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PSYCHOLOGICAL DISTRESS AND CARDIAC DISEASE

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PSYCHOLOGICAL DISTRESS AND CARDIAC DISEASE

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Nursing
at the University of Kentucky

By
Tracey Kleeman Vitori

Lexington, Kentucky

Director: Dr. Susan K. Frazier, Associate Professor of Nursing

Lexington, Kentucky

2016

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ABSTRACT OF DISSERTATION

PSYCHOLOGICAL DISTRESS AND CARDIAC DISEASE

The purpose of this dissertation was to evaluate the association of psychological distress with cardiac disease, events, and mortality. Specific aims were to: 1) to evaluate the association between hostility level and recurrence of acute coronary syndrome (ACS) and all-cause mortality in patients with coronary heart disease (CHD); 2) to evaluate the psychometric properties of the Brief Symptom Inventory (BSI) hostility and anxiety subscales in a group of incarcerated participants at high risk of cardiovascular disease; and 3) to evaluate the association of patient and caregiver psychological state with quality of life in both patient and caregiver, and postoperative complications after cardiac surgery.

Specific aim one was addressed through a secondary analysis of data collected during the Patient Response to Myocardial Infarction following a Teaching Intervention Offered by Nurses trial to determine whether hostility was a predictor of ACS recurrence and mortality. Hostility was common after ACS and predicted all-cause mortality. Hostility did not predict recurrent ACS. Specific aim 2 was addressed in a secondary analysis of baseline data from a randomized controlled trial in male prisoners. Participants completed the BSI at baseline prior to the intervention. Internal consistency reliability was good for both subscales (Cronbach's alpha - hostility 0.83, anxiety 0.81). Items from the two dimensions were analyzed together using exploratory factor analysis with varimax rotation. Two dimensions, anxiety and hostility, were identified. Construct validity was supported; those with high anxiety and hostility reported a greater number of days where their self-reported health was rated as fair or poor. Those prisoners with less perceived control had higher levels of anxiety and hostility. Specific aim 3 was addressed through a prospective, descriptive correlational study that measured patient and caregiver anxiety, hostility and depressive symptoms, at baseline to determine whether these predicted quality of life using a multilevel dyadic analysis; and to evaluate the association of baseline anxiety, hostility and depressive symptoms and quality of life with postoperative complications and mortality. Anxiety, hostility, and depressive symptoms were common in both cardiac patients and their caregiver. Psychological state influenced quality of life in both dyad members, but was not associated with complications.

KEYWORDS: Hostility, Anxiety, Dyads, Cardiovascular disease

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May 23, 2016

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PSYCHOLOGICAL DISTRESS AND CARDIAC DISEASE

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This dissertation is dedicated to my grandmother Rosemary Tracey from whom I learned compassion, and witnessed the realities of life and death. Although no longer with us, she shaped my approach to the suffering of others and helped me find confidence in being me. I learned patience, perseverance and dedication.
Now, I really know myself, and I know my voice.
All my love, Tracey.

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CHAPTER ONE

Introduction

Cardiovascular disease is the leading cause of death in the United States;^{1,2} nearly half of the American population will be diagnosed with some form of cardiovascular disease by 2030.^{3,4} The costs for management of cardiac diseases are estimated at \$385 billion per year. Coronary heart disease (CHD), the primary and most preventable cardiac disease, affects approximately 15 million Americans.⁵ As a result of CHD, annually, more than 1.1 million Americans experience an acute interruption in blood flow to cardiac muscle, known as an acute coronary syndrome (ACS); nearly three fourths of these individuals are diagnosed with an acute myocardial infarction (AMI).⁶ Risk factors for CHD include hypertension, hyperlipidemia, diabetes mellitus, obesity, cigarette smoking, and sedentary lifestyle.^{3,7,8} CHD, specifically ischemic heart disease, is the primary cause of death for Caucasians, African Americans, and Hispanic Americans, and the second leading cause of death for Native Americans and Alaskan natives.^{5,9}

The management and treatment of coronary heart disease includes noninvasive lifestyle changes, pharmacological interventions, and invasive interventions that include percutaneous and surgical procedures. Non-invasive interventions include smoking cessation, dietary changes, and increased physical activity;¹⁰⁻¹² effective pharmacological therapies for hypertension,¹²⁻¹⁴ diabetes,¹² and hyperlipidemia,¹⁴ are also integral to management. Invasive interventions include percutaneous coronary angioplasty (PTCA), PTCA with stent placement, coronary artery bypass grafting (CABG) and valve replacements. Approximately 397,000 individuals will need some type of cardiac surgery each year to manage their cardiac disease.^{5,9} Although surgical intervention is an

important component of patient management, it is associated with a number of adverse events and complications that include acute heart failure, myocardial infarction, renal failure, acute respiratory failure, stroke, infections, cardiac dysrhythmias, and psychological distress.¹⁵⁻¹⁷

Psychological distress, which includes anxiety, depression and hostility, has been associated with cardiovascular events, dysrhythmias and sudden cardiac death; however, psychological state is not systematically evaluated in patients at risk for CHD.^{18,19} Eight percent of individuals with cardiac disease reported psychological distress following a recent hospitalization or surgery¹⁸⁻²¹ Moser et al.¹⁸ found the prevalence of anxiety, depressive symptoms and hostility were significantly higher in those with cardiac disease compared with healthy elders. In those who were anxious, recurrent cardiac events occurred in 20-25% during the hospitalization.^{18,22,23} Unfortunately, the consequences of untreated or undertreated anxiety include suboptimal adherence to a treatment regimen with prescribed medications and lifestyle changes;^{11,12} anxiety has also been associated with more in-hospital complications after an acute myocardial infarction.¹⁸ Celano and colleagues²⁴ found anxiety was independently associated with worsening depression, which also contributed to overall treatment failure. While cardiac surgery has been shown to improve physiological status, there are common psychosocial stressors seen in the postoperative period.

Anxiety and phobia disorders have been diagnosed in 11% of post cardiac surgery patients.¹⁶ Depression has a prevalence of 30-45% in patients with known cardiac disease.^{25,26} The consequences of undertreated depression in cardiac patients included an average one day increased length of hospital stay in 10.5% of patients, a 10% increase in

perioperative complications (Odds ratio 1.02 – 1.19, CI 95%, $p = 0.018$)²⁷, and a 10% higher risk of sudden cardiac deaths in cardiac patients treated for depression.²⁸

Depression was diagnosed in 15-20 % of patients recovering from cardiac surgery.²⁶

High levels of depression are of concern, as depression reduces adherence to therapy necessary after a cardiac event.²⁹ Early recognition and treatment of depression may influence behaviors and improve adherence with medications and dietary restrictions.

Hostility has been associated with stress exposure and reactivity, which increased platelet aggregation, heart rate and inflammation.³⁰ Those who reported higher hostility were 5 times more likely to have a coronary event.³¹ Hostility has been closely associated with the concept of anger, and these terms are often used interchangeably despite identified differences. Hostility is considered to be a cognitive trait expressed as a negative attitude toward others; while anger is an emotional state expressed as verbal or physical behaviors that range from mild irritation to fury.³² Hostility and suppressed anger were risk factors for increased inflammatory biomarkers such as interleukin (IL)-6¹⁹ and tumor necrosis factor (TNF) in those with CHD,³³ increased obesity,³⁴ higher total cholesterol,³⁴ and higher triglycerides and fasting blood glucose levels.³³⁻³⁶ Hostility has been found in up to 70% of patients after CABG.³⁷ Hostility influences recovery; patients with hostility struggle with dietary, smoking restrictions and medication adherence.³⁸ Hostility also influenced the caregivers of patients with cardiovascular disease

Caregivers are typically unpaid, and usually family members or friends, who provide assistance with activities of daily living and specific health care activities like taking medication.³⁹ Caregiving after cardiac surgery is vital, as the mean length of stay

after cardiac surgery most recently ranged 4-5 days.⁴⁰ Postoperative cardiac surgery patients frequently required assistance with medications, vital sign monitoring, meal preparation, household chores, personal hygiene, and visitor control.⁴¹ McKee⁴² determined that during recovery, new postoperative expectations might become a source of anxiety, depression, and hostility for the caregiver. Caregivers also experienced a loss of personal freedom, loneliness, social isolation and an increase in responsibility.⁴³ Being the sole caregiver of a postoperative patient may affect individual health and wellbeing resulting in stressors for the caregiver.⁴⁴ Both patients and caregivers experience varying degrees of psychological distress and losses.

Patients may have fear in terms of financial stress,⁴⁵ decreased functional status,⁴⁵ loss of freedom such as in limited driving, return to work, or participation in social activities; these may prolong their recovery.⁴⁶ Some patients reported dependence on their caregiver⁴³ and others reported that the caregiver took control of the recovery process and prohibited patient independence.⁴⁶ Ahldén and colleagues,⁴³ demonstrated that patients and caregivers did not face identical challenges postoperatively, but were equally challenged by new expectations after the surgery.⁴³ During recovery as the dyad (patient and caregiver) spend time together, emotional distress such as anxiety, hostility, and/or depressive symptoms can occur as they attempt to return to normalcy.

After CABG, patients disclosed that they felt excessively tired, physically weak and helpless; while caregivers frequently described increased burden for the patient's medication regimen, diet, and overall activity.^{43,46} Close proximity of patient and caregiver in this stressful situation has been found to be associated with transmission of

psychological state from one member of the dyad to the other or psychological contagion.^{28,47}

Contagion theory provides a framework to systematically examine the association between patient and caregiver psychological state during the perioperative process (Figure 1.).^{48,49} Contagion is described as the emotional transmission of individual emotional expression to another, so that they automatically mimic expressions, vocalizations, postures and movements of another person.^{49,50} When patient and caregiver interact during the postoperative recovery period, individual behavior, emotions and affective state may be subtly transmitted.⁵¹ Individuals unknowingly imitate facial and vocal expressions; perception of the affective state of either individual may be transmitted to the other member of the dyad. When a patient or caregiver is anxious, hostile or exhibits depressive symptoms, the negative emotions may influence the other in a similar fashion.⁵² Neuman and colleagues⁴⁸ demonstrated that affective feelings were transferred between people, and listening to another's voice was sufficient to illicit a similar mood. They also proposed that the process for this contagion was spontaneous and unconscious.

In summary, cardiovascular disease is the primary cause of death in the United States.¹ Surgical intervention can effectively manage some types of cardiovascular disease, but individuals require caregiver support during recovery.⁵³ Psychological distress is common in postoperative cardiac patients and is associated with worse outcomes,^{26,33,54,55} but the impact on caregivers is less clear.^{42,52,56} In addition, patient and caregiver psychological state may influence physical state, and short and long term outcomes of one another.⁵⁷ Thus, the purpose of this dissertation was to investigate the

association of psychological distress and cardiovascular health. Each chapter of this dissertation is part of a program of research focused on the impact of psychological state on outcomes in patients with cardiac disease.

Chapter Two reported a secondary analysis of data from an international, multi-site, randomized clinical trial that evaluated the impact of an educational intervention on patient delay in seeking treatment for ACS, the Patient Response to Myocardial Infarction Following a Teaching Intervention by Nurses (PROMOTION) trial.⁵⁸ In this study, we evaluated the association of self-reported hostility levels with recurrence of ACS and all-cause mortality in patients with known CHD. Patients were followed for 24 months to evaluate cardiac events and mortality after an acute event. Hostility was measured using the Multiple Affective Adjective Checklist (MAACL), a self-report instrument that assessed anxiety, depression and hostility. Recurrence of ACS was defined as an emergency department visit with subsequent hospitalization, or a direct hospital admission for angina, symptoms suggestive of ACS that lasted more than 15 minutes, symptoms accompanied by new, transient, or persistent electrocardiographic (ECG) ST-segment changes with subsequent diagnosis. All-cause mortality, including date and cause of death, was established with a combination of medical record review, review of hospital administrative records, interview with the primary health care provider, family or friend interview, and review of local death records. Hostility scores measured at baseline were used for this investigation, and recurrent ACS event and mortality were evaluated up to 24 months. Hostility was common after ACS and predictive of all-cause mortality. Hostility was not predictive of recurrent ACS. The findings of prior studies were equivocal about the association of negative emotions with

cardiac event recurrence and mortality in patients after acute coronary syndrome.

Although common after ACS, hostility and the association between hostility and cardiac events and outcomes was likely more complex than previously hypothesized.

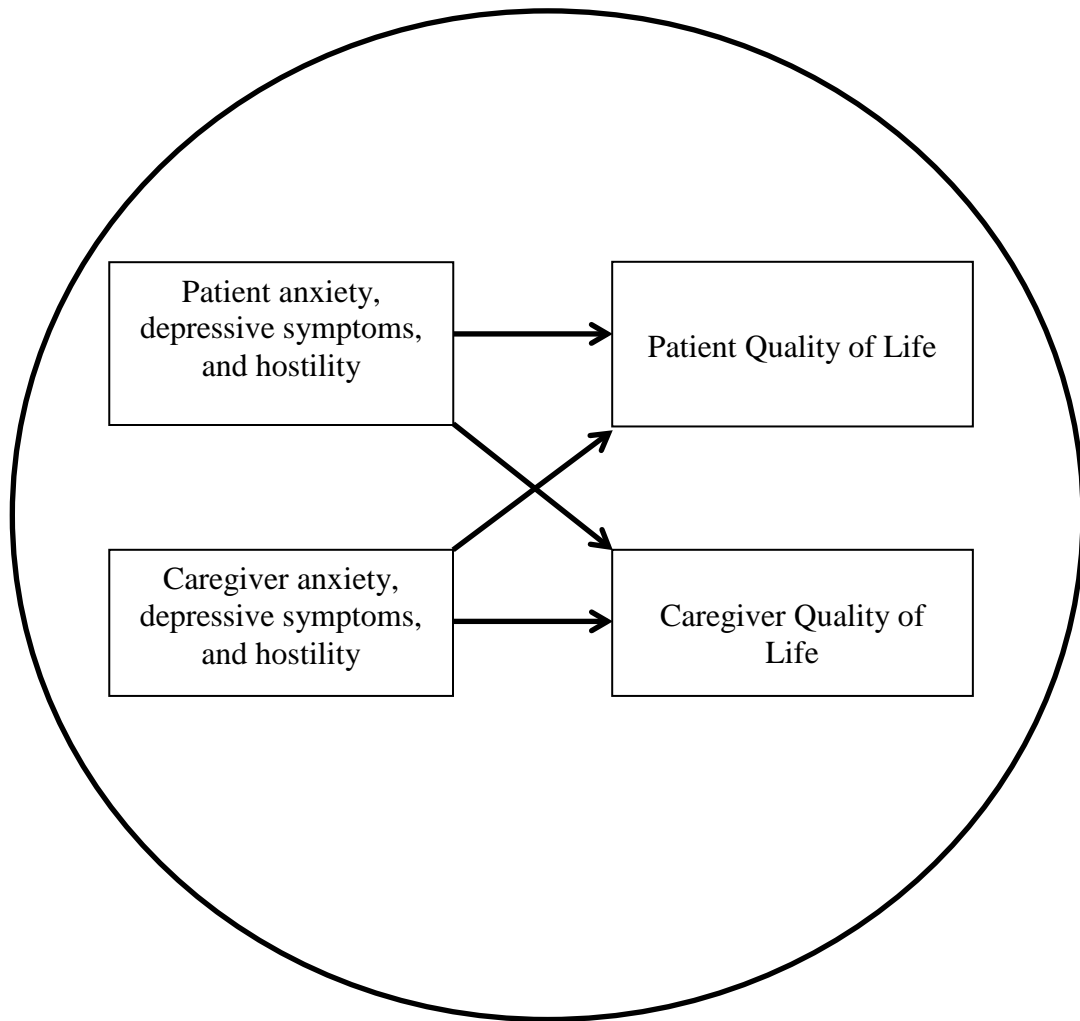
The paper in Chapter Three reported a psychometric evaluation of the Brief Symptom Inventory (BSI) anxiety and hostility subscales in a prison population. This was a secondary analysis of baseline data from a randomized controlled trial of an intervention to reduce cardiovascular risk factors in male prisoners (n = 373). Specifically, we determined internal consistency reliability of the BSI anxiety and hostility subscales, the factor structure of these 2 scales using exploratory factor analysis; and evaluated the construct validity of these scales with hypothesis testing. We hypothesized that self-reported mental health scores would be worse and perceived control lower in those incarcerated individuals with high anxiety and high hostility. Reliability and validity were supported, and a factor analysis identified two dimensions. All the hostility factors loaded on the hostility dimension and five out of six anxiety factors loaded appropriately. Scales were scored using the original structure and a new structure with this item removed. Classification of individuals as anxious or hostile was not different using established cut-points; thus, the original structure was deemed valid. We concluded that the BSI anxiety and hostility subscales were reliable and valid in the prison population.

Chapter Four is a report of an original research study that focused on the evaluation of the association of patient and caregiver psychological state with quality of life, and postoperative complications after cardiac surgery that required sternotomy. The multilevel dyadic analysis, the Actor-Partner Interdependence Model, evaluated the

association of anxiety, hostility, and depressive symptoms in patient and caregiver with quality of life in both. The Actor-Partner Model supported the examination of the “actor effect” which is the association between anxiety, hostility, and depressive symptoms with quality of life in the same individual; the “partner Effect”, examined the association of anxiety, hostility, and depressive symptoms with the quality of life of the other dyad member. Data were collected and analyzed for 45 patient and caregiver dyads. Psychological distress was common in both cardiac patients and their caregiver. Psychological state influenced quality of life in both dyad members, but was not associated with postoperative complications.

Chapter five provides an overall summary of findings from the manuscripts in the dissertation and conclusions developed from these. Recommendations for practice and future research are suggested. The findings from each chapter contributed to our understanding about psychological distress and its association with outcomes in patients with cardiovascular disease.

Figure 1.1 Emotional Contagion Theory



CHAPTER TWO

Hostility Predicts Mortality but not Recurrent ACS in Patients with Coronary Heart Disease

Abstract

OBJECTIVE: Anger and hostility are negative emotions associated with greater risk for development of cardiac disease and cardiac dysrhythmias. However, prior studies are equivocal about the association of negative emotions with cardiac event recurrence and mortality in patients after acute coronary syndrome (ACS).

METHODS: We performed a secondary analysis of data collected during the PROMOTION trial to determine whether hostility was a predictor of ACS recurrence and mortality. Demographic and clinical data were collected at baseline; hostility was measured with the Multiple Adjective Affect Checklist (MAACL), and patients were followed for 24 months for evaluation of recurrent cardiac events and all-cause mortality. Cox proportional hazards regression determined whether hostility scores predicted recurrence of ACS events or all-cause mortality.

RESULTS: The majority of patients ($n = 2321$) were married (73%), Caucasian (97%) men (68%) with a mean age of 67 ± 11 years. Fifty seven percent of men and 56% of women scored as hostile based on the established MAACL cutpoint (mean score = 7.56 ± 3.8). Hostility predicted all-cause mortality ($p < 0.039$), but was not a predictor of ACS recurrence ($p = 0.792$). Prior percutaneous coronary intervention and hypertension diagnosis were independent predictors of ACS recurrence. Hostility, older age and prior infarction were the only additional independent predictors of mortality.

CONCLUSION: Hostility was common after ACS and predictive of all-cause mortality.

Hostility was not predictive of recurrent ACS. Thus, the association described by prior investigators is likely more complex than previously hypothesized.

Key words: Hostility, cardiovascular disease, acute myocardial infarction, acute coronary syndrome

Introduction

Coronary heart disease (CHD) is the leading cause of death and disability in the United States and the developed world.^{1,2} Modifiable and non-modifiable risk factors for CHD including obesity, hypertension, hyperlipidemia, age and family history are routinely evaluated by clinicians. However, psychological factors like anxiety and depression are also associated with cardiovascular events, dysrhythmias and sudden cardiac death, but are not always assessed in patients at risk for CHD.^{18,19,21} Prior investigators concluded that anger and hostility were related to development of atherosclerosis and cardiac events; however, research support for this association has been equivocal.^{19,28,59,60}

Hostility, a multidimensional construct that consists of physiological, biobehavioral, and cognitive dimensions, is defined as a cynical, antagonistic, resentful attitude toward others, with negative interactions characterized by sarcasm, impatience, irritability or negativism.^{18,28,61} In a meta-analysis of 25 studies, Chida and Steptoe³² found that higher levels of hostility increased the risk of CHD development by nearly 20%. Additionally, in those with established CHD, higher levels of hostility increased the risk of cardiac events by 24%. Other investigators found that greater hostility was associated with an increased rate of recurrent acute coronary syndrome (ACS) after percutaneous coronary intervention (PCI),⁶² shorter time to ACS recurrence,⁶³ double the risk of ischemic heart disease diagnosis in a 10-year follow-up period,⁶⁴ and the development of atherosclerosis, as evaluated by carotid intimal thickness⁶⁵ and coronary calcification.⁶⁰ Burg and colleagues⁶³ found that patients with implanted cardioverter defibrillators (ICDs) were more likely to feel anger and hostility in the 15 minute period

prior to ventricular dysrhythmias that required cardioversion. These findings are consistent with a biobehavioral framework in which biological and behavioral factors are associated with hostility, which resulted in cardiovascular disease and cardiac events.

Hostility also has been associated with poorer health behaviors that resulted in the development and progression of atherosclerosis and CHD.³⁰ Individuals who reported increased hostility were more likely to be obese,⁶⁶ smoke cigarettes,⁶⁷ were less likely to have healthy diets,⁶⁸ and more likely to abuse alcohol.⁶⁹ Those with higher hostility scores perceived more major and minor stress in daily living,³⁰ responded more negatively to their existing social support persons,⁷⁰ and were more likely to report loneliness, which was coupled with reduced physical activity.⁷¹ Thus, behaviors found in individuals who were more hostile were consistent with common risk factors for CHD.

Investigators have identified a number of physiological alterations in those with greater hostility. Individuals with higher hostility scores have been found to have autonomic dysregulation, with sympathetic hyperactivity, parasympathetic withdrawal, and subsequently reduced heart rate variability, a risk factor for dysrhythmias and sudden cardiac death.⁷² Amplified blood pressure reactivity and a higher concentration of proinflammatory cytokines have been found in those with greater hostility.⁷³ Individuals with hostility and hypertension, but no history of CHD, demonstrated an increased rate of platelet aggregation,⁷⁴ and African American women with more hostility exhibited impaired glucose homeostasis, a precursor for type 2 diabetes mellitus.⁷⁵ Investigators have identified an association between hostility and reduced central serotonin concentration, metabolic syndrome, and increased risk for CHD;⁷⁶ however, other investigators recommended caution, as there were equivocal findings about the impact of

serotonin deficiency on cardiovascular health, and several methodological issues with these studies.⁷⁷ These physiological responses as a result of hostility potentially increased the likelihood of serious cardiac events like ACS, lethal cardiac dysrhythmias, and greater mortality in individuals with CHD.

Due to the equivocal nature of prior research findings about hostility and cardiovascular outcomes, we conducted a secondary analysis of existing data to evaluate the association between self-reported hostility level and recurrence of ACS and all-cause mortality in patients with known CHD. The specific aims of this study were to: 1) describe the degree of hostility in an international group of patients with known CHD; 2) determine whether hostility predicted ACS recurrence during a 24 month follow-up period; and 3) determine whether hostility predicted all-cause mortality in these participants.

Methods

We performed a secondary analysis of data from an international, multi-site, randomized clinical trial that evaluated the impact of an educational intervention on patient delay in seeking treatment for ACS symptoms, the Patient Response to Myocardial Infarction Following a Teaching Intervention by Nurses (PROMOTION) trial.⁵⁸ Demographic, clinical, and psychological data were collected at baseline, and at 3, 12 and 24 months. Patients were followed for 24 months to evaluate cardiac events and mortality. Hostility scores measured at baseline were used for this investigation, and recurrent ACS event and mortality were evaluated out to 24 months.

Sample

Participants were recruited from cardiology, internal medicine or family practice clinics, associated with four US health care facilities, one in Australia, and one in New Zealand (Los Angeles, CA, Lexington, KY, San Diego, CA, Seattle, WA, Sydney, Australia, and Auckland, New Zealand). The PROMOTION trial enrolled community dwelling participants (n = 3522) with confirmed CHD, identified by medical record history of CHD, prior MI, PCI, or coronary artery bypass graft surgery. Patients were excluded if they had a life threatening comorbidity, untreated malignancies, neurological conditions, cognitive impairment, or were unable to read or understand English. For this investigation, we included only those participants (n = 2321) who had completed the hostility measure at baseline and had complete demographic and clinical history (i.e., sex, age, education level, ethnicity, marital status, history of angina, PCI, MI, CABG, current diagnosis of diabetes and hypertension, and current smoking).

Measures

Demographic data

Demographic data were collected by research nurses, or research assistants who met face-to-face with participants via interview and standard questionnaires.

Demographics collected were age, sex, marital status, ethnicity, education level, type of insurance and household income.

Clinical data

Clinical data were also obtained using questionnaires, as well as medical record review, and included history of coronary artery bypass graft (CABG), AMI, PCI, hypertension diagnosis, diabetes mellitus diagnosis, and current cigarette smoking.

Hostility

Hostility was measured using the Multiple Affective Adjective Checklist (MAACL), a self-report instrument. The MAACL assesses anxiety, depression and hostility; the instrument consists of 132 positive and negative adjectives arranged in alphabetical order, representing the three emotional states. Patients responded by selecting adjectives that described how they were currently feeling. The MAACL was scored by adding the number of negative adjectives selected and the positive adjectives not selected; higher scores indicated greater anxiety, depression, or hostility. Standard thresholds for anxiety, depression and hostility have been established at 7, 11, and 7,¹⁸ respectively. The MAACL measures the intensity of emotions, but is not used to make a clinical diagnosis. This instrument was chosen because of its clinical utility, ease of comparisons among sites, and because dysphoric symptoms, even in the absence of clinical diagnosis, have been shown to negatively impact outcomes.^{18,78} The MAACL has been previously used in studies of antepartum patients evaluating depressive symptoms during high risk pregnancies,⁷⁹ and in evaluating hostility with head and neck cancer patients.⁸⁰ Adequate sensitivity, reliability and validity have been previously reported.^{81,82}

ACS Recurrence

For this investigation, recurrence of ACS was defined as an emergency department visit with subsequent hospitalization, or a direct hospital admission for: 1) angina, 2) symptoms suggestive of ACS that lasted more than 15 minutes, 3) symptoms accompanied by new, transient, or persistent electrocardiographic (ECG) ST-segment changes with subsequent diagnosis of: a) AMI, either ST-elevation infarction or non-ST-

elevation infarction, b) post-infarction angina, c) unstable or stable angina, d) angina requiring revascularization, or e) dysrhythmias that resulted in myocardial ischemia or hemodynamic dysfunction that were attributed to ischemic heart disease. Final diagnosis was determined by a combination of medical record review, review of hospital administrative records, and patient and family interview.

All-Cause Mortality

All-cause mortality, including date and cause of death, was established with a combination of medical record review, review of hospital administrative records, interview with the primary health care provider, family or friend, and review of local death records. As part of the baseline data collection, participants were requested to provide a contact person and phone number in the event that the patient was unable to be contacted during the follow-up period.

Procedure

After Institutional Review Board approval from each site, participants were recruited and enrolled from cardiology, internal medicine, and family practice clinics at each of the sites. Data were collected by trained research associates using a structured interview, the MAACL, and the medical record. Research associates were trained to collect all data, and fidelity was systematically evaluated by each site PI. Patients or their surrogates were interviewed at 3, 12, and 24 months about emergency department visits and hospitalizations through telephone contact. Although recall bias is a potential issue with this procedure, with meticulous discussion, participants or their surrogates were able to recall hospital admissions and approximate dates. Research associates validated each hospital admission with the medical record. International Statistical Classification of

Diseases and Related Health Problems, (ICD-9 codes 410 (AMI), 411 (other acute and sub-acute forms of ischemic heart disease), 412-414 (prior AMI, angina pectoris, and other forms of ischemic heart disease), 427 (cardiac dysrhythmias) or 786.5 (chest pain) assigned at discharge by the primary health care provider were considered to be recurrent ACS.

When participants were unable to be contacted, hospital and medical records were evaluated to determine whether death had occurred. When death was not confirmed with medical record review, research associates phoned the contact person provided at enrollment. When the contact person was not available or did not have current information, local death records were searched, and death was excluded or confirmed. For the original study, data were entered into an Access database at each data collection site, and then sent to the data coordinating center at the University of Kentucky where it was merged for analysis. A complete review of all collected data and quality checks was performed at the data coordinating center to ensure the completeness of data and identify outliers. Study records were reviewed and medical records requested when missing data were found. For this secondary analysis, data were exported into a PASW spreadsheet, examined for missing data, evaluated for data distribution, and cleaned prior to analysis (PASW, version 21, Chicago, IL).

Data Analysis

Descriptive statistics were used to characterize the participants and to report hostility scores. Cox proportional hazards modeling was used to determine whether the hostility score at baseline predicted ACS recurrence or all-cause mortality. We used Cox regressions with all variables entered in one block to predict either ACS readmission or

all-cause mortality; these regressions included controlled variables (sex, age, education, ethnicity, marital status, prior history of PCI, CABG, MI, diagnosis of diabetes or hypertension, or whether they were currently smoking) and hostility scores. In the Cox regression analyses, hostility scores were dichotomized to create two groups, hostile or not hostile, using the established cut point of 7.^{18,83} Treatment of hostility scores as categorical level data is justified, because the scores obtained from psychological questionnaires are not truly interval level data.¹⁸ Cox proportional hazards regression analysis with construction of hazard plots was used to compare recurrence of cardiac event and mortality among the hostile and non-hostile groups. An a priori alpha level of 0.05 was used to determine significance.

Results

Characteristics of the Participants

In the primary study, 3522 participants were enrolled; however, only those who had complete data for all variables of interest were included in this analysis (n = 2321). Of the 2321 participants, most were married or cohabiting (73%), Caucasian (93%), males (68%) aged 67 ± 11 years. Participants were well educated, with 63% reporting more than a high school education; nearly half (49%) had private insurance. Participants reported prior AMI (54%), CABG (47%), PCI (48%), and the presence of cardiovascular risk factors that included hypertension (54%), diabetes mellitus (20%), hyperlipidemia (64%), and current cigarette smoking (5%).

When placed into hostile and non-hostile groups using the established cutpoint¹⁸ and compared, hostile participants were on average 3 years younger ($p < 0.01$), were less educated (61% high school or less, $p = 0.007$), were more likely to have diabetes (65%, p

≤ 0.01), and to be a current smoker (76%, $p \leq 0.001$). There were no other demographic or clinical differences between these two groups (Table 1).

The two end points evaluated within this study were ACS recurrence that required rehospitalization for ACS event and all-cause mortality. One hundred ninety-three participants (8.3%) were rehospitalized during the study time period. Thirty-eight (1.6%) patients died during the trial.

Prevalence of Hostility

Participant hostility scores ranged from 0 to 26; on average, hostility scores were 7.6 ± 3.8 . Participants were categorized as hostile or non-hostile based on their individual score and the established cut-point of 7;¹⁸ those categorized as hostile comprised the majority (57%).

Prediction of ACS recurrence

Cox regressions were used to determine independent predictors of ACS recurrence with all variables entered in one block; variables included known covariates and were controlled (sex, education, ethnicity, marital status, prior history of PCI, CABG, MI, diagnosis of DM or HTN, or currently smoking) and hostility scores. In the Cox regression analyses, the model was determined to be significant (Chi square 37.7, $p < 0.001$) using the Omnibus Test of Model Coefficients. This analysis identified two independent predictors of ACS recurrence. Participants with a prior history of PCI, had a 50% increased risk of ACS recurrence (OR 1.5, CI=1.2-2.0, $p = 0.01$). History of hypertension was also associated with a 50% increase in risk of ACS recurrence (OR 1.5, CI = 1.1-2.0, $p = 0.001$). Hostility was not an independent predictor of ACS recurrence (OR 0.96, CI = 0.74-1.24, $p = 0.79$) (Table 3, and Figure 2.).

Prediction of Mortality

Cox regressions were used to determine independent predictors of mortality with all variables entered in one block; variables included were known covariates, and therefore controlled (age, sex, education, ethnicity, marital status, prior history of PCI, CABG, MI, diagnosis of DM or HTN, or whether they were currently smoking) and hostility scores. In the Cox regression analyses, the model was determined to be significant (Chi square 43.4, $p \leq 0.01$) using the Omnibus Test of Model Coefficients. This analysis identified three independent predictors of mortality; age (OR 1.09, CI 1.07-1.11, $p < 0.01$), history of previous MI (OR 2.15, CI 1.41-3.29, $p < 0.001$), and hostility were independent predictors of all-cause mortality (OR 1.52, CI 1.02-2.28, $p \leq 0.038$) (Table 2 and Figure 1.). For every year increase in age, there was an associated 9% increase in the likelihood of mortality. Prior MI more than doubled the likelihood of death, and a one unit increase in hostility score, as measured with the MAACL, was associated with a 52% increase in likelihood of mortality.

Discussion

Nearly two thirds of our participants, with known CHD were classified as hostile using the established cut point of 7 for the MAACL.¹⁸ This prevalence was more than double that of participants in the Women's Health Initiative study (hostile group = 27%), which included postmenopausal women who were cancer and heart disease-free at enrollment.⁸⁴ The reported prevalence of hostility in other populations was also considerably lower than in our sample; individuals with schizophrenia had a hostility prevalence of 27.9%,⁸⁵ and a sample of healthy adults, which included police and fire personnel, military personnel and victims of crime, had a prevalence of 22%.⁸⁶ Thus, the

prevalence of hostility in our CHD participants was considerably higher in comparison with these other groups. Similar to our findings, Newman and colleagues⁸⁷ found that 90% of their study participants with known CHD (n = 1,729) were scored as hostile, which was based on individual interviews, rather than an established instrument like the MAACL used in our study. Thus, hostility prevalence was significantly higher in the studies of individuals with known CHD, regardless of how hostility was measured. Unfortunately, most studies that measured hostility used a variety of instruments without an established cut-point. Most often these other studies used a median split value⁸⁸ or divided the participants into hostile and non-hostile groups using quartiles;^{84,89-93} thus, prevalence of hostility in many of these studies was not reported, and direct comparisons with our study finding were not possible.⁹⁴

When participants with hostility were compared to those without hostility, those with hostility were on average 3 years younger ($p < 0.05$). This is consistent with Wong and colleagues,⁹² who also found that hostile participants were 3 years younger than non-hostile participants. Boyle and colleagues⁹⁵ found that younger age and hostility were associated with mortality, but only in the participants who were less than 62 years of age. Another group of investigators⁹⁶ further clarified the association between age and hostility when they found that age moderated the relationship between inflammation and hostility in younger adults, particularly in women. They demonstrated that hostility in younger adults incited a greater inflammatory response, particularly in interleukin-6, tumor necrosis factor, and high sensitivity C-reactive protein. This is an intriguing finding given that these biological responses are associated with cardiovascular risk.⁷³

We also found that 61% of the participants categorized as hostile reported having a high school education or less. Similarly, Wong and colleagues⁹² reported higher hostility in those with high school education, and Versey and Caplan⁶⁶ found nearly three fourths of their sample with hostility reported a high school education or less. Thus, this finding is consistent with other studies assessing the relationship between hostility and cardiac disease. An increased level of perceived stress has been associated with less income and lower levels of education. Stressful social conditions may be more difficult for those with poorer coping mechanisms and less insight, which may support a mechanism behind the association between lower education and hostility.

A larger proportion than predicted of hostile participants was also more likely to smoke cigarettes and have a diabetes diagnosis. This is consistent with the findings of other investigators.^{67,97,98} In prior studies, individuals categorized as hostile were more likely to exhibit risk factors for cardiac disease that included cigarette smoking,⁶⁷ a sedentary lifestyle,⁹² unhealthy dietary intake⁶⁸ and obesity.⁶⁸ Van den Bree and colleagues⁶⁸ found that hostility was associated with consuming larger quantities of food, and other unhealthy eating habits. Wong and colleagues⁹² concluded that poorer health behaviors mediated the association between hostility and cardiovascular events. In addition, the degree of hostility could also influence the strength of the association between health behaviors and cardiac events, so it may also act as a moderator.

Hostility was not an independent predictor of ACS recurrence in these participants. Similarly, Song and colleagues⁹⁹ followed a small sample of patients (n = 35) for 6 months after PCI to manage ACS, and found that hostility was not a predictor of recurrent cardiac event; however, trait anger and homocysteine concentration predicted

recurrent stenosis. The lack of association between hostility and recurrence in our study is in contrast to the conclusions of a number of other investigators.^{8,32,92,99} Wong and colleagues⁹² followed individuals with known CHD (n = 1022) for an average of 7.4 years, and found that individuals in the highest quartile of hostility score exhibited a 58% greater likelihood of recurrent cardiac event compared with those in the lowest quartile, after controlling for cardiovascular risk factors, hyperlipidemia, hypertension, diabetes, and inactivity. These investigators concluded that the association between hostility and recurrent cardiac events was moderated by physical inactivity and cigarette smoking. Tindle and colleagues⁸⁴ found that women with the highest quartile hostility scores had a 13% greater likelihood of recurrent AMI, 16% greater likelihood of all-cause mortality, and a 25% greater likelihood of CHD mortality, after controlling for a number of demographic variables and known CHD risk factors. Haas and colleagues¹⁰⁰ followed men with CHD for 4 years and found that high hostility doubled the likelihood of recurrent cardiac events; however, hostility did not confer risk for recurrence in women. Thus, there are equivocal findings about the association between hostility and recurrent cardiac events, and hypothetical sex differences

Hostility was a predictor of all-cause mortality in our large sample of participants. Similarly, a number of investigators found that hostility predicted mortality in individuals with CHD.^{95,101-103} However, Lemogne and colleagues¹⁰⁴ suggested that hostility mediated the association between depression and mortality in a cohort of healthy working adults in France; while Klabber and colleagues found that cynical hostility was significantly associated with mortality independent of health behaviors.¹⁰⁵ In a related analysis, Hoen and colleagues¹⁰⁶ followed individuals with stable CHD for an average of

7.1 years, and found that those with a positive affect were 16% more likely to survive, but this effect was primarily explained by the increase in level of physical activity. Thus, the mechanisms that produce increased likelihood of mortality in those with hostility requires further investigation.

Our finding is dissimilar to that of Kaufman and colleagues,⁹⁵ who determined that hostility was not predictive of mortality in patients followed for 1 year after AMI. Boyle and colleagues⁹⁵ also found that hostility was not a predictor of mortality (HR 1.13, CI - 0.92-1.38, $p = 0.23$) in older individuals with CHD (> 61.2 years), but was an independent predictor of mortality in the younger age group (HR 1.52, CI - 1.15- 1.99, $p = 0.003$). In a related study, Angerer and colleagues¹⁰⁷ found that cynical hostility total score and subscale scores for cynicism, hostile affect, and aggressive responding, were not predictive of CHD progression. These investigators concluded that the association between hostility and mortality was more complex than initially hypothesized. Thus, associations between hostility and mortality are complex, are likely influenced by multiple behavioral and biological variables, and may reflect moderation or mediation effects of hostility with multiple psychological and physiological variables.

Hostility, a multidimensional personality trait, is characterized by negative attitudes toward others, cynicism, aggressive behaviors, and mistrust.¹⁰⁸ Although multiple studies focused on the association of hostility and cardiovascular disease development,¹⁰⁹ progression,^{61,92,109} and outcomes,⁹² a majority of these used a self-report measure of hostility. Self-report measures may be prone to bias, particularly in individuals who lack insight into their own thoughts and behaviors.¹⁰⁸ Newman and colleagues⁸⁷ used an objective 12-minute taped interview to objectively measure hostility

through interpersonal cues and manifestations of hostility during the interview. These investigators found that any objective evidence of hostility was associated with twice the likelihood of ischemic heart disease during a 10-year follow-up period; however, self-reported hostility was not a predictor. Thus, the measurement strategy employed in the majority of hostility studies may have significantly influenced study outcomes, and could be responsible for equivocal findings.

Our study had several limitations. First, this was a secondary analysis of existing data; thus, we were limited to variables in the original study. However, variables known to influence the outcomes of interest, ACS recurrence and mortality, were available in the data. Second, the instrument used to evaluate hostility was self-report and had limited use in cardiac patients.¹¹⁰ However, this instrument was previously used in other chronic disease populations, and has demonstrated adequate psychometrics in a hospitalized patients with arthritis,¹¹¹ incarcerated Vietnam veterans, alcoholics,¹¹² university students, and women undergoing in vitro fertilization. Finally, the ethnic diversity of participants was limited, as 93% of the sample was Caucasian. However, these data were from a geographically diverse, multi-site international study with participants from 3 countries (US, New Zealand, Australia), and four cities in the US (Los Angeles, CA, Lexington, KY, San Diego, CA, Seattle, WA). While our findings are not widely generalizable they may prove beneficial for future research.

Conclusion

A majority of our CHD participants self-reported hostility using a psychometrically sound instrument. Hostility was identified as a predictor of mortality during the 24-month follow-up period; but was not a predictor of ACS recurrence in these

individuals. Future studies should include objective measurement of hostility, and analyses that focus on potential moderation or mediation effects between hostility, other psychological constructs, like anxiety and depression, biomarkers of inflammation, cardiac disease development and progression, and cardiac events and mortality. A clear understanding of the complex interplay of these psychological and physiological variables would offer the opportunity to tailor interventions intended to improve patient outcomes.

Table 2.1 Sociodemographic and clinical characteristics of participants (n =2,321)

Variable	Total Sample (n = 2321)	Hostile (n=1324)	Non-hostile (n=997)	p value
Sex (male)	1575 (68%)	903 (68%)	672 (67%)	0.69
Age in years	68 ± 11	66 ±11	69 ± 10	< 0.001
Education				
High School or Less	855 (37%)	519 (39%)	336 (34%)	0.007
More than High School	1466 (63%)	805 (61%)	661 65%)	
Ethnicity				
Caucasian	2151 (93%)	1217 (92%)	934 (94%)	0.11
All others	170 (7%)	107 (8%)	63 (6%)	
Marital Status				
Married/cohabitating	1689 (73%)	971 (73%)	718 (72%)	0.48
Single/divorced/widow	632 (27%)	353 (27%)	279 (28%)	
Prior AMI	1253 (54%)	703 (53%)	550 (55%)	0.32
Prior PCI	1114 (48%)	632 (48%)	482 (48%)	0.80
Prior CABG	1089 (47%)	619 (47%)	470 (47%)	0.85
Hypertension	1244 (54%)	694 (52%)	550 (55%)	0.19
Diabetes mellitus	467 (20%)	302 (23%)	165 (17%)	< 0.001
Current smoking	111 (5%)	84 (6%)	27 (3%)	< 0.001
Hostility score	7.55± 3.8	10.3 ± 2.6	4 ± 1.6	< 0.001

Values are mean ± SD or n (%), groups compared with independent t test or Chi square based on level of measurement

AMI-acute myocardial infarction, PCI-percutaneous coronary intervention, CABG-coronary artery bypass graft

Table 2.2 Independent predictors of ACS recurrence (n = 2,321)

Variable	β	Exp B	95% Confidence Interval	p value
Age	0.007	1.007	0.99-1.01	0.28
Sex (male)	-0.13	0.983	0.74-1.31	0.93
Education (\leq high school)	0.267	1.03	1.00-1.94	0.44
Ethnicity (Caucasian)	-0.110	0.89	0.58-1.03	0.62
Marital Status (single)	-0.370	0.69	0.52-0.90	0.08
Prior PCI	0.465	1.59	1.2-2.0	0.001
Prior CABG	-0.51	0.95	0.72-1.24	0.70
Prior AMI	0.266	1.24	0.96-1.62	0.08
Hypertension	.0448	1.56	1.91-2.04	0.001
Diabetes mellitus	0.267	1.31	0.99-1.7	0.06
Current smoking	0.100	1.11	0.66-1.8	0.70
Hostility score (not hostile)	-0.050	0.96	0.74-1.2	0.79

Chi Square 49.6, $p \leq 0.001$

CABG-coronary artery bypass graft, PCI-percutaneous coronary intervention, and AMI-acute myocardial infarction

Table 2.3 Independent predictors of mortality (n = 2,321)

Variable	B	Exp B	95% Confidence Interval	p value
Age	0.89	1.09	1.06-1.12	<0.001
Sex (male)	-0.36	0.69	0.43-1.11	0.12
Education (≤ high school)	-0.31	0.96	0.64-1.46	0.88
Ethnicity (Caucasian)	-0.31	0.73	0.35-1.5	0.73
Marital Status (single)	-0.15	0.51	0.54-1.3	0.51
Prior PCI	-0.12	0.88	0.59-1.33	0.51
Prior CABG	0.16	1.18	0.78-1.7	0.42
Prior AMI	0.769	2.15	1.41-3.29	< 0.001
Hypertension	0.98	1.10	.074-1.6	0.63
Diabetes mellitus	0.13	1.13	0.71-1.8	0.59
Current smoking	-0.52	0.58	0.14-2.4	0.47
Hostility score (not hostile)	0.424	1.52	1.02-2.28	0.03
Mortality	38 (1.6%)			0.03

Chi Square 43.7, p = <0.001

CABG-coronary artery bypass graft, PCI-percutaneous coronary intervention, AMI-acute myocardial infarction

Figure Legends

Figure 2.1: Hazard Plot for Recurrent ACS

Figure 2.2: Hazard Plot for All-cause mortality

Figure 2.1 Hazard Plot- Recurrent ACS

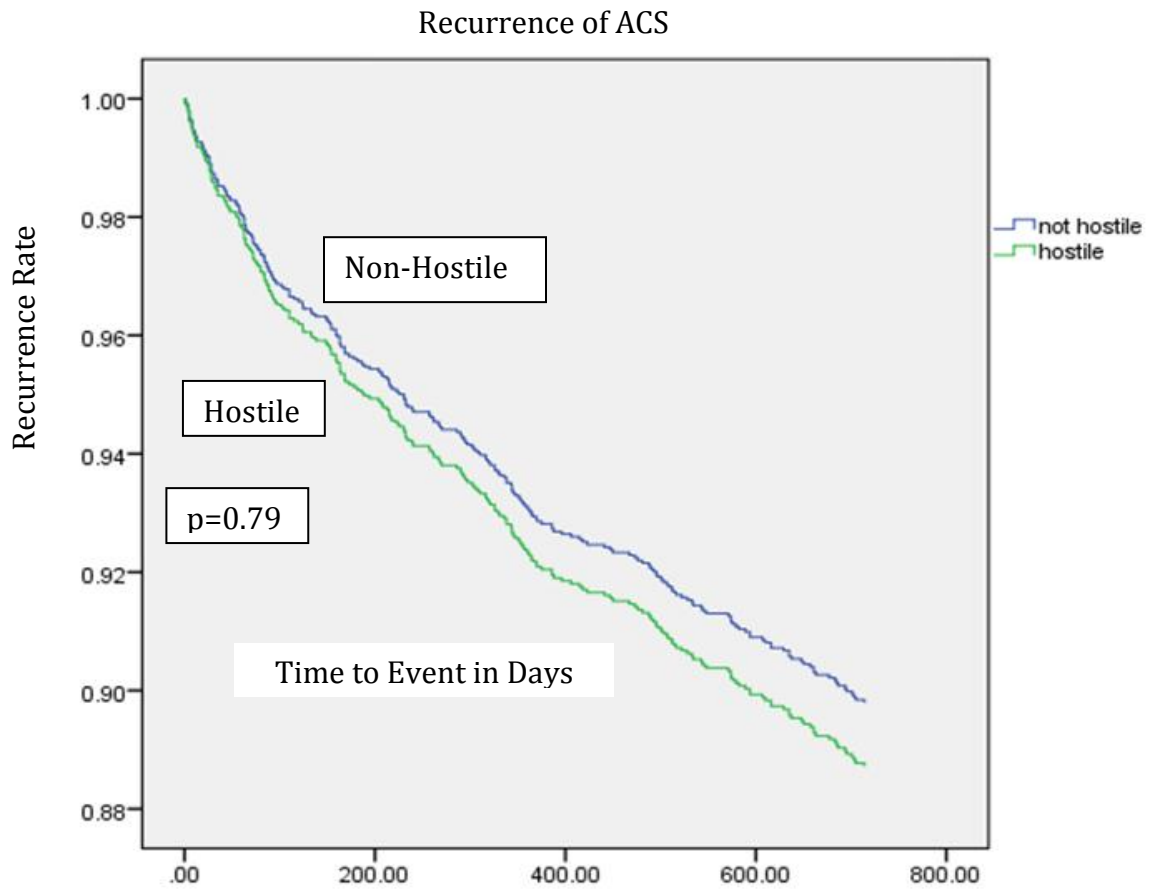
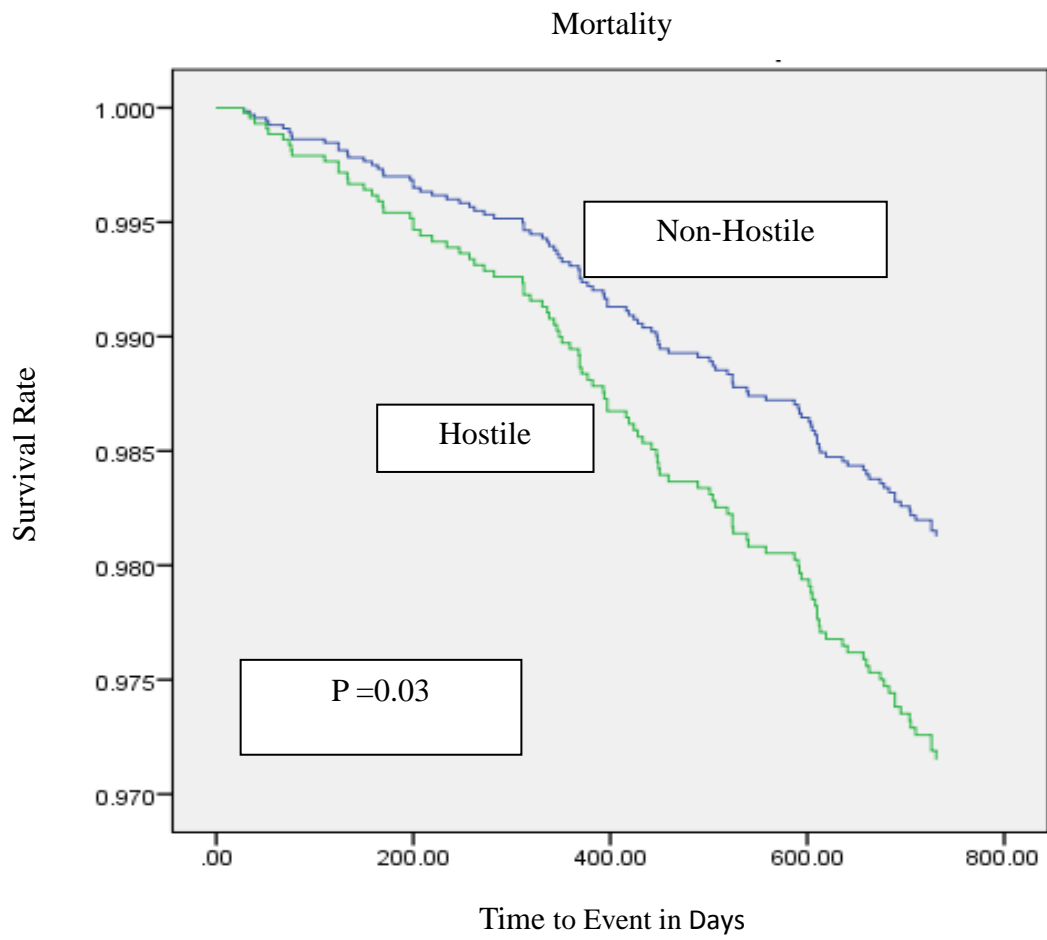


Figure 2.2 Hazard Plot for All-cause mortality



CHAPTER THREE

The psychometric properties of the BSI Hostility and Anxiety subscales in a prison population

Abstract

OBJECTIVE: An estimated 2.3 million individuals are currently incarcerated in the U.S.; psychological distress occurs in nearly half. Anxiety and hostility, components of psychological distress, are associated with greater risk for serious cardiac consequences. Prior studies used the Brief Symptom Inventory (BSI) to evaluate anxiety and hostility in prisoners; however, the psychometrics of the BSI in this population has not been evaluated. Thus, the purpose of this study was to evaluate the psychometric properties of these BSI scales in incarcerated participants.

METHODS: This was a secondary analysis of baseline data from a randomized controlled trial of an intervention to reduce cardiovascular risk factors in male prisoners ($n = 373$). Participants provided demographic data and completed the BSI at baseline prior to the intervention. Cronbach's alpha was used to determine internal consistency reliability. Factor analysis evaluated the factor structure of the instrument. Hypothesis testing determined construct validity; we hypothesized that self-reported mental health scores would be worse in those with higher anxiety and higher hostility, and that lower perceived control would be evident in those with higher anxiety and hostility.

RESULTS: Participants were incarcerated males who were primarily Caucasians (63%) aged 36 ± 10 years. Internal consistency reliability was good (Cronbach's alpha - hostility 0.83, anxiety 0.81). Items from the two dimensions were analyzed together using exploratory factor analysis with varimax rotation. Two dimensions, anxiety and hostility, were identified. However, one anxiety item, feeling tense or keyed up, loaded in the

hostility dimension. Scales were scored using the original structure and a new structure with this item moved. Classification of individuals as anxious or hostile was not different using established cut-points; thus, the original structure was deemed valid. Construct validity was also supported; those with high anxiety reported a greater number of days (in the last 30 days) where their self-reported health was rated as fair or poor. Those prisoners with lower perceived control had higher levels of anxiety and hostility.

CONCLUSION: The BSI anxiety and hostility subscales are reliable and valid in the prison population.

Key words: Anxiety, Hostility, Brief Symptom Inventory, Reliability, Validity, Psychometrics, Prison Population

Introduction

There are an estimated 1,574,800 persons in both state and federal penitentiaries in the United States, including 1,463,500 males and 111,300 females.¹¹³ The American prison population has increased four-fold in the last decade, and the U.S. incarcerates more individuals than any other civilized nation.¹¹⁴ Over one and a half million U.S. inmates rely on the prison system for management of chronic health conditions, and disease prevention and health promotion.¹¹⁴ Heart disease (35%), suicide (29%), and cancer (23%) are the leading causes of death for inmates and those recently discharged from prisons.^{115,116}

An estimated 35% of individuals imprisoned in local, state and federal systems die from heart disease annually.¹¹⁷ Incarceration history was identified as an independent risk factor for hypertension and left ventricular hypertrophy in young men (ages 18-30); men previously incarcerated were 70% more likely to have hypertension (OR 1.7, 95%, CI 1.2 to 2.6, $p = 0.02$), and 2.7 times more likely to develop left ventricular hypertrophy (OR 2.7, 95%, CI 0.9 to 7.9, $p = 0.005$) when compared with others in the general population.¹¹⁸ Left ventricular hypertrophy increased cardiac risk and mortality, and there was a direct relationship between left ventricular hypertrophy and hypertension.¹¹⁹ Arries and Maposa¹¹⁶ identified hypertension as the most common risk factor for coronary heart disease among inmates, followed by cigarette smoking, lack of exercise and obesity.

Prisoners learn to adapt to minimal privacy, frequent threats to personal safety, and living on “high alert” because of the fear of bodily harm.¹²⁰ This chronic state of stress is hypothesized to have long term effect on behavioral health. The prevalence rate

of psychological distress in prisoners with behavioral health disorders is three times that of the general population,¹²¹ and many are left to self-manage anxiety or hostility.

Psychological distress, which includes anxiety and hostility, increases the progression of cardiovascular disease,^{59,122,123} and negative emotions are often intensified in highly stressful situations such as incarceration.^{18,91,124,125} An estimated 14% of prisoners have a treatable mental illness,^{126,127} and 22% have cardiovascular disease¹¹⁵ upon entry into the prison system. Anxiety and hostility are also associated with platelet dysfunction, and catecholamine release, which stimulates inflammation, and has been linked with mortality.^{30,74,92,99,108,128,129} Anxiety is an independent risk factor for coronary heart disease, and for increased mortality in patients with coronary heart disease.¹³⁰ Hostility has also been associated with higher mortality in patients with heart disease.^{32,131} Chida and Steptoe³² found that hostility was associated with readmissions and deaths in patients with coronary heart disease (HR 1.19, CI 1.05-1.35, $p = 0.008$), and with a 24% increased likelihood of mortality in the presence of hostility in those with existing coronary heart disease (HR 1.24, CI 1.08-1.42, $p = 0.002$).¹³² Both anxiety and hostility have been associated with reduced immune function, abnormal cardiac function, and an increased risk of mortality.^{21,116} Therefore, it is vital to have reliable and valid measures of these emotional states, so that targeted interventions may be developed and implemented. Thus, the purpose of this study was to evaluate the psychometric properties of the Brief Symptom Inventory (BSI) hostility and anxiety scales in a group of incarcerated participants. The specific aims were: 1) to determine internal consistency reliability of the BSI anxiety and hostility subscales; 2) to determine the factor structure of these 2 scales using exploratory factor analysis; and 3) to evaluate the construct

validity of these scales with hypothesis testing. We hypothesized that self-reported general health scores and perceived control would be worse in those incarcerated individuals with high anxiety and high hostility.

Methods

Design

This was a secondary analysis of baseline data from a clinical trial where an intervention to reduce cardiovascular risk factors was tested with incarcerated men in Kentucky.¹³³ In the original study, all incarcerated men who enrolled received the intervention. All participants had 2 baseline measurement periods three months apart, an initial baseline, and a pre-intervention baseline. For this analysis, the initial baseline was used. For this psychometric evaluation, we included those individuals who had complete baseline data for age, marital status, ethnicity, educational level, crime(s) that required incarceration, self-reported health status, perceived control scores, body mass index (BMI), glycosylated hemoglobin (HbA_{1c}), total cholesterol, and baseline BSI anxiety and hostility scores.

Sample and Setting

The original study was conducted in four Kentucky state-operated minimum to medium security prisons for men, the Luther Lockett Correctional Complex, Kentucky State Reformatory, Little Sandy Correctional Center in Sandy Hook, and Eastern Kentucky Correctional Complex located in Morgan County. Incarcerated men were eligible for study participation when they were: 1) aged 18 and older; 2) at least 7 months or more from parole; 3) educated to at least the 8th grade; and 4) English speaking. Individuals were excluded from participation when they: 1) were acutely febrile at the

time of data collection; 2) had a history of acute myocardial infarction or percutaneous coronary intervention; 3) exhibited an auscultated systolic blood pressure ≥ 160 mmHg and/or diastolic pressure ≥ 100 mmHg; 4) had a diagnosis of asthma, chronic obstructive pulmonary disease, cystic fibrosis, insulin-dependent diabetes, or chronic heart failure; and 5) exhibited an unstable mental illness evidenced by admission to a psychiatric unit one month prior to the commencement of the study, or engaged in inappropriate behavior demonstrated by placement in the segregation unit during the month prior to commencement of the study.

Measures

Sociodemographic and clinical variables

Sociodemographic and clinical variables included in this secondary analysis were age, marital status, educational level, ethnicity, crimes that required incarceration, BMI, total cholesterol, and HbA_{1c}.

BSI Anxiety and Hostility Subscales

The BSI was developed by Derogatis and colleagues in 1982,¹³⁴ this instrument provides an overview of psychological state at a given point in time. The BSI was developed from the Symptom Checklist 90 Revised (SLC-90-R).¹³⁵ The complete BSI includes 53 items that evaluate nine dimensions of psychological state.^{134,135} The nine dimensions include somatization, depression, anxiety, hostility, obsessive-compulsive disorder, phobic anxiety, paranoid ideation, interpersonal sensitivity, and psychoticism. The BSI has been used with large samples in diverse settings including outpatient psychiatric patients (n=1002), normal healthy individuals (n=719), and psychiatric inpatients (n=313).¹³⁴ Previous supportive evidence of reliability was established in large

diverse forensic inpatient and outpatient psychiatric populations (N=1002)¹³⁵ where Cronbach's coefficient ranged from 0.71 to 0.81 for each of the nine scales.¹³⁴

Convergent validity of the original SCL-90-R was evaluated against the Minnesota Multiphasic Personality Inventory (MMPI) in 209 symptomatic volunteers; convergent validity was supported. Correlation coefficients for anxiety and hostility were between 0.31-0.57.^{134,135}

Anxiety is defined as nervousness, feeling of angst, apprehension or nervousness to an internal or external stimulus that creates a negative emotion with uncertainty.²³ The anxiety subscale includes six items that evaluate anxiety, restlessness, nervousness, panic, and tension. Each item is rated on a 5 point Likert scale from 0 = not at all to 4 = extremely. The subscale score is the average of the six items; higher scores equate to higher anxiety levels. In healthy individuals, outpatient psychiatric and inpatient psychiatric patients, mean scores of 0.35, 1.70 and 1.70 were found respectively, and are considered cut points.^{134,136}

Hostility is defined as a cynical, antagonistic, resentful attitude towards others, with negative interactions characterized by sarcasm, impatience, irritability or negativism.^{18,28} The hostility subscale includes five items that evaluate feelings of annoyance and irritability, urges to break things, frequent arguments, and uncontrollable outbursts or temper.¹³⁴ Each item is rated on a 5 point Likert scale ranging from 0 = not at all to 4 = extremely. The subscale score is the average of the five items; higher scores indicate higher levels of hostility. In healthy individuals, outpatient psychiatric and inpatient psychiatric patients, mean scores of 0.35, 1.16, and 1.00 were identified, and are used as cut points.^{134,136}

Inmate Health Risk Assessment

The Inmate Health Risk Assessment (I-HRA) is a self-report instrument developed from items on the Behavioral Risk Factor Surveillance Survey (BRFSS).¹³³ The BRFSS was developed in 1984 by the Center for Disease Control for the purpose of collecting data from individual states about U.S. citizens and the health-related risk behaviors, chronic health diseases and preventive services.¹³⁷ The I-HRA¹³⁷ has 20 individual items which measure inmate involvement in modifiable health behaviors, such as usual dietary intake, perceived level of energy, tobacco use and smoking habits, typical sleep patterns, presence of social support, and degree and type of health care coverage. We used one question that requested the participant to rate their current mental health. This item was measured with a 5 point scale 1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor.

Control Attitude Scale-Revised

Perceived control is the belief that an individual has control over their health, stress, and behavior, and can influence important outcomes by their actions.^{138,139} Perceived control was measured using the Control Attitude Scale (CAS-R), an eight item instrument that contains 2 items from the original Control Attitude Scale and 6 items from the Cardiac Attitudes Index. Each of the items are rated on a Likert-type scale with 1 = totally disagree to 5 = totally agree. The scale is scored by adding the eight individual items, and the total score can range between 8 and 40, with higher scores indicating higher levels of perceived control.¹³⁸ Perceived control has previously been associated with worse outcomes in patients with coronary heart disease¹⁴⁰, acute myocardial infarction²² and heart failure patients.^{141,142}

Moser et al.¹³⁸ performed a psychometric evaluation with data from cardiac patients; patients were diagnosed with coronary heart disease, acute myocardial infarction and heart failure. Reliability using Cronbach's alpha was acceptable for all three populations, 0.73, 0.72, and 0.76 respectively.¹³⁸ Item total correlations and inter-item correlation coefficients for all three were above 0.3.¹³⁸ Hypothesis testing concluded increased perceived control was independently related to lower levels of anxiety and depression in these three populations.¹³⁸ Thus, the CAS-R was a psychometrically sound instrument in patients with cardiac disease living in diverse setting.

Procedure

Approval for the study was obtained from the Kentucky Department of Corrections and the University of Kentucky Medical Institutional Review Board. The baseline data were collected at a dedicated health booth located in the recreational room of each facility approximately one week after informed consent was obtained. The inmates scheduled individual appointments to complete the instruments and ensure confidentiality was maintained. The pre-intervention baseline data were collected at a scheduled appointment in a dedicated booth in the recreational room three months after the initial baseline data. Once both baseline data collections were completed, the behavioral cardiovascular risk reduction education sessions commenced. These twice weekly sessions dedicated to education, counseling and exercise were delivered for 12 weeks. Immediately following the 12 weeks, post intervention data were collected and final data were collected at 3 months after the intervention. Data were double entered from the original data forms, and accuracy was evaluated and assured prior to analysis. For this secondary analysis, we used data from the first baseline, and included only those

participants who had complete data for age, education, ethnicity, marital status, BMI, total cholesterol, HbA1c, incarceration crime(s) committed, baseline anxiety scores, baseline hostility scores, perceived control scores, and perception of current health.

Data Analysis

Descriptive statistics were used to characterize the participants. Internal consistency reliability was assessed with Cronbach's alpha coefficient using the 11 items (five from hostility and six from anxiety) from both scales, and for each scale separately. A coefficient of .70 or greater was considered evidence of internal consistency reliability.^{143,144} Item and inter-item correlations were used to demonstrate homogeneity and interrelatedness. Items with correlations that were more than 0.9 were considered redundant; items with correlations less than 0.2 were considered unrelated to items in the scale.¹⁴³ Item analyses were performed using item-total correlations (i.e. correlation of the individual items with the scale total omitting that item) and Cronbach's alpha with item deletion.

Exploratory factor analysis was used to evaluate the dimensionality of the 11 items. Data appropriateness for factor analysis was determined using Bartlett's test and Kaiser-Meyer Olkin cutpoints.^{145,146} Factors were extracted based on Eigenvalues greater than one. The items were then rotated using principal component extraction with varimax rotation. Based on the varimax rotation results, the items were categorized into factors. Construct validity was evaluated using hypothesis testing. We hypothesized that lower perceived control scores and poorer self-reported mental health score from the IHRA would be associated with higher anxiety and hostility. All data analyses were

performed with SPSS version 21.0 (IBM, Armonk, NY), and an a priori alpha level of 0.05 was used to determine significance for all tests.

Results

Characteristics of the Participants

Male participants (n =373) were primarily Caucasians (63%) who were single, widowed or divorced (86%), with a high school education or less (59%), and were 36 ± 9 years of age (Table 1). The most common reasons for incarceration included theft (32%), assault/battery (30%) and murder/manslaughter (29%). More than one third of our participants regularly smoked cigarettes (38%). Nearly one fifth (19%) of participants were prescribed antihypertensive medications. However, more than three fourths of participants (77%) rated their current general health as good, very good or excellent.

Internal Consistency Reliability

Cronbach's alphas for the baseline anxiety and hostility subscales were 0.79 and 0.83 respectively. The inter-item correlations for all items in the BSI anxiety and hostility subscales were acceptable, and ranged from 0.22 to 0.67.¹⁴⁷ Each subscale was evaluated separately. There was no improvement in the Cronbach's alpha with removal of any items; thus, all items were retained. Item to item correlations for the anxiety scale was 0.33 to 0.67 and inter-item correlation was 0.48, which indicated acceptable interrelatedness among the items (Table 3.2.). The item to item correlations for the hostility subscale were 0.48 to 0.65 with inter-item correlation of 0.54, also indicating interrelatedness at an acceptable level and scale homogeneity. Item-total correlations were greater than 0.30 (range = 0.46 to 0.65) for all items in the hostility subscale (Table 3.2.).

Construct Validity

Evaluation of construct validity using exploratory factor analysis identified the presence of two factors after rotation; these explained 63.4% total item variance (Table 3.3.). Nine out of the eleven items demonstrated strong factor loadings above 0.7.¹⁴⁸ However, two anxiety items (#4 and #6) cross-loaded with the hostility factor. Anxiety #4 related to the feeling of being “tense and keyed up”; while anxiety #6 represented “feeling so restless you couldn't sit still”. After calculating total score using the original subscales and subscales with the anxiety items moved to the hostility scale, the scores were not different and did not support removing the items or adding them to the hostility scale. Thus, the original 6 anxiety items and 5 hostility items were maintained.

To provide support additional support for construct validity, we tested the hypotheses that lower perceived control and worse self-reported mental health scores would be associated with high anxiety, and high hostility.¹⁴⁹ Participants were dichotomized into anxious and not anxious groups using a cut point of 0.35 based on published norms from healthy adults.¹³⁴ A significantly greater proportion of individuals classified as anxious reported worse mental health (anxious group 35%, nonanxious 25%, $p < 0.01$).

Participants were also categorized into hostile and not hostile groups using a cut point of 0.35 based on published norms for healthy adults.¹³⁴ Self-reported mental health was not different between the hostile and non-hostile groups. However, self-reported perceived control scores were significantly worse in those with high anxiety (high anxiety - 30.7 ± 5.2 , low anxiety - 34.0 ± 5.0 , $p < 0.001$) and high hostility (30.9 ± 5.1 , low hostility 33.4 ± 5.3 , $p < 0.001$), indicating participants with lower perceived

control reported more anxiety and hostility (Table 3.5). Thus, our hypothesis testing supported construct validity for the BSI anxiety and hostility subscales in this population.

Discussion

This is the first psychometric analysis of the anxiety and hostility subscales of the BSI in a prison population. We found evidence to support the reliability and validity of the anxiety and hostility subscales in the prison population. Cronbach's coefficients demonstrated good internal consistency reliability; factor analysis with varimax rotation supported two factors, anxiety and hostility. Hypothesis testing established that those prisoners with higher anxiety and hostility reported worse self-reported health and lower perceived control. Thus, our hypothesis testing supported the construct validity of these BSI scales.

The majority of prisoners in this study reported anxiety (57%) and hostility (58%), and more than a fourth (27%) reported anxiety and hostility simultaneously. In the U.S., 18% of healthy elders and 37% adults with coronary disease reported anxiety; whereas 30% of health elders and 60% adults who had undergone a coronary artery bypass graft experienced hostility.¹⁸ Thus, our incarcerated participants had a higher than typical prevalence.¹⁵⁰ General stress, including the adjustment period to incarceration, could explain a higher than expected prevalence. The stressors previously identified by prisoners were personal and environmental, and included lack of privacy and close quarters, which led to the fear for personal safety.^{118,151} Edwards¹⁵² posited that psychological distress was influenced by aggravating (deprivation) or protective factors impacting a prisoner's baseline mental health. He also identified that those prisoners newer to the prison system had higher levels of distress, and prisoners with lower

educational levels had limited coping skills and difficulty in managing stress.¹⁵² Thus, it is not surprising that anxiety and hostility were prevalent in these participants.

Our analyses supported adequate internal consistency reliability with reliability estimates for anxiety 0.81 and hostility 0.83; thus, the BSI was internally consistent in this population. This is similar to the findings from previous studies by Valera,¹⁵³ Boulet,¹³⁵ Derogatis,¹³⁴ and Khalil et al.¹³⁶ Prior investigators found reliability coefficients for the anxiety subscale that ranged from 0.78 to 0.86, and the hostility subscale that ranged from 0.68 to 0.81.^{134,153} Consistent with our findings, Loutsiou-Ladd et al¹⁵⁴ found strong reliability (anxiety 0.82, hostility 0.78) in the BSI.¹⁵⁴

Item–total correlation coefficients and Cronbach’s alpha with item deletion of the BSI anxiety and hostility subscales were acceptable (> 0.20) in our study;¹⁵⁵ all items contributed to the anxiety and hostility subscales. These alpha coefficients were similar to those of Boulet and colleagues¹³⁵ in a male psychiatric inpatient and outpatient population. In our study, two item-total correlation coefficients on the anxiety scale were observed to be < 0.5 (“being scared for no reason” and “having spells of terror or panic”), which indicated those two items may not measure the same construct as the other items. In this case, having a lower item-total correlation did not impact the factorability of the individual items. This situation did raise a concern in terms of how well the scales discriminate between the anxiety and hostility; however, internal consistency was evaluated with those items, and no significant difference was found. Thus, the original structure was retained.

Our analyses supported the construct validity of the BSI anxiety and hostility subscales in the prisoner population. Principal components factor analysis with varimax

rotation provided evidence for the presence of two factors; these were consistent with the concepts anxiety and hostility. When measured together, these subscales separated and formed their individual factors. Our finding is similar to the that in the original study by Derogatis,¹³⁴ and follow up studies that evaluated factor dimensions.^{156,157} However, construct validity for both the anxiety or hostility subscales was not supported in a study by Benishek et al.¹⁵⁸ that included subjects in a substance abuse treatment facility. Those investigators identified one factor on which all nine dimensions of the BSI loaded.¹⁵⁸ Thus, Benishek and colleagues¹⁵⁸ supported the use of the BSI to evaluate general psychological state, but not separate concepts like anxiety and hostility. Kellett et al.¹⁵⁷ explored the dimensionality of the BSI with a sample of mildly intellectually impaired individuals where eight clear dimensions were identified. The anxiety subscale was robust, while the hostility subscale loaded on a separate factor, and also cross loaded onto a general stress factor. These findings were not robust, and were proposed to this support the original psychometric analysis from Derogatis and colleagues.¹³⁴ Thus, a majority of psychometric evaluations including ours supported the factor structure of the anxiety and hostility subscales.

Construct validity for the anxiety subscale was supported by hypothesis testing; we found that those with high anxiety reported worse mental health, while those with high anxiety and hostility reported lower perceived control. Boulet et al¹³⁵ evaluated construct validity using the Minnesota Multiphasic Personality Inventory (MMPI) to assess convergent validity by examining correlations between the BSI subscale scores and similar constructs from the MMPI. However, these investigators did not support either discriminant or convergent validity when the BSI was compared with global stress.

Khalil et al¹³⁶ evaluated construct validity using hypothesis testing for the anxiety subscale in a subgroup of patients with heart failure and normal renal function using the Beck Depression Index (BDI). They found that the anxiety subscale was a predictor of the depression score in patients with heart failure and normal renal function, but not with those with renal dysfunction. Thus, construct validity was supported only in those with normal renal function and heart failure. Long et al¹⁵⁹ measured longitudinal construct validity in patients with schizophrenia or schizophrenia-related illnesses at baseline and three years. They supported using individual subscales of the BSI. They found goodness of fit in both anxiety and hostility to measure the construct.

Limitations

Our study had some limitations. This was a secondary analysis of data collected for other purposes. This limited our choice of data, especially for hypothesis testing. We could not determine fidelity to study procedures and data validity. However, the original investigators were rigorous in their conduct of the study; evidence of procedure fidelity and data validity was apparent. The measures used in our analyses were obtained with self-report measures. This may have introduced some degree of social desirability bias. However, measurement of subjective phenomena requires self-report measures.

Conclusion

Anxiety and hostility were prevalent in this population of incarcerated men, as more than half of our participants reported high levels of both psychological states, and more than one fourth reported both simultaneously. Based on our analyses, the BSI anxiety and hostility subscales were psychometrically sound in this population. Longitudinal measures of anxiety and hostility could be used to evaluate ongoing

psychological state in incarcerated individuals, and to determine the efficacy of interventions intended to reduce cardiovascular risk that are aimed at psychological distress. Long term reduction of cardiovascular morbidity and mortality could be the consequence.

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Table 3.1 Characteristics of participants (n = 373)

Characteristic	Mean \pm SD or n (%)
Age in years	36 \pm 9
Ethnicity	
Caucasian	238 (63%)
African American	129 (34%)
Other	11 (3%)
Marital Status	
Married / cohabitate	51 (14%)
Single/divorced/widowed	319 (86%)
Education Level	
High school or less	224 (59%)
Some college or technical school	142 (38%)
Undergraduate or graduate degree	13 (3%)
Self-reported mental health	
Excellent	32 (9%)
Very good	51 (22%)
Good	104 (45%)
Fair	52 (23%)
Poor	6 (3%)
Body mass index in kg/m ²	28.5 \pm 4.8
Total cholesterol in mg/dL.	171 \pm 33
Glycosylated hemoglobin%	5.4 \pm 0.5%
Crimes that required incarceration	
Theft/Robbery	75 (32%)
Assault/Battery	70 (30%)
Murder/manslaughter	67 (29%)
Sex Crimes	21 (9%)

Proportions may not total 100% due to rounding

Table 3.2 Correlation Item Analysis for the BSI

BSI item	Mean \pm (SD)	Item-total Correlation	Cronbach's alpha if item deleted
Nervousness or shakiness inside	0.59 (0.91)	0.56	0.86
Scared for no reason	0.22 (0.64)	0.49	0.87
Feeling fearful	0.34 (0.82)	0.51	0.87
Feeling tense or keyed up	1.09 (1.13)	0.77	0.85
Spells of terror or panic	0.25 (0.73)	0.47	0.87
Feeling so restless you can't sit still	0.81 (1.14)	0.55	0.87
Easily annoyed or irritated	1.45 (1.30)	0.72	0.85
Temper outburst you could not control	0.56 (0.95)	0.65	0.86
Urges to beat, injure, harm someone	0.45 (0.96)	0.47	0.87
Urges to break or smash something	0.49 (1.02)	0.68	0.86
Getting into frequent arguments	0.52 (0.90)	0.64	0.86

Cronbach's alpha for all 11 items 0.87

Table 3.3 Factor Analysis and Varimax Rotation Component Matrix of the BSI Hostility and Anxiety subscales (N = 373)

Instrument Items	Factor 1	Factor 2
Temper outburst you could not control	.778	.212
Urges to break or smash something	.771	.246
Easily annoyed or irritated	.757	.222
Urges to beat, injure, harm someone	.750	
Getting into frequent arguments	.736	.225
Feeling tense or keyed up	.734	.355
Feeling so restless you can't sit still	.611	.327
Spells of terror or panic	.183	.824
Feeling fearful	.273	.822
Scared for no reason	.186	.794
Nervousness or shakiness inside	.288	.732

Factor 1= hostility; Factor 2=anxiety

Table 3.4 Comparison of Self-reported baseline Perceived Mental Health Scores for prisoners with Anxiety and Hostility (N = 373)

Variable	Anxiety			Hostility		
	Anxious (n = 97)	Not Anxious (n = 136)	P value	Hostile (n=122)	Not Hostile (n = 111)	P value
Perceived Mental Health	0.021			0.175		
Excellent /Very Good / Good	65 (37%)	110 (63%)		87 (50 %)	88 (50%)	
Fair / Poor	32 (55%)	26 (45%)		35(60%)	23 (40%)	

Values are f (%), Chi-square analyses used to determine association

Table 3.5 Comparison of perceived control scores for prisoners with anxiety and hostility (n = 373)

Variable	Anxiety			Hostility		
	Anxious (n = 132)	Not Anxious (n = 96)	P value	Hostile (n=130)	Not Hostile (n=102)	P value
Perceived Control	30.7 ± 5.2	34.0 ± 5.	< 0.001	30.9 ± 5.1	33.4 ± 5.3	< 0.001

Values are M ± SD

CHAPTER FOUR

Association of psychological distress to surgical outcomes and quality of life in patients and their caregivers after cardiac surgery

Abstract

BACKGROUND: Cardiovascular disease may require surgical intervention, which may be associated with postoperative psychological distress. Emotional contagion theory postulates that individuals in relationships like caregiver and patient develop convergence of affect and emotions; emotional state and emotional convergence may influence physiological status and quality of life in both patient and caregiver.

OBJECTIVES: To determine whether patient and caregiver anxiety, hostility and depressive symptoms, measured at baseline predicted quality of life (physical and mental well-being) using a multilevel dyadic analysis in cardiac surgery patients and their caregivers; and to evaluate the association of baseline patient anxiety, hostility, and depressive symptoms with postoperative complications and mortality in cardiac surgery patients.

METHODS: In this prospective, descriptive correlational study, adults (n = 45) scheduled for cardiac surgery and their primary caregiver (n = 45) provided demographic and clinical data at baseline. Anxiety, hostility, and depressive symptoms were measured at baseline, and one week, and one month after surgery in patients and their caregivers. Multi-level dyadic modeling evaluated emotional convergence in the dyad and determined whether there were actor (individual emotion influences own quality of life) or partner (individual emotion influences other dyad member quality of life) effects; logistic regression determined the predictive power of anxiety, hostility, and depressive

symptoms for postoperative complications after controlling for age, gender and education level.

RESULTS: In this cross-sectional study, we recruited 45 dyads (patients 78% males, aged 69 ± 10 years and caregivers 82% females, aged 62 ± 11 years). Instrument scores for anxiety, hostility, and depressive symptoms exceeded the cutpoint for 82%, 62% and 48% of patients, and 73%, 57%, and 31% of caregivers, respectively. Anxiety had an actor effect for both patients and caregivers for mental well-being (both $p < .01$); patients and caregivers with higher anxiety symptoms had poorer quality of life. Hostility had actor effects for patient on physical well-being only ($p < 0.001$); thus, patients with higher hostility scores had worse physical quality of life. Hostility was also associated with an actor effect for mental well-being in the caregiver, but not the patient. There was a partner effect for patient hostility and caregiver mental well-being; thus, higher patient hostility was associated with worse caregiver mental well-being. Depressive symptoms exhibited actor effect for patients and caregivers (both $p < .001$) on mental well-being; thus, patients and caregivers with higher depressive symptoms had poorer quality of life. Anxiety, hostility and depressive symptoms scores did not predict postoperative complications; gender was the only independent predictor of complications.

CONCLUSION: Anxiety, hostility, and depressive symptoms were common in both cardiac patients and their caregiver. Psychological state influenced quality of life in both dyad members, but was not associated with complications. A comprehensive understanding of psychological state in both patient and caregiver prior to cardiac surgery may contribute to effective interventions to improve quality of life and other outcomes.

Introduction

Cardiovascular disease is the leading cause of death in the United States; by the year 2030, 40.5% of the US population will have some form of cardiovascular disease.¹⁶⁰ An estimated 7,235,000 cardiac surgeries are performed annually to address these disorders.¹⁶¹ Although surgical intervention is an important component of patient management, surgical intervention is also associated with a number of adverse events and complications that include acute heart failure, myocardial infarction, renal failure, acute respiratory failure, stroke, infection, and cardiac dysrhythmias.¹⁶²

Perioperative psychological distress is common in cardiac surgery patients, and may worsen outcomes.^{5,19,163,164} Depression was found in 15-20 % of patients after cardiac surgery;²⁶ there was a 10% higher risk of sudden cardiac deaths after surgery in those treated for depression.¹⁶⁵ Anxiety and phobia disorders were found in 11% of cardiac surgery patients,²⁶ and hostility in up to 70% of patients after cardiac revascularization.¹⁸ Depression after cardiac surgery was associated with vagal withdrawal¹⁶² and reduced heart rate variability, a known correlate of serious cardiac dysrhythmias and sudden cardiac death.^{72,166} Anxiety was associated with a nearly 3 fold increase in the risk for major adverse events;⁵⁴ while persistent hostility increased the likelihood of coronary artery disease after heart transplant by 8 fold.¹⁶⁷ Elevated hostility levels are associated with decreased vagal tone affecting autonomic nervous system and heart rate variability which may increase risk for dysrhythmias and sudden cardiac death.^{88,166,168} Thus, identification and appropriate management of psychological distress is imperative for recovery.

Efficient and effective transition from hospital care to home care after surgery is also of importance to patients, providers, and payers.⁵ Currently, hospital length of stay after coronary artery bypass graft is only 4-5 days; thus, patients require support and assistance for many activities of daily living and interventions after hospital discharge.⁵ Caregivers are typically family members or close friends. Although 70% of patients recovered in a linear fashion without complications; 30% of patients developed complications and required more extensive and longer term care after hospital discharge.⁵ Thus, caregivers are an essential element of post-surgical recovery. However, caregiving can be stressful and produce psychological distress in the caregiver.^{52,169}

The emotional contagion theory⁴⁷ proposes that individuals in relationships develop convergence of affect and emotions; the closer the relationship, the greater the emotional convergence. This may significantly influence physiological status and quality of life in patient and caregiver.^{48,56} Understanding the interaction of patient and caregiver psychological state on quality of life and recovery could support tailored interventions to improve outcomes and quality of life for both patient and caregiver.

Purpose

The purpose of this study was to evaluate the association of patient and caregiver psychological state (anxiety, hostility, depressive symptoms) with quality of life in both patient and caregiver, and with postoperative complications after cardiac surgery. The specific aims were : (1) to determine whether patient anxiety, hostility and depressive symptoms, as well as caregiver anxiety, hostility, and depressive symptoms, measured at baseline (preoperative) predicted quality of life before surgery using a multilevel dyadic analysis in patient and caregiver; and (2) to evaluate the association of baseline

preoperative anxiety, hostility, and depressive symptoms in adult cardiac surgery patients with postoperative complications (dysrhythmias, postoperative infections, myocardial ischemia, organ dysfunction (glomerular filtration rate [GFR] < 60ml/min/1.73m, PaO₂/FiO₂ < 200mm Hg), and mortality. We controlled for age, sex, and Society of Thoracic Surgeons (STS) predictive risk score obtained with the initial clinical assessment.

Methods

Design

We used a prospective, descriptive correlational design, and included adult patients (n = 45) scheduled for cardiac surgery with sternotomy, and their primary caregiver (n = 45). Demographic and clinical measures for patient and caregiver demographic variables were obtained at baseline. Psychological variables (anxiety, hostility, depressive symptoms, and quality of life) were measured at baseline before surgery, and 1 week, and 1 month after cardiac surgery in patients and their caregivers. This paper reports analysis of only the baseline data.

Sample and Setting

A convenience sample of patients who required cardiac surgery (n = 45) and their primary caregiver (n = 45), defined as the individual who provided the majority of daily care to the patient, were recruited from a single community hospital in Southwest Ohio. Annually at this facility, there were 146 cardiac surgeries in 2012 and 174 in 2013. Post-surgery protocols used were based on those from the Society of Thoracic Surgery and Society of Critical Care Medicine for extubation,^{170,171} dysrhythmia management, and cardiac surgery recovery.¹⁷² The complication rate for cardiac surgery was

approximately 5% in the year 2013. Complications included post-operative hemorrhage, mediastinitis, acute renal failure, and stroke. Cardiac surgery patients at this facility were typically 98% Caucasian, 1% African American, and less than 1% Asian and American Indian.

Eligible patients included those: 1) scheduled for cardiac surgery that required sternotomy (CABG, valve replacement, valve repair and/or aortic dissection); 2) over 18 years of age; 3) able to speak and read the English language; 4) available by telephone after hospital discharge; 5) discharged home after surgery; and 6) demonstrated to be preoperatively cognitively intact as determined by the Montreal Cognitive Assessment. Patients were excluded when: 1) there was a pre-hospitalization diagnosis of a major depressive disorder or serious mental illness, psychosis or schizophrenia; or 2) they were without a formal caregiver.

Eligible caregivers were: 1) over 18 years of age; 2) identified as the primary caregiver for the patient; 3) able to read and write the English language; and 4) available by telephone. Caregivers were excluded when: 1) they had a terminal illness; 2) they had a score of < 26 on the Montreal Cognitive Assessment; or 3) the patient became ineligible for the study.

Measures

Demographic (age, sex, ethnicity, education level, work status, socioeconomic status, etc.), and clinical variables for patients (Society of Thoracic Surgeons (STS) predictive risk score, type of surgery, anesthesia, length of surgery, transfusion, length of stay, hours of intubation after surgery, development of pleural effusion requiring evacuation, development of atrial fibrillation or tachycardia / bradycardia dysrhythmias)

were obtained at baseline or at hospital discharge from the medical chart. Caregiver demographic variables (age, sex, ethnicity, relationship to patient) were measured at baseline upon enrollment. Psychological variables (anxiety, hostility, depressive symptoms, and quality of life) were measured at baseline, and 1 week, 1 month after surgery in patients and their caregivers.

Hostility

Hostility is a modifiable personality trait and complex set of attitudes that motivate aggressive and angry behavior.^{31,134} Hostility was measured using the 5-item hostility subscale of the Brief Symptom Inventory (BSI).¹³⁴ The hostility subscale measured hostile thoughts, feelings and actions. Each item was rated on a 5 point scale of distress, ranging from 0 (not at all) to 4 (extremely). Total score was the average rating of the five items; higher scores indicated greater hostility. Pearson's correlation for hostility between the BSI and hostility in symptomatic psychiatric patients was 0.56 indicating adequate construct validity.¹⁷³ Internal consistency and test retest reliability were reported as 0.78 and 0.81 respectively.¹³⁴

Anxiety

Anxiety is a feeling of distress, unease, nervousness, tension and trembling, feelings of apprehension, dread, terror and panic. Anxiety was measured using the 6-item anxiety subscale of the BSI.¹³⁴ The anxiety scale has six items that evaluate anxiety, restlessness, nervousness, panic, and tension. Each item was rated on a 5 point scale of distress, ranging from 0 (not at all) to 4 (extremely); items were totaled and higher scores indicated more anxiety. Pearson's correlation for anxiety with the BSI and anxiety in symptomatic psychiatric patients was 0.57, indicating adequate construct validity.¹⁷³

Internal consistency and test retest reliability were 0.81 and 0.71, respectively indicating adequate reliability.¹³⁴

Depressive symptoms

Depressive symptoms are a persistent feeling of sadness, emptiness, or irritability accompanied by somatic and cognitive changes that significantly affect an individual's capacity to function.¹³⁴ Depressive symptoms were measured using the 9-item Patient Health Questionnaire (PHQ-9).¹⁷⁴ Individuals were asked to self-report how often they were bothered by the 9 items in the past 2 weeks. Each item was scored using a Likert-type scale, with scores ranging from 0 (not bothered at all) to 3 (nearly every day). Total score was obtained by summing the individual scores; total scores ranged from 0 to 27, with higher scores indicating a higher degree of depressive symptoms. Hammash and colleagues¹⁷⁵ examined the psychometrics of the PHQ-9 in patients with heart failure, and found reliability and validity were supported. Cronbach's alpha for the PHQ-9 was reported as 0.85.¹⁷⁵ A cut-point of 10 had a specificity of 0.92 and sensitivity of 0.70 in identifying depressive symptoms.¹⁷⁵ Concurrent validity between the PHQ-9 and the Beck Depression Inventory (BDI-II) was 84%.¹⁷⁵ Additionally, PHQ-9 scores strongly correlated with BDI-II scores ($r = 0.78$, $p < 0.01$).¹⁷⁵

Quality of life

Quality of life (QoL) is a broad multidimensional term used to describe subjective perception of mental and physical well-being and happiness.¹⁷⁶ QoL has physical, occupation, social, somatic and psychological dimensions.¹⁷⁷ QoL was measured using the Short Form Health Survey (SF-12) scale. The SF-12 is a 12 item subset of the Medical Outcome Study health survey short form SF-36, which is a validated QoL

instrument that measures individual perceptions of functional health and well-being.¹⁷⁸ The SF-12 is a self-report survey used in both healthy and patient populations; the SF-12 has been used in many cardiac populations.¹⁷⁷⁻¹⁸⁰ The instrument is scored using a norm-based approach; 50 is the average score.^{178,181} The possible range of scores is 0-100 with higher scores indicating a better QOL. In patients with cardiac and cardiovascular disease, the Cronbach's alphas were 0.84 for the physical and mental well-being subscales.¹⁸² Ware and colleagues^{178,183} compared participants with and without mental health problems and found construct validity was also supported. The instrument has good test retest reliability with coefficients of 0.89 for physical and 0.76 for well-being subscales among adults.¹⁷⁷

STS predictive risk score

The STS maintains a National Database established in 1989. Using these data, STS risk prediction models were developed, and a scoring system devised to predict risk of morbidity and mortality after CABG, aortic valve replacement (AVR), combined CABG and AVR, and additional mitral and tricuspid valve replacement surgeries.¹⁸⁴ The STS score is a composite score that measures the risk adjusted, risk-standard morbidity and mortality rate for cardiac surgeries.¹⁸⁵

Procedure

Approval was obtained from the Mercy Health-Jewish Hospital (proxy for Mercy Health Anderson Hospital) and University of Kentucky Medical Institutional Review Boards. Participants were recruited from the physician office and preoperative area of the hospital. Available demographic and clinical variables were obtained by medical record review, and patient and primary caregiver interview. Upon enrollment all patients and

caregivers completed the BSI anxiety and hostility subscales, the PHQ-9, and the SF-12 in this order. When needed, the PI read each instrument aloud and the individual indicated their responses. We used a designated private space for interviews and instrument completion; the patient and caregiver were interviewed separately. The PI was immediately available to answer questions or clarify instructions. For the 1 week and 1 month data collection procedure, the PI met the patient and caregiver in the surgeon's office during routine postoperative visits, and collected BSI, PHQ-9 and QoL data at that time. All data were collected in private rooms, and patient and caregiver were separated during this time. All data were collected via paper and pencil format. Data were double entered into SPSS and evaluated for accuracy of data entry. Data from twelve dyads were double entered with 99% accuracy demonstrated. Errors were corrected to produce 100% accuracy prior to analysis.

Data analysis

Clinical and demographic data were summarized using means, standard deviations, and frequency and percentages. Patient and caregiver sociodemographic and study variables (anxiety, hostility, depressive symptoms) were compared with independent t tests or Chi square analyses based on the level of measurement of each variable. Pearson product-moment correlations examined the association among anxiety, hostility, depression, physical well-being, and mental well-being within patients and caregivers. To respond to specific aim 1, we used multi-level dyadic modeling, also known as the actor-partner interdependence model (APIM) regression with distinguishable dyads.¹⁸⁶ The patient and caregiver were the dyad members. The actor effect was evaluated as the effect of patient and caregiver anxiety, depression and hostility on their own quality of life; the

partner effect was evaluated as the effect of patient and caregiver anxiety, depression and hostility on their dyadic partner's quality of life. After controlling for age and sex, baseline data were restructured into a pairwise dyadic dataset, and grand means were calculated prior to analysis. These analyses provided unstandardized and standardized regression coefficients for both actor and partner effects. To respond to specific aim 2, we used logistic regression to determine whether preoperative anxiety, hostility, and depressive symptoms predicted postoperative complications and mortality, while controlling for age, sex, and STS risk score. Regression was performed using the Enter method, and variables were entered in blocks after evaluation of regression assumptions. The first block contained demographic variables (age, sex); the second block contained clinical variables (STS risk score), and the final block contained the scores for anxiety, hostility, or depressive symptoms. Odds ratios and 95% confidence intervals were calculated for the likelihood of postoperative complications (yes/no) and mortality (yes/no). All analyses were performed using SPSS version 23.0 (Armonk, NY). An a priori alpha level of 0.05 determined significance in all analyses.

Results

Characteristics of the Participants

Patients

A total of 90 subjects (45 patients and 45 caregivers) were enrolled in this study (Table 4.1.). The majority of patients were Caucasian (96%), males (78%), with an average age of 69 ± 10 years. Thirty-seven percent of patients were employed preoperatively, while 20% reported an annual income of less than \$20,000. Nearly one third (30%) of the patients had earned less than a high school education. Acute myocardial infarction was the most common preoperative event (54%). Comorbidities

included hypertension (60%), diabetes (42%) and cigarette smoking (20%). The three most common complications after surgery were atrial fibrillation (32%), acute kidney failure (22%), and pleural effusions (11%). These complications are common in the cardiac surgery postoperative period.¹⁸⁷⁻¹⁸⁹ One patient developed multisystem organ failure and died; thus mortality was 2% for this sample.

The average STS risk score for these patients was 4 ± 3 . Mean FEV₁ was $73 \pm 21\%$, and average GFR was 57 ± 10 ml/min/1.73m. These values indicated a low level of preoperative risk for morbidity and mortality. Patients underwent CABG (69%), valve replacement (22%), or a combination of CABG and valve procedure (7%). Patients required an average of 119 minutes of mechanical ventilation after surgery, consistent with the Society of Thoracic Surgery guidelines and recommendations.¹⁹⁰ Approximately half of patients experienced a complication (Table 4.1.). The most common complications were postoperative atrial fibrillation (32%), renal failure (22%), and pleural effusions (11%). Based on published cut points for the anxiety,^{18,134,136} hostility,^{18,134,136} and depressive symptoms measures,¹⁷⁴ 82% of patients reported high anxiety, 62% were hostile, and 49% exhibited significant depressive symptoms.

Caregivers

Caregivers were primarily female (82%), Caucasians (98%) aged 62 ± 11 years (Table 4.1.). Nearly half (49%) of caregivers were employed, and reported an average income of \$42,000. More than half of caregivers were spouses (58%); while nearly one fifth were adult daughters (18%). The majority (82%) of caregivers had received some post high school education or training. Based on published cut points for the anxiety,^{18,134,136} hostility,^{134,136} and depressive symptoms measures,¹⁷⁴ 73% of caregivers

reported high anxiety, 58% were hostile, and 31% exhibited significant depressive symptoms.

When patient and caregiver demographic variables were compared (Table 4.1.), patients were on average 7 years older than their caregivers; significantly more patients than predicted were male and more caregivers than predicted were female. Comparison of scores for anxiety, hostility, depressive symptoms, and quality of life (Table 4.2) demonstrated significant differences in physical well-being between dyad members; patient physical well-being was significantly worse than the caregiver ($p = 0.001$). There were no other significant differences between patient and caregiver found.

A correlation matrix of the scores for patient and caregiver anxiety, hostility, depressive symptoms, and quality of life (physical well-being score, mental well-being score) was developed using Pearson's product moment correlation coefficients to evaluate linear relationships among these variables (Table 4.3.). Patient anxiety scores were positively associated with their own hostility score ($r = 0.729$, $p < 0.01$), their own depressive symptoms score ($r = 0.786$, $p < 0.01$), negatively correlated with their own physical well-being ($r = -0.338$, $p < 0.05$) and mental well-being scores ($r = -0.521$, $p < 0.05$); thus, as patient anxiety increased, hostility and depressive symptoms scores increased and physical and mental well-being scores decreased. Patient hostility scores were correlated with patient depressive symptoms scores ($r = 0.712$, $p < 0.01$), patient physical well-being scores ($r = -0.35$, $p < 0.05$), and caregiver mental well-being scores ($r = -0.335$, $p < 0.05$). Thus, as patient hostility increased, patient depressive symptoms increased, and caregiver mental well-being decreased. Patient depressive symptoms scores correlated with patient physical ($r = -0.341$, $p < 0.05$) and mental well-being ($r = 0.631$, p

< 0.01); as patient depressive symptoms score increased, patient physical and mental well-being decreased. Patient physical well-being scores were correlated with caregiver physical well-being scores; thus, as patient physical well-being scores increased, so did the caregiver scores.

Caregiver anxiety scores were correlated with caregiver hostility ($r = 0.727$, $p < 0.01$), depressive symptoms ($r = 0.494$, $p < 0.01$), physical well-being ($r = -0.372$, $p < 0.05$), and mental well-being scores ($r = -0.512$, $p < 0.01$); thus, as caregiver anxiety increased, caregiver hostility and depressive symptoms scores increased, and physical and mental well-being scores decreased. Caregiver hostility scores were correlated with caregiver depressive symptoms ($r = 0.599$, $p < 0.01$), and physical ($r = -0.356$, $p < 0.05$) and mental ($r = -0.554$, $p < 0.01$) well-being scores; thus, as caregiver hostility scores increased, caregiver depressive symptoms scores also increased and caregiver physical and mental well-being scores decreased. Caregiver depressive symptoms scores were correlated with caregiver physical ($r = -0.328$, $p < 0.05$) and mental ($r = -0.497$, $p < 0.05$) well-being; as depressive symptoms score increased, physical and mental well-being scores decreased.

Evaluation of emotional contagion between patient and caregiver

Association between anxiety and quality of life (physical and mental well-being) in patient and caregiver

APIM regression identified actor effects for both patient and caregiver anxiety and mental well-being (patient $B = -1.14$, $p < 0.001$, caregiver $B = -0.81$, $p < 0.001$) (Table 4.4, Figure 4.1); however, there were no actor or partner effects for physical well-being

(Figure 4.2). Thus, higher anxiety in both dyad members was associated with their own poorer mental well-being.

Association between hostility and quality of life in patient and caregiver

APIM regression demonstrated an actor effect between hostility and physical well-being in the patient, but not the caregiver (patient $B = -0.82$, $p = 0.045$, caregiver $B = -0.94$, $p = 0.13$) (Table 4.4, Figure 4.3). Hostility was also associated with an actor effect for mental well-being in the caregiver, but not the patient (patient $B = -0.66$, $p = 0.13$, caregiver $B = -1.99$, $p \leq 0.001$), and there was a partner effect for caregiver mental well-being (caregiver $B = -0.70$, $p = 0.01$); Thus, higher patient hostility was associated with worse patient physical well-being and worse caregiver mental well-being (Figure 4.3), and higher caregiver hostility was associated with worse caregiver mental well-being (Figure 4.4).

Association between depression and quality of life in patient and caregiver

APIM regression determined that neither patient nor caregiver depressive symptoms influenced physical well-being in either dyad partner; thus, there were no actor or partner effects detected for physical well-being (patient $B = -0.484$, $p = 0.06$, caregiver $B = -0.276$, $p = 0.23$) (Table 4.4, Figure 4.5). However, depressive symptoms did demonstrate actor effects on mental well-being for both dyad members; (Figure 4.6) thus, higher depressive symptom scores were associated with poorer mental well-being in both patient and caregiver (patient $B = -1.125$, $p < 0.001$, caregiver $B = -0.687$, $p < 0.001$).

Association of baseline anxiety, hostility and depressive symptoms with postoperative complications and mortality

We developed 3 logistic regression models to determine whether anxiety, hostility and depressive symptoms predicted postoperative complications. Regression was performed using the Enter method, and variables were entered in blocks after evaluation of regression assumptions. The first block contained demographic variables (age, sex); the second block contained STS risk score, and the final block contained the scores for anxiety, hostility, or depressive symptoms. Odds ratios and 95% confidence intervals were calculated for the likelihood of postoperative complications.

In the first model with anxiety score, the model fit was evaluated using the Omnibus Tests of Model Coefficients and the Hosmer-Lemeshow test; these analyses determined that we identified a significant model ($p = .01$) with acceptable model fit ($p = 0.803$), respectively. Female sex was the only significant independent predictor of complications in this model (OR 0.064, CI 0.007-0.624, $p = 0.018$) (Table 4.5). Females had a 94% lower likelihood of postoperative complications compared with men. In the second model with hostility score, the model fit was evaluated using the Omnibus Tests of Model Coefficients and the Hosmer-Lemeshow test; these analyses determined that we identified a significant model ($p = 0.01$) with acceptable model fit ($p = 0.804$), respectively. Female sex was the only significant independent predictor of complications after cardiac surgery (OR 0.066, CI 0.007-0.643, $p = 0.19$) (Table 4.6); females had a 93% lower likelihood of complications compared with men. In the third model with depressive symptoms score, the model fit was evaluated using the Omnibus Tests of Model Coefficients and the Hosmer-Lemeshow test; these analyses determined that we

identified a significant model ($p < .01$) with acceptable model fit ($p = .804$), respectively. Again, the female sex was the only significant independent predictor for postoperative complications (OR 0.064, CI 0.006-0.647, $p = 0.02$) (Table 4.7); compared with men, females had a 94% lower likelihood of postoperative complications. We were unable to evaluate predictors of mortality in this group of participants, as only one patient died (2%); thus, statistical power to evaluate predictors of mortality was insufficient.

Discussion

The purpose of our study was to determine whether patient and caregiver anxiety, hostility and depressive symptoms measured at baseline predicted preoperative quality of life in either dyad member using APIM regression, and to determine whether these psychological states predicted postoperative complications and mortality. We found that higher anxiety in both patient and caregiver was associated with their own poorer mental well-being, higher patient hostility was associated with worse patient physical well-being and worse caregiver mental well-being, caregiver hostility was associated with worse caregiver mental well-being, and more depressive symptoms were associated with worse mental well-being for both dyad members. Anxiety, hostility and depressive symptoms scores were not predictive of postoperative complications; however, female sex was associated with a 93-94% reduced likelihood of postoperative complications. Thus, emotional state influenced quality of life in both dyad members, but was not associated with complications.

Higher anxiety scores in our patient and caregiver participants was associated with worse mental well-being scores, but had no effect on the dyad partner's physical or mental well-being. High anxiety is common in preoperative patients and their

families.^{42,191} Higher anxiety has a previously demonstrated association with worse quality of life,¹⁵⁰ poorer mental well-being,¹⁹² and worse morbidity and mortality.^{150,193} Thus, our finding that higher anxiety was associated with worse mental well-being in both dyad members is consistent with other investigations.^{169,186} Only one other investigation explored actor partner effects of anxiety in a cardiac population. Chung and colleagues¹⁹⁴ used the APIM to evaluate the association between anxiety and quality of life in patients with heart failure and their spousal caregiver; these investigators found both actor and partner effects. Thus, higher anxiety in the patient and the caregiver was associated with worse quality of life in both the patient and the caregiver.

There are several differences between our investigation and Chung and colleagues¹⁹⁴ study that may have produced these different findings. First, our caregiver participants were spouses, daughters, sons, and parents; while Chung and colleagues¹⁹⁴ studied only spousal caregivers. The relationship between patient and caregivers other than the spouse is different,¹⁹⁵⁻¹⁹⁷ and could have reduced the measured partner effect, as proximity prior to surgical intervention was lower than with spouses. Second, our patients were awaiting cardiac surgery, overall had not been chronically ill, and had not required caregiver support prior to this. Thus, our patients were more independent than those patients with heart failure which could have reduced any partner effect. Third, the caregivers in our study had not yet participated in significant caregiving activities, while those in Chung and colleagues study had been active caregivers for patients with a chronic need for caregiver assistance.

Higher patient hostility scores were associated with worse patient physical well-being and worse caregiver mental well-being; while higher caregiver hostility scores

were associated with worse mental well-being in the caregiver. Higher hostility levels have been associated with cardiovascular disease progression, metabolic syndrome, and worse cardiac outcomes in prior investigations.^{198,199} Moser and colleagues,¹⁸ estimated that approximately 20% of patients experienced higher hostility after an acute myocardial infarction, episode of heart failure, or cardiac surgery. The association between higher hostility and worse quality of life is consistent with the findings of other investigators.¹⁷⁹ Silarova and colleagues²⁰⁰ found that higher hostility was associated with worse mental well-being in patient with coronary heart disease; while, other investigators provided evidence of worse quality of life associated with higher hostility in patients after stroke. Thomson and colleagues^{169,201} performed a study of preoperative cardiac surgery patients and their caregivers and found that worse preoperative quality of life of both patient and caregiver, poorer preoperative physical health of both the patient and caregiver, as well as worse preoperative patient mental well-being, was associated with worse postoperative quality of life in both dyad members. However, these investigators did not use dyadic statistical analysis, which made interpretation of actor and partner effects impossible. Our findings may reflect a more valid estimation of these effects compared with Thomson and colleagues because we used a dyadic statistical approach developed specifically to evaluate actor and partner effects,²⁰² while those investigators used Chi square, repeated measures ANOVA, correlation coefficients, and standard regression analyses.

Higher depressive scores in our patient and caregiver participants were associated with worse mental well-being scores for both dyad members, but had no effect on the dyad partner's physical well-being. High depressive scores are common in preoperative patients and their families.^{201,203} Other investigators have reported the association

between depressive symptoms and reduced quality of life in cardiac patients; thus, our findings are consistent.²⁰⁴⁻²⁰⁶ However, we did not find a partner effect, as individual depressive symptom score was not associated with the other dyad partner's quality of life score. In contrast, other investigators²⁰³ have found partner effects for depressive symptoms and quality of life. Monin and colleagues²⁰³ found that more depressive symptoms in older community-dwelling adults from the Cardiovascular Health Study were associated with worse depressive symptoms in their spouse; while, Chung and colleagues¹⁹⁴ found a partner effect for depressive symptoms in their study of patients with heart failure and their caregivers. Thus, higher depressive symptoms in one member of the dyad were associated with worse quality of life in the other member.

We used the PHQ-9 to measure depressive symptoms, while Monin and colleagues²⁰³ used the Center for Epidemiologic Studies Depression scale, and Chung and colleagues¹⁹⁴ used the Brief Symptom Inventory depressive symptoms scale; thus, differences in the sensitivity and specificity of the depressive symptoms measures could have resulted in these different findings. In addition, 49% of our patients and 31% of our caregivers exhibited depressive symptoms with scores above the established cut point for the PHQ-9. Chung and colleagues reported that 56% of their patients and caregivers exceeded the cut point for depressive symptoms.¹⁸⁶ Thus, a lower prevalence of depressive symptoms, particularly in the caregiver, in combination with a small sample size, may have resulted in inadequate statistical power to detect partner effects for depressive symptoms on quality of life. Depression in the postoperative period may reduce participation in rehabilitation and ultimately impact recovery.^{26,55}

Complications were common in our sample with about half of patients experiencing at least one complication; however, none of the psychological measures (anxiety, hostility, depressive symptoms) were independent predictors of complications. Atrial fibrillation was the most common complication in our patients (32%) followed by renal injury (23%) and pleural effusion that required management (11%); the prevalence of these complications in other studies of postoperative patients²⁰⁷ after cardiac surgery ranged from 26% to 34% for atrial fibrillation,^{208,209} 13% to 21% for renal injury,^{210,211} and 17% to 48% for pleural effusion.²¹² The prevalence of atrial fibrillation and renal injury fell within these reported ranges, but the prevalence for pleural effusion in our sample was much less than other investigators identified. The lower prevalence of complications combined with the small sample size likely provided statistical inadequate power. These instruments may also not have provided sensitive and specific measurement of these subjective psychological states; a study design that uses triangulation of measures of these variables could be useful.

Prior investigators supported an association between psychological state and morbidity and mortality after cardiac surgery. Tully and colleagues²⁶ demonstrated that patient preoperative anxiety was associated with greater all-cause mortality (HR = 1.88, 95% CI 1.12-3.17); while, Williams and colleagues²¹³ found that higher preoperative anxiety was associated with a 5 times greater likelihood of postoperative complications. Patron and colleagues¹⁶² determined that depressive symptoms were associated with reduction in heart rate variability after cardiac surgery, a known correlate of cardiac dysrhythmias and sudden cardiac death.²¹⁴⁻²¹⁶ Levels of anxiety, hostility, and depressive symptoms, although higher than the instrument cut point, could have been inadequate to

produce neurohormonal activation, one mechanism that may produce or contribute to complications.^{162,198}

Sex was the only independent predictor of complications in our patients; men were more likely to develop complications compared with women. Koch and colleagues^{217,218} found that although women had more risk factors, sex was not an independent risk factor for perioperative morbidity and mortality. Doenst and colleagues²¹⁹ also found no sex difference in survival in patients following combined CABG and valve replacement; however, women did have higher preoperative risk scores and higher incidence of stroke over time. Berndt and colleagues²²⁰ found no sex differences in morbidity or mortality in octogenarians after CABG surgery, and Ried and colleagues²²¹ found similar results in septuagenarians and octogenarians. In contrast, Pollock and colleagues²²² identified a 39% higher risk for mortality in women after isolated CABG surgery; while Saxena and colleagues²²³ found that women had significantly greater 30-day mortality, but a reduced risk of early surgical complications. Thus, sex differences in morbidity after cardiac surgery are equivocal.

Limitations

Our data have limitations that affect generalizability including the use of a single surgical facility, a majority Caucasian sample, and the use of a cross-sectional design. The use of self-report instruments may be associated with the possibility of social desirability bias; however, these variables are subjective in nature and require self-report. In addition, we measured only state psychological variables; thus, trait levels of these constructs could provide a more comprehensive understanding of psychological influences. Based on our power analysis our sample size was sufficient; however, a larger

sample may have improved our ability to demonstrate partner effects. Additionally, we did not measure marital quality in those dyads where the spouse was the caregiver, as marital quality is a well-established predictor of quality of life in married couples.²²⁴

Conclusion

Anxiety, hostility and depressive symptoms were highly prevalent in our preoperative cardiac surgical patients and their caregivers. Psychological state influenced quality of life in both dyad members, but was not associated with complications. Longitudinal evaluation of dyadic psychological state after cardiac surgery would provide a more comprehensive representation of emotional contagion in this population and its influence outcomes. Preoperative psychological state in both patient and caregiver may offer a target for interventions to improve quality of life.

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Table 4.1 Characteristics of the participants (n = 90)

Variable	Patient (n = 45)	Caregiver (n = 45)	p value
Sex (male)	35 (78%)	8 (18%)	< 0.01
Age in years	69 ± 10	62 ± 11	< 0.01
Education			
High School or Less	20 (44%)	14 (31%)	0.25
Technical School	15 (33%)	13 (29%)	
Graduated College	10 (22%)	18 (40%)	
Ethnicity			
Caucasian	43 (96%)	44 (98%)	0.33
All others	2 (4%)	1 (2%)	
Marital			
Married/cohabitating	31 (69%)	34 (76%)	0.35
Single/divorced/widow	14 (31%)	11 (24%)	
Caregiver Relationship			
Spouse		27 (60%)	
Daughter		8 (18%)	
Son		3 (7%)	
Friend		3 (7%)	
Sibling		2 (4%)	
Parent		2 (4%)	
Prior AMI	13 (29%)		
Prior PCI	11 (24%)		
Prior CABG	3 (7%)		
Hypertension diagnosis	27 (60%)		
Diabetes mellitus	19 (42%)		
Current smoking	9 (20%)		
Proportion with Anxiety	37 (82%)	33 (73%)	0.92
Proportion with Hostility	28 (62%)	26 (58%)	0.30

Table 4.1 (Continued) Characteristics of the participants (n = 90)

Variable	Patient (n = 45)	Caregiver (n = 45)	p value
Proportion with Depressive symptoms			0.07
Not depressed	23 (51%)	31 (69%)	
Mild / Moderate	19 (42%)	11 (24%)	
Moderate / Severe	3 (7%)	3 (7%)	
Complications			
All complications	22 (49%)		
Atrial fibrillation	14 (31%)		
AMI	2 (4%)		
Pleural Effusion	5 (11%)		
Pneumonia	2 (4%)		
Renal Injury	10 (22%)		
Stroke	1 (2%)		
Thrombocytopenia	4 (9%)		
Infection	1 (2%)		
Mortality	1 (2%)		

P = <0.05. Values are mean \pm SD or n (%), groups compared with independent t test or Chi square. AMI-acute myocardial infarction, CABG-coronary artery bypass graft, PCI-percutaneous intervention

Table 4.2 Comparison of patient and caregiver psychological scores (n = 90)

Characteristics	Patients (n = 45)	Caregiver (n = 45)	95% CI for Mean Difference	P value
Anxiety score	3.2 ± 3.1	3.9 ± 4.3	-2.0 - 0.65	0.42
Hostility score	1.6 ± 2.4	1.2 ± 1.4	-4.6 - 1.11	0.48
Depression score	6.1 ± 4.6	4.0 ± 4.8	0.16 - 4.06	0.64
QoL Physical Well-being score	41.3 ± 7.7	47.9 ± 9.6	-9.5 - -3.7	0.001
QoL Mental Well-being score	41.7 ± 8.4	43.6 ± 6.6	-5.0 - 1.1	0.71

Values are mean ± SD scores, comparison performed with paired t tests, QoL = quality of life.

Table 4.3 Correlations among anxiety, hostility, depressive symptoms, and quality of life scores in patient-caregiver dyads. (n = 90)

	Patient anxiety	Caregiver anxiety	Patient hostility	Caregiver hostility	Patient depressive	Caregiver depressive	Patient physical well-being	Caregiver physical well-being	Patient mental well-being	Caregiver mental well-being
Patient anxiety	-									
Caregiver anxiety	.123	-								
Patient hostility	.729**	.082	-							
Caregiver hostility	.033	.727**	.093	-						
Patient depressive	.786**	.060	.712**	.090	-					
Caregiver depressive	-.012	.494**	.074	.599**	.067	-				
Patient physical well-being	-.338*	-.216	-.350*	-.165	-.341*	-.109	-			
Caregiver physical well-being	-.214	-.372*	-.131	-.356*	-.257	-.328*	.431**	-		
Patient mental well-being	-.521**	-.150	-.272	-.203	-.631**	-.178	.039	.259	-	
Caregiver mental well-being	-.121	-.512**	-.335*	-.554**	-.141	-.497**	.188	-.039	.060	-

* p < 0.05, ** p < 0.01

Table 4.4 The actor and partner effects of anxiety, hostility and depressive symptoms on physical and mental well-being of quality of life (n =90)

	Patients (n = 45)				Caregivers (n =45)			
	B	β	t	p-value	B	β	T	p-value
Anxiety								
Physical well-being								
Actor effect	-0.61	0.30	-2.01	0.051	-0.53	0.27	-1.95	0.057
Partner effect	-0.26	0.29	-0.90	0.37	-0.27	0.28	-0.96	0.34
Anxiety								
Mental well-being								
Actor effect	- 1.14	0.29	-3.90	< 0.001	- 0.81	0.23	-3.50	0.001
Partner effect	- 1.66	0.28	-0.59	0.55	- 0.08	0.24	-0.34	0.73
Hostility								
Physical well-being								
Actor effect	-0.82	0.40	-2.06	0.045	-0.94	0.62	-1.51	0.13
Partner effect	-0.26	0.66	-0.41	0.68	0.03	0.38	0.10	0.92
Hostility								
Mental well-being								
Actor effect	-0.66	0.43	-1.54	0.13	-1.99	0.47	-4.24	< 0.001
Partner effect	-0.85	0.71	-1.20	0.23	-0.70	0.29	-2.43	0.01
Depression								
Physical well-being								
Actor effect	-0.48	0.25	-1.91	0.06	-0.27	0.22	-1.20	0.23
Partner effect	-0.02	0.23	-0.11	0.91	-0.23	0.23	-0.97	-0.33
Depression								
Metal well-being								
Actor effect	-1.12	0.22	-5.06	< 0.001	-0.68	0.18	-3.63	< 0.001
Partner effect	0.22	0.20	-1.08	0.28	-0.18	0.19	-0.96	0.34

B: the unstandardized coefficients, β : standardized coefficients

Table 4.5 Predictors of complications with self-reported baseline anxiety score (n = 44)

Block	Variable	Exp (B)	95% CI	p value
1	Age	1.07	0.99 - 1.16	0.117
	Sex	0.064	0.007-0.64	0.02
2	STS Score	1.14	0.95 - 1.34	0.16
3	Anxiety	0.90	0.71 - 1.13	0.34

Omnibus Test of Model Coefficients p = 0.01, Hosmer-Lemeshow model fit (p = .803)

Table 4.6 Predictors of complications with self-reported hostility score (n = 44)

Block	Variable	Exp(B)	95% CI	p value
1	Age	1.06	0.98 - 1.15	0.14
	Sex	0.06	0.007- 0.64	0.01
2	STS Score	1.16	0.97 - 1.39	0.10
3	Hostility	0.83	0.57 - 1.19	0.17

Omnibus Tests of Model Coefficients p = 0.01, Hosmer-Lemeshow p = 0.81

Table 4.7 Predictors of complications with self-reported depressive symptoms score (n = 44)

Block	Variable	Exp(B)	95% CI	p value
1	Age	1.06	0.98 - 1.15	0.13
	Sex	.064	0.006-0.65	.020
2	STS Score	1.15	0.964 - 1.39	0.13
3	Depression	0.96	0.82 - 1.12	0.61

Omnibus Tests of Model Coefficients p = 0.01, Hosmer-Lemeshow p = 0.81

Figure 4.1 Anxiety and physical well-being: The actor and partner effects as predictors of physical well-being using the Actor-Partner Interdependence Model with distinguishable dyads regression model (n = 90)

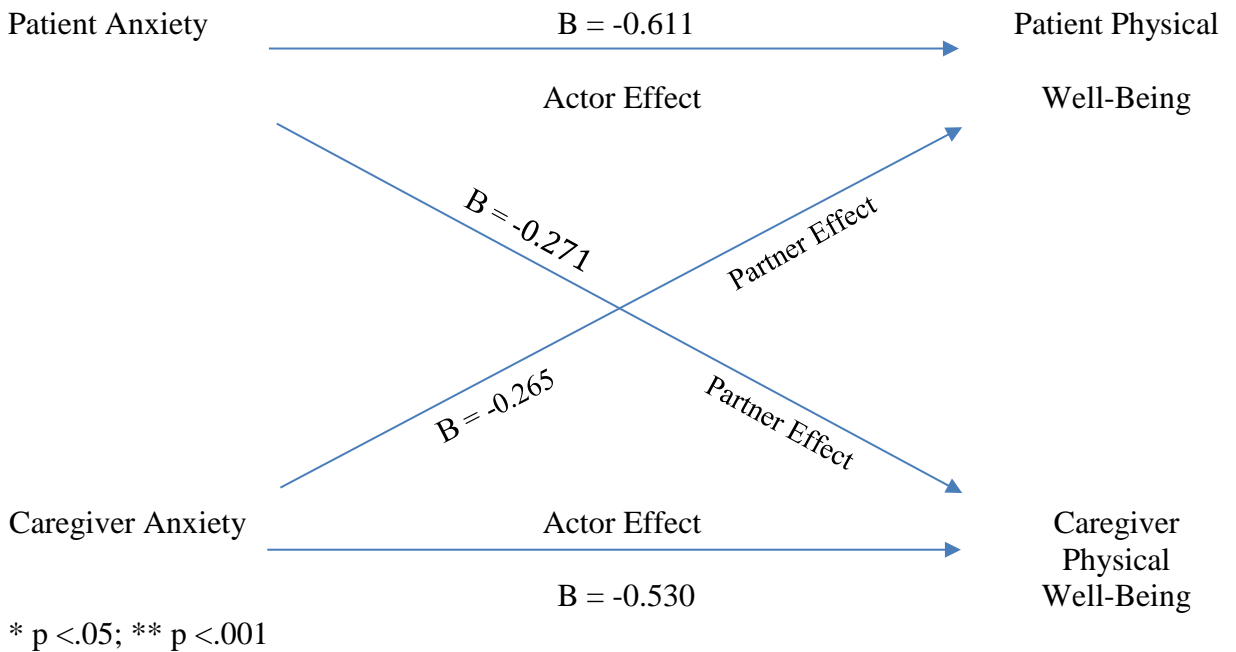


Figure 4.2 Anxiety and mental well-being: The actor and partner effects as predictors of mental well-being using the Actor-Partner Interdependence Model with distinguishable dyads regression model (n = 90)

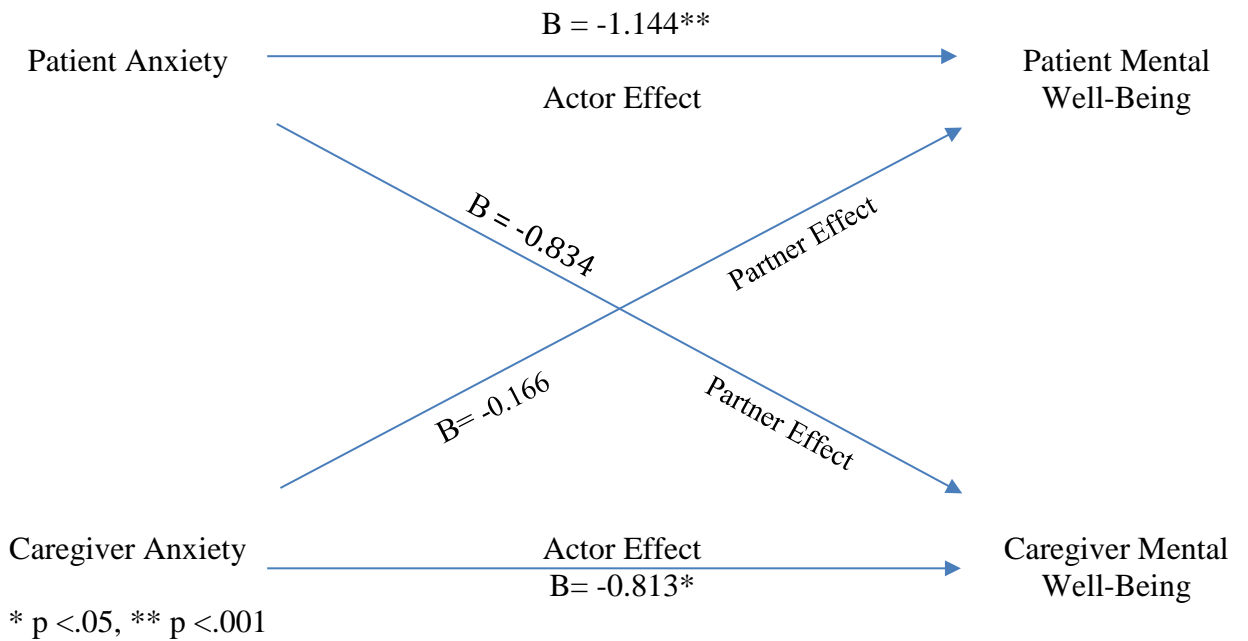


Figure 4.3 Hostility and physical well-being: The actor and partner effects as predictors of physical well-being using the Actor-Partner Interdependence Model with distinguishable dyads regression model (n = 90)

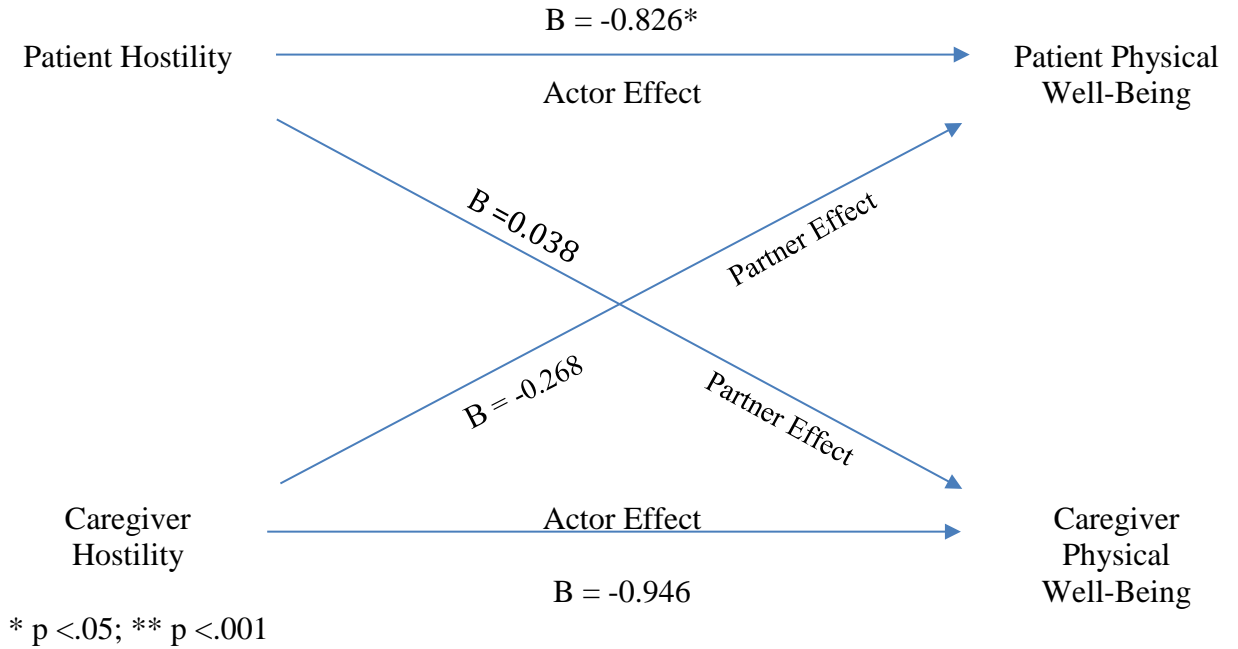


Figure 4.4 Hostility and Mental well-being: The actor and partner effects as predictors of mental well-being using the Actor-Partner Interdependence Model with distinguishable dyads regression model (n = 90)

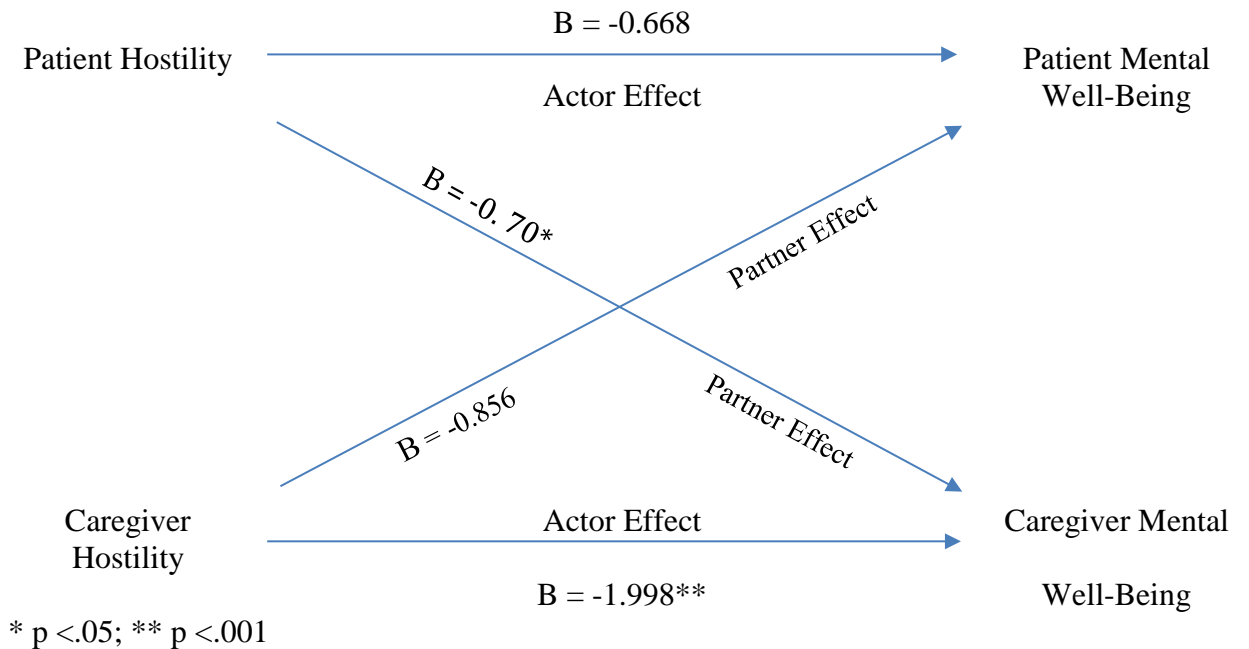


Figure 4.5 Depression and physical well-being: The actor and partner effects as predictors of physical well-being using the Actor-Partner Interdependence Model with distinguishable dyads regression model (n = 90)

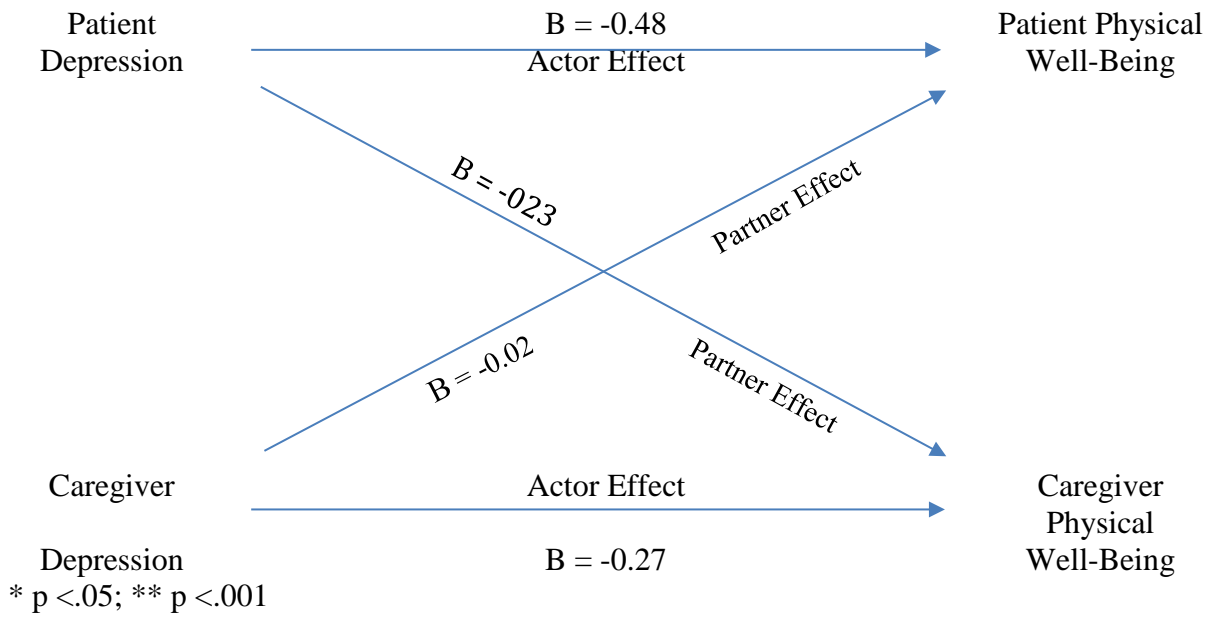
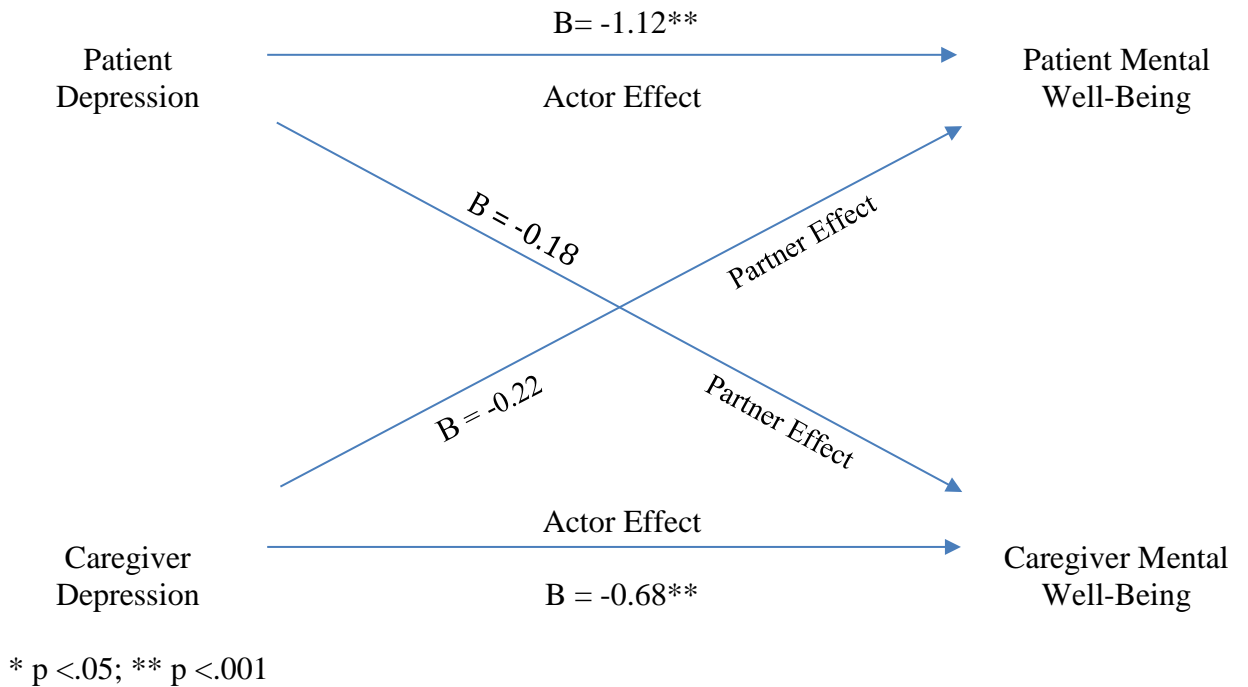


Figure 4.6 Depression and mental well-being: The actor and partner effects as predictors of mental well-being using the Actor-Partner Interdependence Model with distinguishable dyads regression model (n = 90)



CHAPTER FIVE

Conclusion

Cardiovascular disease is the leading cause of death in developed countries.³ In 2010, an estimated 51,400,000 American adults were diagnosed with cardiovascular disease (CVD).^{3,5,225} In the United States, CVD has been the leading cause of death each year since 1900, except for 1918 during the influenza epidemic.³ In 2012, CVD was linked to 17% of deaths in the United States, which equates to 1 out of every 6 deaths.³ Additionally, CVD was linked to more deaths than cancer, chronic lower respiratory diseases, accidents, and diabetes mellitus combined¹⁶¹ in 2008. Annually, it is estimated that 785,000 Americans will develop new coronary artery disease¹⁶¹ (CAD). Risk factors for CAD include hyperlipidemia, hypertension, diabetes, cigarette smoking, sedentary lifestyle, and obesity. Management of CAD may be conservative medical management, which includes low fat, low sodium diet, exercise prescription, smoking cessation, weight loss for obesity, adherence to lipid lowering, antihypertensive, and other medications, with additional follow up with a cardiologist.^{12,226} Percutaneous revascularization may be used, particularly for acute coronary syndrome (ACS), and surgical revascularization, coronary artery bypass grafting (CABG), may be required for immediate correction of coronary blood flow, for multi-vessel disease, or failed medical management.

Cardiac surgery was used to manage CAD, valvular heart disease and aortic dissection for 395,000 patients in 2010.¹⁶³ However, surgical intervention is associated with a number of potential complications; these include atrial fibrillation, which occurs in 40-70% of patients after cardiac surgery; prevalence in those who have aortic valve surgery was as high as 74%.^{16,227,228} Pleural effusion occurred in approximately 44%-70%

of patients after cardiac surgery,^{16,37,40} and renal injury with subsequent renal dysfunction occurred in 30-40% of post cardiac surgery patients.²²⁹⁻²³² Complications increased length of stay by two to three days,¹⁶ and stimulated or worsened psychological distress in both patient and caregiver.⁴²

Psychological distress may include anxiety, hostility and depressive symptoms, which have been associated with poorer recovery and greater mortality after cardiac surgery.^{96,233} These emotional states can be significant barriers to rehabilitation in those recovering from cardiac surgery.^{161,164,234} Anxiety may induce autonomic-arousal symptoms like tachycardia, cardiac dysrhythmias, and dyspnea, which may deter patients from activities such as cardiac rehabilitation or activities of daily living.²⁶ Hostility may exert an adrenergic response, which can increase blood pressure, promote increased cigarette smoking, medication nonadherence, or physical inactivity.^{92,108} Depressive symptoms can exacerbate postoperative weakness, low endurance, low stamina, melancholy mood which may prevent patients from participation in their recovery.^{26,235} Moser and colleagues¹⁸ identified anxiety, hostility and depressive symptoms in those who survived a myocardial infarction; subsequent cardiac surgery reduced quality of life, and increased health care costs when compared to those without these emotional states. Wu and colleagues²³⁶ demonstrated a five-fold increase in cardiac events in depressed patients who were nonadherent to medications, which was similar to findings by Ziegelstein et al²³⁷ who demonstrated depressed patients had reduced adherence to medical regimen. Anxiety was seen in 37-44% of patients who had cardiac surgery; hostility was experienced by up to 62%, and depressive symptoms were detected in 53% of cardiac surgery patients.^{26,238-241} Patient recovery after cardiac surgery in those with

higher degrees of preoperative anxiety and depression has been associated with a higher symptom burden that included dyspnea, fatigue, insomnia, continued anxiety, peripheral edema, greater incisional pain, and anorexia.²³³

Emotional distress can be managed, but must be recognized and effectively treated to improve postoperative outcomes.¹⁸ In this dissertation, chapter two reported a secondary analysis of data from a large multi-site clinical trial; hostility was determined to be a predictor of mortality, but not of recurrence of ACS. Chapter three reported a psychometric evaluation of the BSI hostility and anxiety subscales in incarcerated individuals in a clinical trial testing a cardiovascular risk reduction intervention; we found support for the psychometric properties of these subscales in this population. In chapter four, we evaluated the association of patient and caregiver psychological state (anxiety, hostility, depression) with quality of life in both patient and caregiver, and determined whether these psychological states predicted postoperative complications after cardiac surgery. We found that anxiety, hostility, and depressive symptoms were common in both patient and caregiver before cardiac surgery; these states reduced quality of life for the patient and caregiver, and patient hostility decreased caregiver quality of life. Complications were prevalent, but were not predicted by anxiety, hostility or depressive symptoms scores. The findings from these studies expanded our understanding of the impact of psychological state on outcomes like cardiovascular risk and quality of life.

Psychological distress is associated with the progression of cardiovascular disease^{30,32} and dysrhythmias.⁷² Hostility has been linked to cardiovascular events since 1959, and has been determined to be associated with a 20% increase in CAD.³² In

chapter two, we measured hostility in cardiac patients from six international sites to determine its predictive power for recurrent ACS and mortality. Although hostility was not an independent predictor of recurrent ACS (OR 0.96, CI = 0.74-1.24, $p = 0.79$), it was predictive of all-cause mortality (OR 1.52, CI 1.02-2.28, $p = 0.03$); there was a 52% increase in the likelihood of all-cause mortality for every one unit increase in hostility score. Psychological state, hostility in particular, and the impact of hostility on cardiac patient outcomes has been equivocal in prior research findings.^{18,99,242,243} Hostility is a complex construct and the underlying mechanisms that contribute to alterations in cardiovascular function associated with hostility are not well understood; hostility may function as a moderator or mediator for cardiovascular outcomes. A comprehensive understanding of the association of hostility and other psychological states with outcomes will contribute to the development of effective interventions to improve outcomes in patients with cardiac disease.⁹²

In the second manuscript, we performed psychometric testing of the anxiety and hostility scales of the Brief Symptom Inventory (BSI). In 1982, Derogatis and colleagues¹³⁴ developed this instrument to measure psychological state at a given point in time. The BSI is a short instrument that can be used to either to measure global psychological distress, or to evaluate individual perception of a single psychological state. We focused on the measurement of anxiety and hostility with the subscales of this instrument. The validity and reliability of these subscales have been supported in psychiatric populations, but not in prisoners.¹³⁴ Based on our analyses, the BSI anxiety and hostility subscales were psychometrically sound in this population. Future research should include evaluation of longitudinal data to evaluate the trajectory of anxiety and

hostility in incarcerated individuals, and to determine the association of psychological state to outcomes in this highly vulnerable population. Long term reduction of cardiovascular morbidity and mortality would be the goal of this research focus.

In chapter four, I was the principal investigator and reported an original investigation that specifically explored whether anxiety, hostility, and depressive symptoms predicted quality of life in patients before cardiac surgery and their caregivers using a multilevel dyadic approach, the actor partner interdependence model (APIM). Emotional contagion theory proposes that individual affect may influence psychological and physiological status, and subsequent quality of life in individuals in close relationships like patient and caregiver.⁴⁸ Anxiety, hostility and depressive symptoms were common in both preoperative cardiac surgery patients and their primary caregivers. At baseline, higher anxiety and depressive symptoms were associated with worse mental well-being of both patient and caregiver, considered an actor effect in the APIM. Higher hostility was associated with poorer physical well-being for the patient, an actor effect, and worse mental well-being for the caregiver, a partner effect. This indicated that there was emotional contagion for this measured variable before cardiac surgery. Preoperative psychological state did not predict postoperative complications. The only independent predictor of complications was sex; women were 93-94% less likely to develop postoperative complications in this convenience sample. Preoperative psychological status requires attention for both patient and caregiver to improve quality of life.

Research and Clinical Implications

We found that hostility was a predictor of all-cause mortality in patients with known CAD. Regular measurement of hostility in this population could be clinically

useful. Identification of appropriate cut points for psychometrically sound, established hostility measures are needed, so that clinicians may identify those patients at risk for higher mortality. Determination of the physiological mechanisms that underpin worse outcomes is required for a comprehensive understanding this phenomenon. As hostility was not determined to predict recurrent ACS in our study, further investigation of the phenomenon must include evaluation of the role of hostility as a moderator or mediator of outcomes like recurrent ACS. Development of effective interventions to reduce hostility in the CAD population is needed and could contribute to improved outcomes when implemented clinically.

Anxiety and hostility were highly prevalent in the participants in the prison study. The BSI anxiety and hostility subscales were determined to be psychometrically sound in these participants; thus, these scales could be useful for clinical monitoring of psychological state, and for use in a longitudinal investigation of psychological state and its association with cardiovascular risk, morbidity and mortality in this highly vulnerable population. A particular challenge for clinicians and scientists would be the development and implementation of effective interventions to reduce anxiety and hostility in this highly adverse environment.

Anxiety, hostility, and depressive symptoms were common for both patient and caregiver before cardiac surgery. Although scientists previously developed preoperative teaching and support interventions that included patient and family/caregivers, outcomes of those interventions were not studied using dyadic analysis. Systematic evaluation of psychological state of both patient and caregiver using dyadic analysis would provide a realistic, comprehensive understanding of emotional state for both patient and family

before surgery, psychological contagion and its effect on a variety of outcomes for both patient and family, and offer evidence to support the development of effective interventions for both patient and family that may improve psychological and physiological outcomes for both.

Although we did not find that psychological state predicted complications in our participants, further investigation is needed, as our finding was in contrast to a number of other scientists. Systematic evaluation of the mechanisms that generate poorer outcomes because of psychological state would highlight physiological targets for intervention. Identification of moderators and/or mediators of poorer outcomes would also be useful for the development of comprehensive interventions to improve outcomes.

Summary

The findings of this dissertation support proactive assessment of psychological state by healthcare providers for patients and family/caregivers and the importance of attention to psychological state for a variety of cardiac patient populations. A comprehensive understanding of the mechanisms that produce worse outcomes for those with higher anxiety, hostility, and depressive symptoms will support a full understanding of the complexity of these states, and offer targets for the development of effective interventions to reduce cardiovascular risk, morbidity, and mortality.

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Chapter Three

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Chapter Four

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Chapter Five

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VITA

Educational Background

Year	Degree	Institution
2007	Masters of Science	Wright State University, Dayton, OH
1997	Master in Education	Xavier University, Cincinnati, OH
1992	Masters of Science in Nursing	University of Cincinnati, Cincinnati OH
1988	Bachelors of Science in Nursing	College of Mount St. Joseph, Cincinnati OH

Professional Positions Held

Dates	Institution and Location	Position
June 2012-present	Mercy Anderson Cincinnati, OH	Acute Care Nurse Practitioner, Cardiac Surgery
March 2008-June 2012	UC Health at University Hospital & West Chester Hospital, Cincinnati OH	Acute Care Nurse Practitioner
February 2003-March 2008	The Christ Hospital, Cincinnati, OH	Cardiothoracic & Surgical Intensive Care Unit
April 1999 – December 2002	International Business Machines (IBM)	Health Care Practice Operations & Resource Manager. Consultant
May 1997-April 1999	Envision Group, Cincinnati, OH	Human Resource Development
April 1994-May 1997	American Nursing Care Cincinnati, OH	Program Manager, Parent-Child

June 1992-February 1994	Good Samaritan Hospital, Cincinnati, OH	Neonatal Nurse Practitioner
May 1989-June 1992	Children's Hospital Medical Center Cincinnati, OH	Critical Care Transport Assistant Nurse Manager
May 1988 – May 1989	Children's Hospital Medical Center Cincinnati, OH	Registered Nurse

Scholarship and Professional Honors

Sigma Theta Tau International Delta Psi Chapter Nursing Research Award	2015
UK Graduate School Academic Year Fellowship	2015
AACN Student Policy Summit Fellow	2015
Nominated by University of Kentucky College of Nursing faculty for Dissertation Year Fellowship	2015
Sigma Theta Tau International Delta Psi Chapter Professional Award	2015
Preventative Cardiovascular Nurse Association Scholarship	2014
Preventative Cardiovascular Nurse Association Scholarship	2013
UK Graduate School Academic Year Fellowship	2013
UK College of Nursing Graduate Year New Opportunity Fellowship	2012
UK College of Nursing Graduate Scholarship	2012