI or HF are unable to complete a self-report anxiety instrument. Future research may uncover physiologic measures that reliably reflect anxiety for patients with cardiac disease.

Clinicians are more likely to assess anxiety if the assessment instruments are easy to administer, score, interpret, and document. Previous investigators suggested that a single-item anxiety assessment instrument may allay clinicians' concerns about the length and complexities of available anxiety assessment instruments.⁶ The study in chapter five was completed to ascertain whether a single-item anxiety assessment instrument, the Anxiety Level Index (ALI), was a valid alternative to the State Anxiety Inventory¹⁶ (SAI) or the anxiety subscale of the Brief Symptom Inventory¹⁷ (BSI) for assessing state anxiety for patients with AMI. Results of this prospective, multi-center study indicated that the ALI correlated significantly with both the SAI and the anxiety subscale of the BSI. Nevertheless, more advanced statistical analyses using the Bland-Altman method revealed that the ALI was not a valid measure of anxiety. Although the one-item anxiety scale does not appear to be sufficient, this research area must not become dormant. There are short, easy-to-use alternatives that are not burdensome to most patients or nursing staff. For example, the anxiety subscale of the BSI is only six items. The Faces Anxiety Scale²⁰ is a newer, single-item anxiety instrument composed of five faces that may be useful for patients who have difficulty completing even a six-item anxiety assessment instrument. The five faces range from a neutral face to a face showing extreme anxiety; the patient specifies which face best represents his or her current level of anxiety. The fate of whether the Faces Anxiety Scale is a valid measure of anxiety for patients with AMI awaits results of future research.

Considering the findings from chapters three, four, and five, there is a need for clinicians and researchers from the disciplines of nursing, medicine, psychoneuroendocrinology, biology, behavioral science, and neuropsychology to

collaboratively develop a common conceptualization of anxiety that has relevance to cardiac patients, and then to select or create a valid and reliable anxiety assessment instrument that is congruent with the agreed-upon conceptualization. Thereafter, it will be feasible to assess anxiety consistently, compare findings across studies, identify scores that signal the need for treatment, and evaluate the effectiveness of interventions designed to reduce anxiety.

Contradictory findings regarding the prognostic value of anxiety contribute to indifference about anxiety. For example, many,^{3,8,10,12,21} but not all,²²⁻²⁵ investigators reported that independently of demographic and clinical variables, anxiety predicted future cardiac events (i.e., reinfarction, unstable angina, dysrhythmias, mortality) during the follow-up period for patients with AMI or HF. A possible reason for these inconclusive findings is that anxiety was not consistently conceptualized and measured. Worth remembering though, is that research findings are often somewhat inconsistent, especially when disparate research methods are used. For example, it is controversial whether fibrinolytic therapy or primary angioplasty restores coronary circulation more rapidly and reduces mortality for patients with AMI. Research findings differ based on the fibrinolytic agent, length of patient delay in seeking care, type of facility, and measured end-point.²⁶ Despite these mixed findings, no one has suggested that fibrinolytic and angioplasty practice and research areas be disregarded. So too, anxiety research must continue, preferably in a more consistent manner that will facilitate comparison among studies.

Outcomes of interest include not only future cardiac events, but also daily health status. Nearly 4 million Americans live with symptomatic HF.¹ It is well-known that

symptoms of HF adversely affect patients' health status. Chapter six of this dissertation was a descriptive, correlational study to determine the best model of health status from among relevant sociodemographic, clinical, health perception, and emotional variables for patients with HF. Worse New York Heart Association (NYHA) class, higher anxiety, and higher depression predicted worse health-related quality of life, explaining 37% of the variance. Better NYHA class and higher anxiety predicted higher levels of physical activity and explained 17% of the variance. Worse NYHA class and higher depression predicted greater symptom burden, explaining 52% of the variance. Of interest is that traditional sociodemographic and clinical variables such as age, gender, left ventricular ejection fraction, and comorbidities did not predict health-related quality of life, activity level, or symptom burden. Experts have only recently viewed health status as an important assessment parameter and treatment outcome. Importantly, interventions to improve health status should target not only physical, but also emotional, well-being. It is well within the scope of nursing practice to assess and treat anxiety. Holistic and caring foci are core nursing values. If nurses lead the way, perhaps clinicians from other disciplines will become more cognizant about the importance of assessing and treating anxiety.

In reality, practice guidelines inadequately address the assessment and treatment of anxiety. For instance, the most recent American College of Cardiology (ACC) and American Heart Association (AHA) guidelines for unstable angina and non-ST-segment elevation AMI²⁷ and the ACC/AHA guidelines for chronic HF²⁸ do not contain recommendations for the assessment or management of anxiety. According to the ACC/AHA guidelines for management of ST-elevation AMI, "It is reasonable to use

anxiolytic medications in STEMI [ST-elevation myocardial infarction] patients to alleviate short-term anxiety..." and "it is reasonable to routinely assess the patient's anxiety level and manage it with behavioral interventions and referral for counseling."²⁹ p. ⁸⁶ But, what is "routinely"? And, what "behavioral interventions" should be initiated? Also missing in the guidelines are specifics for *how* to assess anxiety. Although inclusion of anxiety assessment recommendations in practice guidelines is a good first step, clinicians are often unaware of or unfamiliar with guidelines, disagree with the guidelines, disbelieve that the guidelines will improve outcomes, or are seemingly unable or unwilling to change long-standing practices, and thus do not incorporate guidelines into their practice.³⁰⁻³³ Health care delivery models that emphasize the role of nurses and nurse practitioners have produced superior results regarding both adherence to guidelines and outcomes such as readmission rates, length of hospital stay, and mortality.³⁴⁻³⁷ For example, in one study, three approaches to implementing beta-blockers were compared: 1) provider education, 2) provider and patient notification regarding beta-blocker therapy, and 3) nurse practitioner (NP) facilitator.³¹ Patients assigned to the NP facilitator were more likely to have beta-blockers initiated, have the dose uptitrated, and achieve the target dose.

Often, clinicians rush to use new diagnostic or therapeutic equipment. For example, cardiologists quickly integrated pulmonary artery catheters, drug-coated coronary stents, and biventricular pacemakers into practice. In contrast, clinicians seem reluctant to adopt the assessment and treatment of anxiety into their clinical practice. This reluctance may stem from inadequate conceptualization of anxiety, inconsistent

measurement of anxiety, and few data about the mechanism(s) by which anxiety contributes to cardiovascular outcomes.

The seventh chapter of this dissertation was a review of neural control of heart rate and heart rate variability (HRV). Although the mechanisms whereby anxiety is associated with cardiac outcomes are not entirely clear,³⁸ the pathophysiologic model suggests that anxiety is associated with adverse outcomes through its stimulatory effects on the sympathetic nervous system. Heart rate variability analysis is one approach that has been used to detect, quantify, and trend changes in autonomic activity for patients with HF. Research findings regarding the HRV variability of patients with HF were appraised. From the literature, it is evident that respiration, reflexes, and the sympathetic, parasympathetic, and intrinsic cardiac nervous systems affect heart rate. Patients with HF had decreased HRV in both the time and frequency domains. Patients with HF who manifested decreased HRV had more cardiac events and higher mortality rates than patients with preserved HRV. There is ample evidence in the literature that anxiety and mental stress, considered an anxiety equivalent, activate the sympathetic nervous system for both healthy and unwell persons.³⁹⁻⁴⁴ Thus, anxiety may activate the sympathetic nervous system which, in turn, contributes to altered HRV.

As mentioned, practice guidelines do not recommend treatment strategies for alleviating anxiety. Relaxing music, in-hospital structured support and education, home visits, home-based self help packages, cardiac rehabilitation, graduated exercise training, structured cognitive therapy and stress management, dietary interventions, biofeedback-relaxation training, audio-visual relaxation training, and mindfulness-based meditation have all been found to reduce anxiety in patients with cardiac disease.⁴⁵⁻⁵⁴ Only one

randomized trial of anxiolytic drugs for patients with AMI or HF has been conducted.⁵⁵ In this dated study, male patients with AMI were randomly assigned to receive diazepam or placebo every 6 hours. There was no difference in patients' self-assessed anxiety levels but patients who received diazepam were drowsier than patients who received the placebo. Although only males were enrolled into this study and care for patients with AMI has changed dramatically over the years, this finding indicates that nonpharmacologic interventions may be more effective than drug therapy in decreasing anxiety. Just as clinicians would consider it unethical not to treat a low cardiac output or hypotension, so should it be for failure to treat anxiety.

Before new strategies can be designed to combat cardiac disease, it is crucial that investigators further explicate the physiologic mechanisms by which anxiety produces adverse outcomes. Research is needed, for example, to delineate the effect of anxiety on neurohormonal responses, myocyte and ventricular function, atherosclerotic plaque integrity, hemostasis, endothelial function, cognitive function, and adherence to treatment regimens. To achieve optimal results, this will require collaboration by scientists from multiple disciplines – nursing, medicine, psychoneuroendocrinology, biology, behavioral science, and neuropsychology.

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51. Moser DK, Kim KA, Baisden-O'Brien J. Impact of a nonpharmacologic cognitive intervention on clinical and psychosocial outcomes in patients with advanced heart failure (abstract). *Circulation*. 1999;100:I-99.

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VITA

Date of Birth	August 24, 1966
Place of Birth	Grand Rapids, Michigan
Education	
1996	Master of Science University of Maryland at Baltimore, Baltimore, MD
1988	Bachelor of Science in Nursing Grand View College, Des Moines, IA
Professional Experience	
08/02 – present	Full-Time PhD Student University of Kentucky, Lexington, KY
08/01 – 07/02	Nurse Manager, Cardiology Services Keesler Air Force Base, MS
10/99 – 08/01	Critical Care Clinical Nurse Specialist Keesler Air Force Base, MS
02/97 – 10/99	Assistant Nurse Manager, Coronary Care Unit Lackland Air Force Base, TX
06/96 – 02/97	Staff Nurse, Coronary Care Unit Lackland Air Force Base, TX
08/94 – 05/96	Full-Time Graduate Student University of Maryland at Baltimore
11/92 – 08/94	Infection Control Officer Offutt Air Force Base, NE
06/90 – 11/92	Staff Nurse, Special Care Unit Offutt Air Force Base, NE

08/89 – 06/90	Staff Nurse, Medical-Pediatric Unit Offutt Air Force Base, NE
03/89 – 08/89	Nurse Intern Offutt Air Force Base, NE
05/88 – 02/89	Staff Nurse, Telemetry Unit Mercy Hospital, Des Moines, IA

Publications

Journal Articles

In review	De Jong MJ , Moser DK, Chung ML. Predictors of health status for heart failure patients. <i>Prog Cardiovasc Nurs</i> .
In review	De Jong MJ , Burns SM, Campbell ML, Chulay M, Grap MJ, Pierce LN, Simpson T. Development of the AACN Sedation Assessment Scale for critically ill patients. <i>Am J Crit Care</i> .
In press	Bentley B, De Jong MJ , Moser DK, Peden AR. Factors related to nonadherence of a low sodium diet in heart failure patients. <i>Eur J Cardiovasc Nurs</i> .
In press	De Jong MJ , Moser DK, Hall LA. The manuscript option dissertation: multiple perspectives. <i>Nurse Author Ed</i> .
In press	Konstam V, Moser DK, De Jong MJ . Depression, anxiety and heart failure: a review. <i>J Card Fail</i> .
In press	De Jong MJ , Hall LA. Measurement of anxiety for patients with cardiac disease: a critical review and analysis. <i>J Cardiovasc Nurs</i> .
2005	De Jong MJ , An K, McKinley S, Garvin BJ, Hall LA, Moser DK. Using a 0-10 scale for assessment of anxiety in patients with acute myocardial infarction. <i>Dimens Crit Care Nurs</i> . 2005;24:139-146.

- 2005 **De Jong MJ**, Randall DC. Heart rate variability analysis in the assessment of autonomic function in heart failure. *J Cardiovasc Nurs*. 2005;20:186-195.
- 2004 **De Jong MJ**, Moser DK, An K, Chung ML. Anxiety is not manifested by elevated heart rate and blood pressure in acutely ill cardiac patients. *Eur J Cardiovasc Nurs*. 2004;3:247-253.
- 2004 **De Jong MJ**, Chung ML, Roser LP, et al. A five-country comparison of anxiety early after acute myocardial infarction. *Eur J Cardiovasc Nurs*. 2004;3:129-134.
- 2004 **De Jong MJ**. Spotting reference errors. *Nurse Author Ed*. 2004;14(2):7-9.
- 2004 An K, **De Jong MJ**, Riegel BJ, et al. A cross-sectional examination of changes in anxiety early after acute myocardial infarction. *Heart Lung*. 2004;33:75-82.
- 2004 Abbott/American Association of Critical-Care Nurses/Saint Thomas Health System Sedation Expert Panel Members (Bader MK, Burns SM, Campbell M, Chulay M, **De Jong M**, et al.). Consensus conference on sedation assessment: a collaborative venture by Abbott Laboratories, American Association of Critical-Care Nurses, and Saint Thomas Health System. *Crit Care Nurse*. 2004;24(2):33-41.
- 2003 **De Jong MJ**. Cellular telephone use while driving: growing awareness of the danger. *J Emerg Nurs*. 2003;29:578-581.
- 2003 **De Jong MJ**, Fausett MB. Anaphylactoid syndrome of pregnancy: a devastating complication requiring intensive care. *Crit Care Nurse*. 2003;23(6):42-48.
- 2003 Mulroy JF, **De Jong MJ**. Syndromes of hypercoagulability. *Am J Nurs*. 2003;103(5):64KK-SS.
- 2002 Dreater P, **De Jong MJ**. Is military nursing for you? *Critical Care Choices* 2002 (Supplement to *Nursing* 2002 and *Nurs Manag*) 2002:37S-38S.

- 2002 **De Jong MJ.** Strategies for a successful return to school. *Crit Care Nurse.* 2002;Suppl:6-9.
- 2001 **De Jong MJ, Sabadie-Garretson W.** Tenecteplase: a promising new fibrinolytic agent. *Dimens Crit Care Nurs.* 2001;20:19-23.
- 2000 **De Jong MJ, Morton PG.** Predictors of atrial dysrhythmias for patients undergoing coronary artery bypass grafting. *Am J Crit Care.* 2000;9:388-396.
- 2000 **De Jong MJ, Beatty DS.** Family perceptions of support interventions in the intensive care unit. *Dimens Crit Care Nurs.* 2000;19:40-47.
- 1999 **De Jong MJ, Wright SL.** New adjunctive therapy for ischemic syndromes. *Crit Care Nurs Clin North Am.* 1999;11:355-371.
- 1999 Ross GK, **De Jong MJ.** Emergency! Pericardial tamponade. *Am J Nurs.* 1999;99(2):35.
- 1998 **De Jong MJ.** Emergency! Hyponatremia. *Am J Nurs.* 1998;98(12):36.
- 1998 **De Jong MJ, Morton PG.** Patients at risk for atrial dysrhythmias after coronary artery bypass grafting. *Dimens Crit Care Nurs.* 1998;98:114-126.
- 1998 **De Jong MJ.** Infective endocarditis. *Am J Nurs.* 1998;98(5):34-35.
- 1997 **De Jong MJ.** Cardiogenic shock. *Am J Nurs.* 1997;97(6):40-41.
- 1997 **De Jong MJ, Morton PG.** Control of vascular complications after cardiac catheterization: a research-based protocol. *Dimens Crit Care Nurs.* 1997;16:170-180.
- Book**
- 2000 **De Jong MJ, Karch AM.** Lippincott's Critical Care Drug Guide. Philadelphia: Lippincott, 2000.

Book Chapters

- In press Moser DK, **De Jong MJ**. Anxiety and heart disease. In Molinari E. (ed.) Italian Handbook of Clinical Psychology and Heart Disease.
- 2005 **De Jong M**, Coombs V, Rempher K, Obias-Mann D, Gordon C. Patient management: cardiovascular system. In: Morton PG, Fontaine D, Hudak CM, Gallo BM, eds. Critical Care Nursing: A Holistic Approach. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2005:292-377.
- 1999 **De Jong MJ**. Musculoskeletal disorders. In: Rosdahl CB, ed. Textbook of Basic Nursing. 7th ed. Philadelphia: Lippincott, 1999:1012-1044.
- 1999 **De Jong MJ**. Skin disorders. In: Rosdahl CB, ed. Textbook of Basic Nursing. 7th ed. Philadelphia: Lippincott, 1999:984-1003.
- 1998 **De Jong MJ**. Heart and neck vessel assessment. In: Weber J, Kelly J, eds. Instructor's Resource Kit to Accompany Lippincott's Learning System: Health Assessment in Nursing. Philadelphia: Lippincott, 1998:115-123.

Abstracts

- 2005 **De Jong MJ**, An K, McKinley S, Garvin B, Hall L, Moser D. Using a 0-10 scale for assessment of anxiety in patients with acute myocardial infarction. *Am J Crit Care*. 2005;14:259-260.
- 2005 **De Jong MJ**, Moser DK, Chung ML. Anxiety, depression, and functional status are the best predictors of health status for patients with heart failure. *Eur J Cardiovasc Nurs*. 2005;4:54.
- 2005 **De Jong MJ**, Moser DK. The trajectory of health-related quality of life in patients in with failure. *Eur J Cardiovasc Nurs*. 2005;4:70-71.
- 2004 **De Jong MJ**, An K, Cherrington CC, Moser DK. Appraising symptom seriousness in acute myocardial infarction: emotional-cognitive variables are most important. *Circulation*. 2004;110:III-664.

- 2004 **De Jong MJ**, Moser DK, Chung ML. Anxiety, depression, and functional status are the best predictors of health status for patients with heart failure. *J Card Fail.* 2004;10:S21.
- 2004 Bentley B, **De Jong M**, Moser D. The hidden reason for patients' nonadherence to low sodium diet recommendations. *J Card Fail.* 2004;10:S21.
- 2004 **De Jong MJ**, Moser D, An K, Chung M. Anxiety is not manifested by elevated heart rate and blood pressure in acutely ill cardiac patients. *Am J Crit Care.* 2004;13:253.
- 1997 **De Jong M**, Morton P. Predictors of atrial arrhythmias for patients undergoing coronary artery bypass grafting. *Am J Crit Care.* 1997;6:243.

Poster Presentations

- 2005 **De Jong M**, An K, McKinley S, Garvin B, Hall L, Moser, D. Using A 0-10 Scale For Assessment Of Anxiety In Patients With Acute Myocardial Infarction. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition, New Orleans, LA.
- 2005 **De Jong MJ**, Moser DK. The trajectory of health-related quality of life in patients with heart failure. Presented at the 5th Annual Spring Meeting of the Working Group on Cardiovascular Nursing of the European Society of Cardiology and the Institute of Nursing Science, Basel, Switzerland.
- 2005 **De Jong MJ**, Moser DK, Chung ML. Anxiety, depression, and functional status are the best predictors of health status for patients with heart failure. Presented at the 5th Annual Spring Meeting of the Working Group on Cardiovascular Nursing of the European Society of Cardiology and the Institute of Nursing Science, Basel, Switzerland.

- 2005 **De Jong MJ**, An K, Cherrington C, Moser D. Appraising symptom seriousness in acute myocardial infarction: emotional-cognitive variables are most influential. Presented at the Graduate Student Poster Session at the 19th Annual Southern Nursing Research Society Conference, Atlanta, GA.
- 2004 **De Jong MJ**, Moser DK, Chung ML. Anxiety, depression, and functional status are the best predictors of health status for patients with heart failure. Presented at the Gill Heart Institute Cardiovascular Research Day, Lexington, KY.
- 2004 **De Jong MJ**, Moser DK, An K, Chung ML. Anxiety is not manifested by elevated heart rate and blood pressure in acutely ill cardiac patients. Presented at the Graduate Student Poster Session at the 18th annual Southern Nursing Research Society Conference, Louisville, KY.
- 2004 Bentley B, **De Jong MJ**, Moser DK. Factors related to nonadherence of a low sodium diet in heart failure patients. Presented at the Graduate Student Poster Session at the 18th annual Southern Nursing Research Society Conference, Louisville, KY.
- 2002 **De Jong MJ**, Miller NL, Novak CS, Pierce IN, Veazey SG. Competency training in the intensive care unit. Presented at the Fourteenth Annual Karen A. Rieder Nursing Research Poster Session at the 108th annual meeting of the Association of Military Surgeons of the United States, Louisville, KY.
- 2002 Gorsuch P, **De Jong MJ**, Damiani DJ. Addressing the new JCAHO pain guidelines: a multidisciplinary approach. Presented at the Fourteenth Annual Karen A. Rieder Nursing Research Poster Session at the 108th annual meeting of the Association of Military Surgeons of the United States, Louisville, KY.

- 2002 Scott S, Kelly C, Coles C, Gorsuch P, **De Jong MJ**, Schaffer J.
Standardized IV medication administration across medical/surgical units in a military medical center. Presented at the Fourteenth Annual Karen A. Rieder Nursing Research Poster Session at the 108th annual meeting of the Association of Military Surgeons of the United States, Louisville, KY.
- 2002 **De Jong MJ**, Scott S, Kelly C, Coles C, Gorsuch P, Schaffer J.
Standardized IV medication administration across medical/surgical units in a military medical center. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition.
- 2002 **De Jong MJ**, Miller N, Novak C, Pierce I, Veazey S. Competency training in the intensive care unit. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition.
- 2002 **De Jong MJ**, Miller N, Novak C, Pierce I, Veazey S. Competency training in the intensive care unit. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition.
- 1999 **De Jong MJ**, DeDecker L. Implementation of a latex allergy program. Presented at the Air Force Executive Leadership Symposium.
- 1999 **De Jong MJ**, DeDecker L. Implementation of a latex allergy program. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition.
- 1998 **De Jong MJ**. Predictors of atrial dysrhythmias for patients undergoing coronary artery bypass grafting. Presented at the Dimensions in Critical Care 1998 symposium sponsored by the San Antonio Chapter of the American Association of Critical-Care Nurses, San Antonio, TX.
- 1998 **De Jong MJ**. Control of local vascular complications after cardiac catheterization. Presented at the Dimensions in Critical Care 1998 symposium sponsored by the San Antonio Chapter of the American Association of Critical-Care Nurses, San Antonio, TX.

- 1997 **De Jong MJ.** Predictors of atrial dysrhythmias for patients undergoing coronary artery bypass grafting. Presented at the Air Force Nursing Executive Leadership Symposium, San Antonio, TX.
- 1997 **De Jong MJ.** Control of local vascular complications after cardiac catheterization. Presented at the Air Force Nursing Executive Leadership Symposium, San Antonio, TX.
- 1996 **De Jong MJ.** Predictors of atrial dysrhythmias for patients undergoing coronary artery bypass grafting. Presented at the Ninth Annual Karen A. Rieder Nursing Research Poster Session at the 103rd annual meeting of the Association of Military Surgeons of the United States, San Antonio, TX.
- 1995 **De Jong MJ.** Control of local vascular complications after cardiac catheterization. Presented at a dinner meeting of the Chesapeake Bay Chapter of the American Association of Critical-Care Nurses, Baltimore, MD.

Oral Research Presentations

- 2005 Anxiety, Depression, and Functional Status are the Best Predictors of Health Status for Patients with Heart Failure. Presented at the 19th Annual Southern Nursing Research Society Conference, Atlanta, GA.
- 2004 Appraising Symptom Seriousness in Acute Myocardial Infarction: Emotional-Cognitive Variables are Most Influential. Presented at Scientific Sessions 2004, New Orleans, LA.
- 2004 Anxiety, Depression, and Functional Status are the Best Predictors of Health Status for Patients with Heart Failure. Presented at the 8th Annual Scientific Meeting of the Heart Failure Society of America, Toronto, Canada.

- 2004 Anxiety is Not Manifested by Elevated Heart Rate and Blood Pressure in Acutely Ill Cardiac Patients. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition, Orlando, FL.

- 1997 Predictors of Atrial Arrhythmias for Patients Undergoing Coronary Artery Bypass Grafting. Presented at the American Association of Critical Care Nurses' National Teaching Institute and Critical Care Exposition, Orlando, FL.

- 1996 Predictors of Atrial Arrhythmias for Patients Undergoing Coronary Artery Bypass Grafting. Presented at the University of Maryland Graduate Research Day, Baltimore, MD.

Selected Educational Presentations

- 2005 Anxiety in Patients with Cardiac Disease. Invited Lecture. Presented at the 6th Scientific Forum on Quality of Care and Outcomes Research in Cardiovascular Disease and Stroke sponsored by the American Heart Association, Washington, DC.

- 2005 Chapter Elections: Keys to a Successful Leadership. Presented at the National Teaching Institute sponsored by the American Association of Critical-Care Nurses, New Orleans, LA.

- 2005 Critical Pathways in ACS: The Nurse's Role in Early ID, Risk Stratification & Treatment. Invited Lecture. Presented with Anne Marie Palatnik at the National Teaching Institute sponsored by the American Association of Critical-Care Nurses, New Orleans, LA.

- 2005 Comprehensive Management of the Heart Failure Patient. Invited lecture. Presented with Brooke Bentley in Jacksonville, FL.

- 2005 Assessment of Health Status for Patients with Heart Failure. Invited lecture. Presented at the 3rd Annual Cardiovascular Update Conference sponsored by the University of Kentucky College of Nursing, Lexington, KY.
- 2004 Cardiovascular Nursing Assessment. Invited lecture. Midway College, College of Nursing.
- 2003 Sedation Assessment: Time for a Change? Invited lecture. Presented with Marianne Chulay and Lorie Wild at the National Teaching Institute sponsored by the American Association of Critical-Care Nurses, San Antonio, TX.
- 2002 Atherogenesis 2002: New Concepts in Plaque Vulnerability and C-Reactive Protein. Invited lecture. Presented at the New Cardiovascular Horizons Conference, New Orleans, LA.
- 2001 Families: Friend or Foe? Interventions for Family Members of Critically Ill Patients. Presented at the Currents Conference sponsored by Region 12 of the American Association of Critical-Care Nurses, Lafayette, LA.
- 2001 Anaphylactoid Syndrome of Pregnancy: A Devastating Obstetrical Complication Requiring Intensive Care. Presented at the Currents Conference sponsored by Region 12 of the American Association of Critical-Care Nurses, Lafayette, LA.
- 2000 Strategies for a Successful Return to School. Presented at the National Teaching Institute sponsored by the American Association of Critical-Care Nurses, Orlando, FL.
- 2000 Strategic Plans Made Simple. Invited lecture. Presented at the Region Fall Meeting sponsored by Region 12 of the American Association of Critical-Care Nurses, New Orleans, LA.

- 2000 Family Presence During Resuscitation. Presented at the Currents Conference sponsored by Region 12 of the American Association of Critical-Care Nurses, Lafayette, LA.
- 2000 Cardiogenic Shock. Presented at the Currents Conference sponsored by Region 12 of the American Association of Critical-Care Nurses, Lafayette, LA.
- 1998 Open Codes: Family Presence During Resuscitation. Presented at the Emergency Medicine on the River Walk Conference, San Antonio, TX.
- 1998 Family Presence During Resuscitation. Invited lecture. Presented at the Dimensions in Critical Care Symposium, sponsored by the Houston Gulf Coast Chapter of the American Association of Critical-Care Nurses, Houston, TX.
- 1998 Control of Vascular Complications After Cardiac Catheterization and Angioplasty. Presented at the Trends in Trauma Nursing and Cardiovascular Nursing '98 Conference, Philadelphia, PA.
- 1998 Predictors of Atrial Dysrhythmias after Coronary Artery Bypass Grafting. Presented at the Trends in Trauma Nursing and Cardiovascular Nursing '98 Conference, Philadelphia, PA.
- 1998 Family Presence During a Code. Invited lecture. Presented at the Research-Based Fall Symposium, sponsored by the San Antonio Chapter of the American Association of Critical-Care Nurses, San Antonio, TX.

Funded Research

- 2005- Linkages Between Anxiety and Outcomes in Heart Failure. De Jong MJ
present (PI), Moser DK, Rayens MK. TriService Nursing Research Program
Graduate Research Award, HU0001-05-1-TS01, \$40,078.

Research

- 2003 Factors Related to Nonadherence of a Low Sodium Diet in Heart Failure Patients. Bentley B (co-PI), De Jong MJ (co-PI), Moser DK, Peden AR. Qualitative research conducted at the University of Kentucky.
- 1997-1998 Family Perceptions of Social Support Interventions in the Intensive Care Unit. De Jong MJ (PI), Beatty DS (Assoc. Investigator). Wilford Hall Medical Center.
- 1997-1998 Research data collector for the American Association of Critical-Care Nurses' Thunder II Pain Study.
- 1995-1996 Predictors of Atrial Arrhythmias for Patients Undergoing Coronary Artery Bypass Grafting. De Jong MJ (PI), Morton PG. Thesis research conducted at the University of Maryland at Baltimore.

Professional Honors

- 2005 Carolyn A. Williams Award. University of Kentucky, College of Nursing Alumni Association.
- 2005 The Chancellor's List.
- 2005 Best Doctoral Podium Presentation. First Annual Student Scholarship Showcase. University of Kentucky, College of Nursing.
- 2005 First Place, Graduate Student Poster Award. Southern Nursing Research Society.
- 2004 Nursing Research Award. Heart Failure Society of America.
- 2004 Honorable Mention, Graduate Student Poster Award. Southern Nursing Research Society.
- 2002-2003 AACN/AJN Nursing Fellows Program, mentor for Janet Mulroy.
- 2002 United States Air Force Meritorious Service Medal.
- 2001 United States Air Force Small Arms Expert Marksman Medal.

- 2000 Company Grade Nurse Officer of the Year Award, Keesler Medical Center.
- 1999 United States Air Force Meritorious Service Medal.
- 1998 Company Grade Nurse Officer of the Year Award, Wilford Hall Medical Center.
- 1997 Sigma Theta Tau Nurse Image Maker Award, Delta Alpha Chapter.
- 1996 Hewlett Packard Award for Excellence in Critical Care Nursing, University of Maryland School of Nursing, Department of Acute and Long Term Care.
- 1996 The Most Outstanding Nursing Research Presentation Award, Graduate Research Day, University of Maryland.
- 1996 The National Dean's List.
- 1996 Who's Who Among Students in American Universities and Colleges.
- 1994 United States Air Force Commendation Medal.
- 1993 Company Grade Officer of the Year, Offutt Air Force Base, Ehrling Bergquist Hospital.
- 1993 Certificate of Special Recognition for projecting a positive image of nursing, Nebraska Nurses Association, District Two.
- 1992 Nurse Company Grade Officer of the Year, Offutt Air Force Base, Ehrling Bergquist Hospital.
- 1991 Company Grade Officer of the Quarter, Offutt Air Force Base, Ehrling Bergquist Hospital.
- 1991 Company Grade Officer of the Quarter First Runner-Up, Offutt Air Force Base.
- 1990 Honorary Recruiter, United States Air Force Recruiting Service.

Professional Certifications

CCNS Certification

CCRN Certification

Professional Organizations

American Association for the Advancement of Science

American Association of Critical-Care Nurses

American Association of Heart Failure Nurses

American Heart Association

Emergency Nurses Association

Heart Failure Society of America

Sigma Theta Tau, International Honor Society of Nursing

Southern Nursing Research Society
