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The Effect of Low Sodium Diet Education in the Prevention of Hospital Readmission for Heart Failure Patients

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By

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The Effect of Low Sodium Diet Education in the Prevention of Hospital Readmission for Heart Failure Patients

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Rate of readmission among hospitalized heart failure (HF) patients is used as an indicator of quality and efficiency of healthcare. A low sodium diet is a component of the accepted treatment for HF. Instruction by dietitians may help reduce dietary sodium without negatively affecting quality of life. The effect of low sodium diet education on hospital readmission within 30 and 45 days of discharge for HF patients (N=52) was conducted. Chi-square analysis determined education did not significantly affect re-admittance within 30 (P=.143) or 45 days (P=.474). Patients readmitted within 30 days were older (P=.005). Men were more likely to be readmitted than women within 30 (P=.021) and 45 days (P=.019). Higher NT-proBNP levels were observed in individuals readmitted within 30 (P=.011) and 45 days (P=.010). Low sodium diet education did not affect readmission but older age, male sex, and higher NT-proBNP values increased the rate of readmission.

Keywords: Heart failure, low sodium diet education, NT-proBNP levels

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CHAPTER I

INTRODUCTION

Approximately 5.1 million Americans 20 years and older have heart failure (HF), also known as congestive heart failure (Go et al., 2013). It is estimated that the prevalence of HF will increase by 25% in 2030 and the cost of HF will increase to an estimated $77.7 billion compared to $24.7 billion in 2010 (Heidenriech et al., 2011). Heart failure is the most common diagnosis-related group (Masoudi, Havreanek, & Krumholz, 2002) as well as the cause for hospital admission and readmission among Medicare patients (Jencks, Williams & Coleman, 2009). More Medicare dollars are spent for the diagnosis and treatment of HF than for any other diagnosis (Masoudi et al., 2002). Readmission rates of patients with HF after discharge are attracting considerable attention from the Institute of Medicine, Medicaid Services, and the Medicare Payment Advisory Commission as an indicator of the quality and efficiency of care (Ross et al., 2008).

In July 2009, the Centers for Medicare and Medicaid Services (CMS) began publicly reporting hospital readmission rates (CMS, 2009). Jencks et al. (2009) reported that 19.6% of Medicare beneficiaries were readmitted within 30 days of hospital discharge, and were financially rewarded for readmissions. However, nearly $17.4 billion could be saved annually by preventing readmissions. In an effort to reverse financial incentives, hospitals will be evaluated and differentiated payments will be generated on

the basis of 30-day periods. Therefore, proposals to reduce hospital readmission have gained prominence in health care reform discussions. The 30-day readmission rates that the CMS publicly reports include acute myocardial infarction, congestive heart failure, and pneumonia (Jencks et al., 2009). The U.S. Senate Finance Committee policy option called for withholding up to 20% of a hospital's inpatient payments on the basis of comparative readmission rates (U.S. Senate Finance Committee, 2009). Original U.S. House of Representatives' options called for penalties of up to 5% of hospital payments for facilities with higher-than-expected readmission rates (U.S. House of Representatives, 2009). However, little attention has been given to the potential for unintended consequences on hospitals serving vulnerable communities (Bhalla & Kalkut, 2010).

After age 65, the incidence of HF is close to 10 per 1000 population and 75% of those with HF have antecedent hypertension (Lloyd-Jones et al., 2002). One in nine deaths has HF mentioned on the death certificate. The number of any-mention deaths attributable to HF was almost as high in 1995 (287,000) as it was in 2009 (275,000) (Go et al., 2013). Survival after onset of HF has improved (Baker, Mulloly, & Getchell, 2006). Among Medicare beneficiaries, the overall 1-year mortality rate has declined slightly over the last decade (Chen, Normand, Wang, & Krumholz, 2011); risk-adjusted 1-year mortality decreased from 31.7% to 29.6% from 1999 to 2008, respectively, with a relative decline of 6.6%.

After HF hospitalization, changes in survival may have changed the denominator of HF patients at risk for recurrent hospitalization. A relative decline of 29.5% from 1998 to 2008 was observed in the rate of hospitalization for HF adjusted for age, sex, and race. In all race-sex categories, age-adjusted HF hospitalization rates declined but at a slower

rate in black men. A savings of $4.1 billion in fee-for-service Medicare can be attributed to this decline in rate of HF hospitalization (Chen et al., 2011).

Heart failure is when the heart cannot pump enough blood and oxygen to support the metabolic needs of the body (Parker, Rodgers, & Cavallari, 2008) and is the result of any structural or functional disorder that affects the ability of the ventricle to fill or eject blood (Hunt et al., 2009; Wells, DiPiro, Schwinghammer, & Dipiro, 2009). Typically, an index event such as an acute myocardial infarction (MI) or chronic hypertension will result in a decrease in the pumping capacity of the heart, leading to various compensatory responses to maintain adequate output (Parker et al., 2008). Nearly any form of heart disease may ultimately lead to the HF syndrome (Hunt et al., 2009). However, for a substantial proportion of the Western world coronary artery disease (CAD), hypertension, and dilated cardiomyopathy are causes for HF (Francis & Pierpont, 1988). Initially, hemodynamic changes in HF patients were thought to lead to progression of the disease but more recent research indicates hemodynamic changes and neurohormonal activation are responsible for the progression of HF. Therefore, pharmacological and non-pharmacological treatments are aimed at maintaining hemodynamic homeostasis as well as decreasing neurohormonal activation (Hoyt & Bowling, 2001).

Heart failure is defined as a clinical syndrome, characterized by specific symptoms in the medical history and on physical examination of the patient. A single diagnostic test does not exist for HF. Cardinal manifestations of HF are fluid retention, pulmonary congestion, and/or peripheral edema (Hunt et al., 2009). Decreased blood flow through the organs, also known as hypovolemic shock, may occur in severe cases. Primary symptoms of HF include dyspnea and fatigue which can lead to exercise

intolerance. Factors that may precipitate or exacerbate HF include negative changes in the way the heart contracts, direct cardiotoxicity and increases in sodium and/or fluid retention, resulting in symptoms associated with volume overload. What is evident is that many of the precipitating factors of HF are preventable (Parker et al., 2008).

Prevention is critical due to poor long-term survival rates of HF patients. Appropriate patient counseling should help decrease the most common reasons for exacerbation of HF: non-compliance with dietary sodium and fluid restrictions, drug therapy, or both (Parker et al., 2008). Primary prevention in the early stages of HF focuses on the aggressive treatment of underlying risk factors such as dyslipidemia, hypertension, and diabetes mellitus (DM) (Parker et al., 2008; Hunt et al., 2009). Lifestyle changes, including adopting a heart-healthy diet, weight management, increased physical activity as tolerated as well as tobacco and alcohol cessation, in conjunction with pharmacotherapy treatment can optimize primary preventative strategies for HF (Parker et al., 2008).

Even though there is no consensus on the optimal level of dietary restriction of sodium, a low sodium diet is an accepted treatment for managing sodium and fluid retention in patients with acute and chronic HF (Parker et al., 2008). Optimally, recommendations for low sodium diets should be the least restrictive while still achieving desired outcomes. Adherence to dietary sodium restrictions can be problematic for patients with HF. However, nutrition counseling administered by a registered dietitian has resulted in a reduction in dietary sodium intake in patients with stable HF, which supports the dietitian's role as part of a multidisciplinary team that aims to help patients achieve and adhere to their sodium restricted diet (Arcand et al., 2005).

This study evaluated the effect of inpatient low sodium diet instruction provided by the clinical dietitian staff at Magnolia Regional Health Center in Corinth, Mississippi, on the incidence of readmission among patients admitted to the hospital with a primary or secondary diagnosis of HF. The purpose of this study was to investigate the effect of low sodium diet education in the prevention of hospital readmission among patients hospitalized for HF. The primary objective of this retrospective study was to investigate the difference between the prevalence of readmission post discharge when the patient was admitted with a diagnosis of HF for those that received low sodium diet education and those that did not. The secondary objective of this study was to investigate the ability of age, body mass index (BMI) level, serum sodium level, N-terminal pro-brain natriuretic peptide **(**NT-proBNP) level, and low sodium diet education to predict readmission among patients hospitalized for HF within 30 and 45 days post discharge.

CHAPTER II

LITERATURE REVEIW

Prevalence of Heart Disease

In 2009, heart disease was the leading cause of death in the United States with a rate of 180.1 per 100,000 population. From 2008 to 2009, the rate of deaths caused by heart disease decreased by 3.4%. Also, males were 1.6 times more likely to die from heart disease than females and blacks were 1.3 times more likely to die from heart disease than whites (Kochanek, Xu, Murphy, Miniño, & Kung, 2011). Heart disease is the leading cause of death in Mississippi. In 2007, 9553 people in Mississippi died from heart disease and stroke, accounting for 34% of all deaths (Mississippi State Department of Health [MSDH], 2007). Heart disease was the leading cause of death for whites and non-whites in Mississippi, killing 8077 people (MSDH, 2007). Rate of death caused by heart disease for non-whites and whites was 346.4 per 100,000 population and 239.6 per 100,000 population, respectively (MSDH, 2007).

Prevalence and Mortality of Heart Failure

Heart failure costs the United States $34.4 billion each year in health care services, medications, and lost productivity. Total cost of HF for 2013 is estimated to be $32 billion (Heidenriech et al., 2011). Approximately 5.1 million Americans 20 years and older have HF (Go et al., 2013). It is estimated that by 2030 the prevalence of HF will

increase by 25% and the cost of HF will increase to an estimated $77.7 billion compared to $24.7 billion in 2010 (Heidenriech et al, 2011). Heart failure is the most common diagnosis-related group (Masoudi et al., 2002) as well as the cause for hospital admission and readmission among Medicare patients (Jencks et al., 2009). More Medicare dollars are spent for the diagnosis and treatment of HF than for any other diagnosis (Masoudi et al., 2002). Readmission rates of patients with HF after discharge are attracting considerable attention from the Institute of Medicine, Medicaid Services, and the Medicare Payment Advisory Commission as an indicator of the quality and efficiency of care (Ross et al., 2008).

In July 2009, the CMS began publicly reporting hospital readmission rates (CMS, 2009). Jencks et al. (2009) reported that 19.6% of Medicare beneficiaries were readmitted within 30 days of hospital discharge. However, nearly $17.4 billion could be saved annually by preventing readmissions. Previously, hospitals were financially rewarded for readmissions. In an effort to reverse financial incentives, hospitals will be evaluated and differentiated payments will be generated on the basis of a 30-day period. Therefore, proposals to reduce hospital readmission have gained prominence in health care reform discussions. The 30-day readmission rates that the CMS publicly reports include acute myocardial infarction, congestive heart failure, and pneumonia (Jencks et al., 2009). The U.S. Senate Finance Committee policy option called for withholding up to 20% of a hospital's inpatient payments on the basis of comparative readmission rates (U.S. Senate Finance Committee, 2009). Original U.S. House of Representatives' options called for penalties of up to 5% of hospital payments for facilities with higher-than-expected readmission rates (U.S. House of Representatives, 2009). However, little attention has

been given to the potential for unintended consequences on hospitals serving vulnerable communities (Bhalla & Kalkut, 2010).

Among 2934 participants in the Health Aging, Body and Composition (ABC) study, the incidence of HF was 13.6 per 1000 persons-years (Kalogeropoulus at al., 2009). In white men the annual rate of new HF events per 1000 population increased from 15.2 for those 65 to 74 years of age to 31.7 for those 75 to 84 years of age and 65.2 per 1000 persons-years for those 85 years of age and older. Prevalence rates for white women and black men also increased with age. For white women ages 65 to 74, 75 to 84, and 85 years of age and older the rates were 8.2, 19.8, and 45.6, respectively, and for black men, the rates were 16.9, 25.5, and 50.6, respectively (National Institutes of Health, National Heart, Lung, and Blood Institute [NIH/NHLBI], 2006).

After HF hospitalization, changes in survival may have changed the denominator of HF patients at risk for recurrent hospitalization. A relative decline of 29.5% was observed from 1998 to 2008 in the rate of hospitalization for HF adjusted for age, sex, and race. In all race-sex categories, age-adjusted HF hospitalization rates declined but at a slower rate for black men. A savings of $4.1 billion in fee-for-service Medicare can be attributed to this decline in rate of HF hospitalization (Chen et al., 2011).

One in nine deaths has HF mentioned on the death certificate. The number of any-mention deaths attributable to HF was almost as high in 2009 (275,000) as it was in 1995 (287,000). In 2009, the overall any-mention death rate for HF was 82.3 per 1000 population (Go et al., 2013). Data from Kaiser Permanente indicate that survival after onset of HF has improved among the elderly (Baker et al., 2006) as well as among Medicare beneficiaries whose overall 1-year mortality rate has declined slightly over the

last decade (Chen et al., 2011). However, the death rate remains high (Chen et al., 2011) and approximately 50% of those diagnosed with HF die within 5 years (Levy et al., 2002; Roger et al., 2004).

In Mississippi from 2007 to 2009, age-adjusted average annual HF death rates were as high as 239.9 to 720.3 deaths per 100,000 and as low as 58.1 to 157.5 deaths per 100,000. Out of the 82 counties in Mississippi, the majority of HF death rates were among the highest, between 239.9 to 720.3 per 100,000. Only nine counties out of 82 counties had average annual death rates for HF less than 239.8 per 100,000. Four counties had a death rate per 100,000 of 204.5 to 239.8, two counties each had death rates of 181.0 to 204.4 and 157.6 to 180.9 per 100,000, and one county had a death rate of 58.1 to 157.5 (Centers for Disease Control and Prevention [CDC], n.d.a.). Heart failuare death rates in the United States are presented by counties in Figure 2.1.

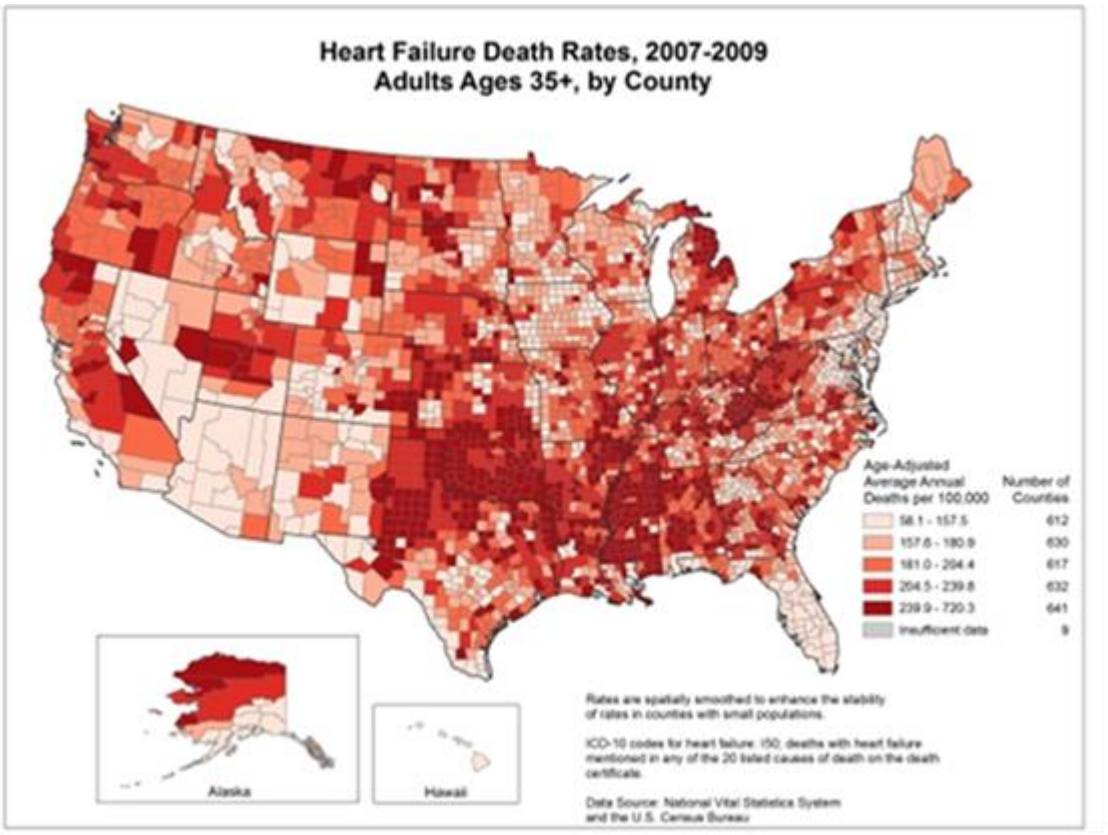

Figure 2.1 Heart Failure Death Rates in the United States, 2007-2009

Source: CDC, n.d.a

Risk Factors for Heart Failure

Demographics

In the Atherosclerosis Risk in Communities (ARIC) study, the age-adjusted incidence rate per 1000 persons-years was much less for white women (3.4) compared to all other groups whose rates were 6.0, 8.1, and 9.1 for white men, black women, and black men, respectively (NIH/NHLBI, 2006). At 40 years of age, the lifetime risk for HF is one in five for both men and women. The lifetime risk for HF without antecedent MI is one in nine and one in six for men and women, respectively (Lloyd-Jones et al., 2002). In the Multi-Ethnic Study of Atherosclerosis (MESA), African Americans had the highest

risk of developing HF, followed by Hispanic, white, and Chinese Americans with 4.6, 3.5, 2.4, and 1.0 per 1000 persons-years, respectively. Higher risk for HF reflected differences in hypertension, DM, and socioeconomic status with African Americans having the highest risk not preceded by clinical MI (Bahrami et al., 2008). In the ABC study, there was a higher overall proportion of HF attributable to modifiable risk factors in black participants (67.8) than in white participants (48.9) (Kalogeropoulus et al., 2009). The incidence of HF is greater among black men and women than white men and women, highest in black men and least prevalent in white women (Go et al., 2013). Greater HF incidence in blacks than whites is explained primarily by the higher atherosclerotic risk factors of blacks (Loeher, Rosamond, Chang, Folsom, & Chambless, 2008).

Hypertension

Hypertension remains an important cause and/or contributor to HF, particularly in women, the elderly, and African Americans (Parker et al., 2008). The lifetime risk of developing HF for people with blood pressure greater than 160/90 mmHg is twice that than those with blood pressure less than 140/90 mm (Lloyd-Jones et al., 2002). Optimal blood pressure control has been shown to decrease the risk of new onset of HF by approximately 50% (Baker, 2002). Approximately one fourth of the American population is hypertensive, and the lifetime risk of developing hypertension in the United States exceeds 75% (Vasan et al., 2002).

Hypertension is an important risk factor for ischemic heart disease and therefore is present in a high percentage of HF patients. Since hypertension and/or ischemic heart disease contribute significantly to the development of HF, it is important to remember

that HF is a largely preventable disease (Parker et al., 2008). Therefore, strategies to control hypertension are an important focus in the effort to prevent HF (Hunt et al., 2009). Among 20,900 male physicians in the Physicians Health Study, the lifetime risk of HF was higher in men with hypertension and healthy lifestyle factors were related to lower risk of HF (Djousse, Driver, & Gaziano, 2009). Healthy lifestyle factors included normal weight, not smoking, regular exercise, moderate alcohol intake as well as consumption of breakfast cereals, fruits, and vegetables (Djousse et al., 2009).

Metabolic Syndrome

Obesity and insulin resistance are important risk factors for the development of HF. Metabolic syndrome includes the clustering of any three of the following cardiovascular risk factors in individual patients: abdominal adiposity, hypertriglyceridemia, low high-density lipoprotein (HDL) cholesterol levels, hypertension, and fasting hyperglycemia (Hunt et al., 2009). The presence of clinical DM markedly increases the likelihood of HF in patients without structural heart disease (He et al., 2001). It is estimated that the prevalence of metabolic syndrome in the United States exceeds 20% of individuals who are at least 20 years of age and 40% of the population over 40 years of age (Kereiakes & Willerson, 2003). The appropriate treatment of DM and dyslipidemia as they occur in isolation may significantly reduce the development of HF (Hunt et al., 2009).

More than one third (35.7%) of adults in the United States are obese (CDC, 2012). In 2011, 39 states had a prevalence of 25% or more and no state had a prevalence of obesity less than 20% (Figure 2.2). The southern region had the highest prevalence of obesity, 29.5%, and Mississippi was one of 12 states that had an obesity prevalence of

30% or more (Figure 2.2). Obesity prevalence was highest in Mississippi (34.9%) and lowest in Colorado (20.7%) (CDC, 2012). Obesity and overweight are determined by one's BMI. An adult that has a BMI of 25.0 to 29.9 kg/m² is considered overweight, and an adult that has a BMI of 30 or greater is classified as obese (Table 2.1, NHLBI, 1998).

Table 2.1 Classification of Overweight and Obesity by BMI

Class	BMI (kg/m^2)
Underweight	Less than 18.5
Normal	18.5 to 24.9
Overweight	25.0 to 29.9
Obesity I	30.0 to 34.9
Obesity II	35.0 to 39.9
Obesity III	40.0 or higher

Source: NHLBI, 1998

Cardiotoxicity

Patients should be strongly advised about the hazards of smoking, as well as the use of alcohol, cocaine, amphetamines, and other illicit drugs due to their cardiotoxic effects. Several studies have failed to determine a significant correlation between the amount of alcohol consumed and the development of HF. However, the American College of Cardiology Foundation/American Heart Association Task Force (ACCF/AHATF) for the 2005 Guidelines for the Diagnosis and Management of Heart Failure in Adults Writing Committee strongly recommends that any new-onset HF patient with a history of alcohol abuse or with current, routine substantial alcohol consumption should be counseled on abstinence (Hunt et al., 2009).

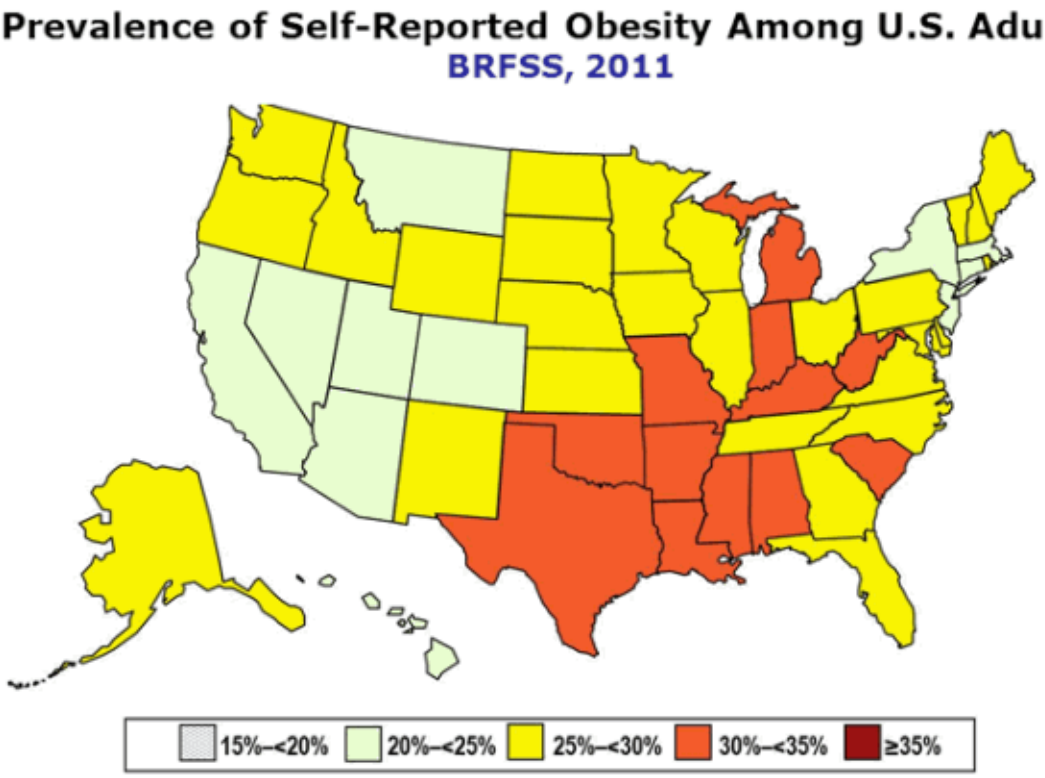

Figure 2.2 Prevalence of Obesity among Adults in the United States

Source: CDC, n.d.b

Etiology

Heart failure is the result of any disorder that affects the ability of the heart to contract (systolic function) and/or relax (diastolic function). Systolic dysfunction typically results in reduced left ventricle (LV) ejection fraction and is usually caused by acute MI. Current estimates suggest 50% of patients with HF have preserved LV systolic function with presumed diastolic dysfunction. These patients are usually elderly, female, and obese as well as have hypertension, atrial fibrillation, or DM (Parker et al., 2008).

A cardinal feature of dilated cardiomyopathies is systolic dysfunction. Although the cause of reduced contractility is unknown, abnormalities such as interstitial fibrosis, cellular infiltrates, cellular hypertrophy, and myocardial cell degeneration are commonly

seen on histological examination. Pressure and/or volume overload causes ventricular hypertrophy such as in cases of systemic and/or pulmonary hypertension (Wells et al., 2009). If overload persists, remodeling of the pulmonary valve causes stenosis and alterations in the geometry of the hypertrophied myocardial cells. This is accompanied by an increase in collagen deposition in the extracellular matrix, which leaves both systolic and diastolic function impaired (Parker et al., 2008).

Coronary artery disease is the most common cause of systolic HF, with nearly 70% of cases leading to MI. Myocardial infarction causes a reduction in muscle mass due to the death of affected myocardial cells. Surviving myocardium undergoes compensatory remodeling, initiating the HF syndrome and leading to further injury of the heart as well as resulting in both systolic and diastolic dysfunction (Parker et al., 2008).

Pathophysiology

Heart failure is when cardiac output is impaired, meaning the heart cannot pump enough blood and oxygen to support the metabolic needs of the body. Cardiac output is defined as the volume of blood ejected per unit of time in liters per minute and is a product of heart rate and stroke volume. Heart rate is controlled by the autonomic nervous system (ANS). Stroke volume is the amount of blood ejected during systole. The most common causes of HF include CAD and hypertension. However, HF can result from any reduction in ventricular filling and/or myocardial contractility. Compensatory mechanisms intended to be short-term responses to maintain circulatory homeostasis are responsible for the symptoms of HF and eventually lead to the progression of the disease (Parker et al., 2008).

Typically, an index event such as an acute MI or chronic hypertension will result in a decrease of the heart's pumping capacity leading to various compensatory responses to maintain adequate output. These include activation of the sympathetic nervous system (SNS), the Frank-Starling Mechanism, vasoconstriction, and ventricular hypertrophy (Parker et al., 2008).

Activation of the SNS results in tachycardia and increased contractibility (Wells et al., 2009). The American Heart Association (AHA) explains tachycardia as a heartbeat that is too fast, defined as a heartbeat greater than 100 beats per minute (AHA, n.d.). This occurs when electrical signals in the heart's upper chambers fire abnormally which interferes with signals coming from the heart's natural pacemaker, the sinoatrial node. The rapid heartbeat does not allow the heart to fill completely before contracting, compromising blood flow to the rest of the body (Parker et al., 2008).

The Frank-Starling Mechanism is the ability of the heart to increase force of contractibility with increases in preload. Preload is determined by LV volume and pressure. Increases in preload occur when the length of myocardial sacromeres are stretched resulting in an increase in force of contraction as the number of cross bridges between thick and thin myofilaments increases. Therefore, the length of sacromere is determined by volume of blood in the ventricle and thus, left ventricular end diastolic volume is the primary determinant of preload. In normal hearts, the preload response is the primary compensatory mechanism such that incremental increases in end diastolic volume results in large increases in cardiac output (Parker et al., 2008).

Augmentation of preload is another compensatory response to decreased cardiac output. Renal perfusion is reduced in HF because of redistribution of blood flow away

from non-vital organs due to depressed cardiac output. The kidneys interpret reduced perfusion as ineffective blood volume, activating the renin-angiotensin-aldesterone system. The renin-angiotensin-aldesterone system is activated in order to maintain blood pressure and increase renal sodium and water retention (Parker et al., 2008).

Reduced renal perfusion and increased sympathetic tone stimulate release of renin from juxta-glomerular cells in the kidney. Renin converts angiotensinogen to angiotensin I. Angiotensin-Converting-Enzyme (ACE) converts angiotensin I to angiotensin II, which feedbacks on the adrenal gland, stimulating the release of aldosterone and providing an additional mechanism for sodium and water retention in the kidneys. As intravascular volume increases due to sodium and water retention, sacromeres are stretched and contractility is enhanced. However, preload will only increase stroke volume to a certain point and the chronically failing heart has usually exhausted its preload reserve. Beyond this point, increases in preload will only lead to pulmonary or systemic congestion (Parker et al., 2008).

Factors that may precipitate or exacerbate HF include negative inotropic effects, direct cardiotoxicity and increases in sodium and/or water retention, resulting in symptoms associated with volume overload. Primary manifestation of symptoms includes dyspnea and fatigue, leading to exercise intolerance. In more severe cases, hypoperfusion may also be present. Common causes of HF exacerbation include noncompliance with medications or dietary recommendations. Forty-three percent of patients admitted with decomposition of HF were assessed as having excess dietary sodium, 34% had excess fluid intake (more than 2.5 L per day), and 24% had drug noncompliance that may have contributed but was not necessarily the primary cause of decomposition. Cardiac events

as well as non-cardiac events, such as pulmonary infections, may also precipitate HF exacerbation (Parker et al., 2008).

What is evident is that many of the precipitating factors are preventable and appropriate patient counseling could help to decrease the most common reasons for exacerbation of HF: noncompliance with dietary sodium and water/fluid restrictions, drug therapy, or both. Prevention is critical due to poor long-term survival rates of HF patients (Parker et al., 2008).

Stages of Heart Failure

Most clinicians are familiar with and use The New York Heart Association (NYHA) functional classification staging system, which is primarily intended to classify symptomatic HF. The NYHA classification system has four classifications, ranging from patients with asymptomatic heart disease to patients with severe heart disease who have symptoms even at rest and increased discomfort with physical activity (Table 2.2) (The Criteria Committee of the New York Heart Association, 1964).

Table 2.2 The New York Heart Association Classification System

Class	Criteria
I	Patients have cardiac disease but without the resulting limitations of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea or anginal pain.
II	Patients have cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea or anginal pain.
III	Patients have cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary physical activity causes fatigue, palpitation, dyspnea or anginal pain.
IV	Patients have cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency or of the angina syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.

Source: The Criteria Committee of the New York Heart Association, 1964

The American College of Cardiology/American Heart Association (ACC/AHA) guidelines for the evaluation and management of chronic HF uses a staging system comprised of four stages, starting with patients who have risk factors and require primary prevention, stage A, to those with advanced HF and severe disease, stage D (Table 2.3). This system recognizes the evolution and progression of HF and emphasizes risk factor modification and preventative strategies unlike the NYHA staging system which focuses primarily on symptomatic classification of heart disease and does not recognize preventative measures (Parker et al., 2008).

Table 2.3 ACC/AHA Practice Guidelines: Stages of Heart Failure

Stage	Criteria
A	At high risk of heart failure but without structural heart disease or symptoms of heart failure.
B	Structural heart disease but without signs or symptoms of heart failure.
C	Structural heart disease with previous or current symptoms of heart failure. Includes patients with known structural heart disease and symptoms such as shortness of breath, fatigue and reduced exercise tolerance.
D	Refractory heart failure requiring specialized interventions. Includes patients who have marked symptoms at rest despite maximal medical therapy.

Source: Hunt et al., 2009

According to the ACC/AHA, stages A and B focus on the aggressive treatment of underlying risk factors such as dyslipidemia, hypertension, and DM. This preventative treatment has been effective and several studies in antihypertensive therapy have reduced the risk of the manifestation of HF in elderly patients with underlying risk factors by 22% to 68%. Lifestyle changes, including adopting a heart-healthy diet, weight maintenance, increased physical activity as tolerated as well as tobacco and alcohol cessation, in conjunction with pharmacotherapy treatment can optimize primary preventative strategies for HF. Secondary prevention strategies are warranted for stages C and D to prevent further cardiac dysfunction and include pharmacoagents such as ACE inhibitors, angiotensin receptor blockers, aldosterone blockers, ß-blockers, and digoxin. Neurohormonal antagonists, ACE inhibitors, and ß-blockers have all been shown to reduce mortality in HF (Parker et al., 2008).

Sodium, Water, and Heart Failure

In HF, sodium and fluid accumulate in the tissues as a result of inadequate blood flow to the kidneys. In an attempt to restore blood flow, aldosterone and antidiuretic hormone are activated and act to promote sodium resorption and conserve water, respectively. Patients with advanced HF typically have symptoms related to the retention of sodium and water. Even asymptomatic patients with mild HF can retain sodium and water if consuming a high sodium diet (Arcand et al., 2011). There is no direct evidence that control of dietary sodium or participation in regular exercise can prevent the development of HF. However, these efforts may have other health benefits in patients with hypertension or other vascular diseases and may enhance their overall sense of well-being (Hunt et al., 2009).

Physiological principles, observational studies, common practice, and expert opinion support dietary sodium restrictions as an accepted treatment for managing sodium and fluid retention in patients with acute and chronic HF (Meadows & Johnson, 2002). According to the current guidelines of the AHA/ACC for management of HF, dietary sodium intake of 2 grams (gm) or less per day can assist in the maintenance of volume balance (Hunt et al., 2009). Dietary Reference Intakes (DRIs) for sodium for healthy adults, ages 14 to 50 years, are an Adequate Intake (AI) of 1.5 gm per day and a tolerable upper intake level (UL) of 2.3 gm per day (Institute of Medicine, 2005; Arcand et al., 2011). In some instances, patients with persistent or recurrent fluid retention in spite of dietary sodium restriction and pharmacological treatment may benefit from an intake of fluid restricted to 2 liters per day (Hunt et al., 2009). However, a summary of the evidence concludes there is limited evidence to support a 2 gm per day sodium diet

(Academy of Nutrition and Dietetics, n.d.). Thus, there is no consensus on the optimal level of dietary restriction of sodium. The degree to which sodium and possibly fluid is restricted should be determined on an individual basis and diets should be the least restrictive while still achieving desired outcomes (Arcand et al., 2011).

A reduced enthusiasm for sodium restriction in practice guidelines for HF patients has occurred as a result of a lack of empirical evidence regarding beneficial or adverse outcomes associated with various levels of sodium intake in compensated, appropriately medicated HF patients (Arcand et al., 2011). Recent studies highlight an alternative hypothesis that low sodium diets in conjunction with high-dose diuretics and fluid restriction could be harmful and in two studies has actually shown to promote increases in hospital readmission and death in patients with HF (Arcand et al., 2011; Paterna et al., 2009; Paterna, Gasparo, Fasullo, Sarullo, & Di, 2008).

Arcand et al. (2005) observed trends toward reduced blood pressure in patients with HF after three months of education on a 2 gm sodium diet. Additionally, those who had two individualized education sessions with a registered dietitian had significant decreases in blood pressure. A potential outcome of this study is that registered dietitian intervention as part of a multidisciplinary team helps patients achieve and improve adherence to a sodium-restricted diet (Arcand et al., 2005). A systematic review of six randomized control trials suggests that multidisciplinary HF management programs which emphasize dietary counseling and/or the reduction of sodium consumption can improve the functional capacity, satisfaction, and quality of life of those with HF (Meadows & Johnson, 2002; Rich, 1999;). Rich et al. (1995) reported that a multidisciplinary intervention, including a registered dietitian for the provision of dietary

instructions had beneficial effects on hospital readmission, quality of life, and cost of care within 90 days of discharge among high risk chronic HF patients. This multidisciplinary approach resulted in a longer event-free survival ($P = 0.09$), fewer readmissions, a better quality of life, and lower health care costs ($P < 0.05$) (Rich et al., 1995).

The Role of Dietary Sodium

Dietary sources of sodium include salt used at the table, salt or sodium chloride, compounds added during preparation and processing of food, sodium naturally found in foods, and chemically softened water. Incidental amounts of sodium can also be ingested through toothpaste and certain medications. Acute decompensated heart failure (ADHF) has been defined as an exacerbation of symptoms that include dyspnea, edema, or fatigue that requires immediate medical attention and often occurs in patients with HF. A prospective follow up study of two outpatient HF clinics from 2003 to 2007, using a cohort of stable, ambulatory, compensated HF patients tested the hypothesis that high sodium intake was related to ADHF in ambulatory HF patients of all-cause hospitalization and mortality. Estimates of sodium were obtained using two 3-day food records. Median sodium intakes were 1.4 ± 0.3 gm, 2.4 ± 0.3 gm, and 3.8 ± 0.8 gm sodium per day in the low, medium, and upper tertiles, respectively. Patients in the upper tertile of sodium intakes had a higher cumulative ADHF event rate at $46 \pm 11\%$ than patients in the lower and middle tertiles whose rates of ADHF events were $12 \pm 6\%$ and $15 \pm 7\%$, respectively (Arcand et al., 2011). This study provides some of the first evidence that patients who consume greater amounts of sodium (2.8 gm/day or more) are at a greater risk for ADHF. Not only did patients with high sodium diets have a 2.5-fold increased risk of an ADHF event but also had elevated risks for all-cause hospitalization

and mortality when adjusted for covariates. This challenges recent conclusions that low sodium diets are associated with adverse outcomes in HF and provides support for more aggressive sodium restrictive diets than those currently recommended for the management of HF (Arcand et al., 2011).

Dietary Quality of Heart Failure Patients

The overall dietary quality of persons with HF was described in a study using data from the National Health and Nutrition Examination Survey (NHANES) 1999-2006. This study suggested that the dietary quality of persons with HF was poor based on sodium intake and additional nutrients listed in the Dietary Approaches to Stop Hypertension (DASH) eating plan. Also, several recent studies suggested that nutrients consistent with the DASH eating plan influence progression and associated outcomes of HF (Lemon et al., 2009). The ACC/AHA joint guidelines endorse adherence to dietary guidelines for common underlying and comorbid conditions in chronic HF such as CAD, hypertension, DM, and hypercholesteremia and recommend restricted sodium intake for patients with symptomatic, non-end-stage HF (Hunt et al., 2009; Lemon et al., 2009).

In the NHANES sample, the average daily sodium intake among persons with HF was 2,728.5 mg/day, 34% achieved the recommended daily intake of 2,000 mg or less per day. The average daily sodium intake was 3,073.1 mg per day among those without HF ages 50 and older in the adult 1999-2006 NHANES sample. This showed some improvement in regards to a reduction in dietary sodium among persons with HF at the population level. The persistence of poor dietary habits among those with HF reinforced the need for primary prevention aimed at improving dietary quality for cardiovascular risk reduction. However, this analysis indicated a 200 mg per day reduction in sodium

consumption among patients with hypertension than those without, suggesting modest success of clinical and public health efforts to decrease sodium consumption. Lower education and income level were identified as two challenges to decreasing sodium consumption. Those with a higher education level were associated with greater ability to read and understand food labels. Those with higher income are allowed more choices of lower sodium foods. This is important because some of the challenges to restricting sodium intake that were identified include requiring careful label reading and food preparation as well as financial limitations when purchasing food. This study also showed that overall dietary potassium intake in persons with HF was low and intake of potassium did not differ according to diuretic therapy. Calcium intake was also observed to be inadequate (Lemon et al., 2009).

Micronutrients

Other micronutrients that may be altered as a result of HF include potassium, calcium, magnesium, and thiamin. Patients with HF are at a higher risk for osteoporosis due to low activity levels, impaired renal function, and prescription drugs that can alter calcium metabolism. Supplementation of calcium must be carefully monitored because it can aggravate heart arrhythmias. Supplementing vitamin D not only enhances calcium absorption but has been shown to improve inflammation in HF patients. Magnesium and thiamin deficiencies are not uncommon in patients with HF partially due to poor dietary intake and the use of diuretics. As with potassium, the diuretics used to treat HF also increase the excretion of magnesium and thiamin (Ahmed et al., 2007).

Potassium is of concern in HF because low serum potassium has been shown to increase disease progression and increase all-cause mortality in those with HF (Ahmed et

al., 2007). Changes in serum potassium due to associated medications can occur due to changes in renal clearance and the amount of aldosterone, renin-angiotensin, and catecholamine secreted. In addition to the use of loop or thiazide diuretics for treatment of HF, deficiency in potassium can also occur in those with HF as a result of poor diet, anorexia, and secretion (Ahmed et al., 2007). Depending on therapy and comorbid conditions, such as renal failure, recommendations for patients with HF regarding potassium intake vary considerably. Therefore, it is difficult to establish a universal goal and potassium levels should be closely monitored by physicians and other healthcare team members in order to make individualized potassium recommendations (Lemon et al. 2009).

Calcium and magnesium are nutrients of concern for HF patients not only because of increased urinary excretion of both nutrients as a result of loop and/or thiazide diuretics in treatments for HF, but because adequate intakes of both nutrients are essential for optimal cardiac function (Lemon et al., 2009). Dietary calcium is implicated for its beneficial role in maintaining electrolyte balance for optimal heart contractibility and rhythm as well as measures of BP (Lemon et al., 2009; Reusser & McCarron, 2006). Calcium can also directly inhibit renal sodium reabsorption and/or lower the activity of the renin-angiotensin system so that it benefits hypertension, one of the leading causes of HF (Lemon et al., 2009; Zemel, Richards, Milstead, & Campbell, 2005). Magnesium primarily influences cardiovascular, neuromuscular, and renal tissues (Lemon et al., 2009; Witte & Clark, 2006). A deficiency in magnesium can further complicate the management of HF, leading to increased sodium retention, decreased potassium uptake as well as affect intracellular concentrations of calcium (Lemon et al., 2009).

Sodium Restriction

Chronic hypertension is a leading cause of HF and sodium restriction continues to be a recommended treatment for managing the symptoms of HF. The thought is that a reduction in intake of salt and foods that contain large amounts of sodium can create changes in food patterns and therefore, alter consumption of other nutrients (Korhonen, Jarvinen, Sarkkinen, & Uusitupa, 2000; Morris, 1997). A reduction in sodium intake has been attributed to decreased intakes of meat, including fish and poultry, as well as grains and dairy products (Morris, 1997), which has been suggested to lead to reductions in iron, magnesium, calcium, and vitamin B-6 (Korhonen et al., 2000). One study conducted in Finland gave participants oral and written instructions on how to reduce their daily salt (sodium chloride) intake to 5 gm per day, which is approximately 2 gm of sodium per day. Participants were advised to reduce their sodium intake by 50% while maintaining as normal a diet as possible. They received free low sodium bread for the duration of the salt-restricted period and were asked to flavor their food with lemon, pepper, herbs, spices, onions, and garlic. Participants were also asked to avoid pickled or smoked meat and vegetable products, as well as choose low sodium versions of cereals and dairy products. During this study sodium intakes were significantly reduced without significant changes to other nutrient intakes. Despite sodium intakes being significantly reduced, minor changes in intakes of other nutrients could be attributed to only moderate compliance of participants with sodium-restricted diet. Only 1 in 5 men and 1 in 3 women achieved a dietary intake of salt less than 5 gm per day. A correlation between energy intake and dietary sodium was observed during this study. A significant decrease in energy intake as the study progressed in the group with the greater decrease in dietary

sodium indicated that salt restriction and energy intake influenced each other (Korhonen et al., 2000). Korhonen et al. (2000) concluded that salt restriction is possible in free-living hypertensive individuals without causing deleterious effects regarding consumption of other nutrients. Therefore, compliance with salt restriction should focus on the reduction of added salt to foods and eliminating foods with high sodium content.

Dietary Education

The primary objective of a pilot study conducted by Philipson, Ekman, Swedberg and Schaufelberger (2010) was to evaluate if dietary restriction instructions and recommendations were effective in reducing sodium and fluid intake in patients with HF and as a secondary objective, if such reductions affect quality of life, thirst, and appetite. The study was conducted over 12 weeks with an intervention and control group. The intervention group (n=17) followed a sodium restricted diet (2-3 gm/day) and fluid restriction (1.5 L/day) and the control group (n=13) received general diet information for HF. The intervention group received information and customized dietary counseling from a dietitian or specially trained nurse on how to reduce sodium intake and restrict fluids. The importance of maintaining constant energy intake was emphasized and recommendations to reduce sodium intake included avoiding using salt when boiling rice, pasta, and potatoes and removing any type of salt from the table as well as using spices and herbs to flavor fish and meat dishes. It was also recommended to avoid foods high in sodium, such as processed and smoked meats, canned ingredients, fast food, and ready-made meals. The dietitian or specially trained nurse worked together with patients to develop a plan for fluid restriction. Participants were contacted by telephone every 2 to 3 weeks and 24-hour diet recalls were used to follow patients' adherence to dietary

recommendations, discuss sodium and fluid intake, and make further recommendations on how to limit sodium and fluid if needed. Urine sodium was monitored to evaluate reductions in sodium and water intake, reductions of at least 25% or less than 90 mmol/L were considered significant. Fifty-seven percent and 25% of patients in the intervention and control group reduced sodium excretion in their urine significantly by 25% or more, respectively. The authors were able to conclude that the participants in this study with stable HF were able to reduce intake of sodium and fluid by following instructions given by a dietitian or specially trained nurse without negatively affecting quality of life (Philipson et al., 2010).

Readmission among Patients Hospitalized for Heart Failure

Ross et al. (2008) examined how patient characteristics, hospital features, process of care, and clinical outcomes related to the risk for readmission among a large and diverse group of patients treated for HF. Approximately 21% of 42,731 patients admitted for HF in New York State during 1995 were readmitted with the same diagnosis within an average period of 6.9 months after their first discharge. This study showed that a simple and convenient scoring system could be calculated based on administrative data at time of discharge and used to estimate a patient's risk of readmission. There was some variation in hospital readmission that could not be explained using the statistical models developed in this study. Patient characteristics including black race, Medicare and Medicaid insurance, ischemic heart disease, idiopathic cardiomyopathy, prior cardiac surgery, peripheral vascular disease, renal disease, DM, and anemia were related to a greater risk of readmission. However, patients undergoing echocardiography, exercise

stress testing, cardiac catheterization, coronary revascularization or any cardiac surgical procedure were more likely not to be readmitted (Ross et al., 2008).

Predictors of Readmission

Low sodium diet

Though the practice of restricting sodium intake has been standard procedure in the medical establishment for many years, the link between sodium intake and cardiac events has not been confirmed. It has been shown that sodium intake does not increase total body storage but does cause relative shifts of fluid from the interstitial to cardiovascular space. In fact, Paterna et al. (2008) assessed the outcome of different doses of sodium intake in medically treated patients with compensated HF and observed significant reductions in readmissions among patients consuming a normal sodium diet. Compensated HF patients who received the same treatment during hospitalization were randomized 30 days after discharge to consume a normal-sodium or low sodium diet. In this study, a normal sodium diet was 120 mmol of sodium, approximately 2.8 gm of sodium per day. Only nine patients receiving the normal sodium diet were readmitted during the 180 day follow up period compared to 30 patients in the low sodium diet group. This study observed that a normal sodium diet with a limited fluid intake of 1,000 ml per day in conjunction with a loop diuretic had lower incidence of rehospitalization and decreases in neurohormonal activation, represented by significant decreases in plasma brain natriuretic peptide, aldosterone levels, and plasma renin activity (PRA). Not only did the normal sodium group have less incidence of readmission and suppression of neurohormonal activation, the low sodium group had significant increases in aldosterone and PRA during follow up. After 180 days, aldosterone levels and PRA were

significantly higher in the low sodium group than the normal sodium group. This study suggests that while a normal sodium diet improves outcomes, sodium depletion has detrimental renal and neurohomonal effects which can exacerbate compensated HF patients and worsen clinical outcomes. Further studies are needed to determine if this is due to the low sodium diet or to a high dose of diuretic in conjunction with a sodium restricted diet (Paterna et al., 2008).

N-Terminal-Pro-Brain Natriuretic Peptide

Diagnosis of HF is primarily based on clinical evaluation and echocardiographic measure of left ventricular systolic function. Biochemical substances such as brain natriuretic peptide (BNP) and N-terminal-pro-brain natriuretic peptide (NT-proBNP) have been suggested as alternative markers for HF. The NT-proBNP has greater stability and therefore, has advantages over BNP. Concentrations of both BNP and NT-proBNP are indicative of left ventricular filling pressure and wall stress (Groenning et al., 2004). However, because NT-proBNP likely reflects myocardial wall tension it also may identify other cardiac pathologies characterized by increased wall stress in addition to a reduced left ventricle ejection fraction (LVEF) (Bay et al., 2003).

Bay et al. (2003) also showed an age-related increase in NT-proBNP concentrations with increasing age across three different intervals of LVEF. Increases in NT-proBNP were not significant for sex or serum creatinine. Furthermore, the results suggest that a patient with a measured value of NT-proBNP below that predicted, after correction for age, sex, and serum creatinine, has a 97% certainty of having an LVEF higher than 40%. Therefore, Bay et al. (2003) concluded that a single measurement of

NT-proBNP at the time of hospital admission can provide important information about LVEF.

Bettencourt et al. (2004) observed that 182 patients consecutively admitted to the hospital due to decompensated HF had variations in NT-proBNP levels that were related to hospital readmission and death within six months. During a six month follow up period, primary end points of readmission and death were observed in 42.9% of HF patients, 26% expired. Variation in NT-proBNP was the strongest predictor of an adverse outcome. Therefore, this study determined that NT-proBNP levels may potentially be useful when evaluating the efficacy of treatment of HF as well as when clinicians are planning discharge of HF patients. Additional variables associated with increased risk for death or readmission included length of hospitalization, heart rate, volume overload, no use of ACE inhibitors, and higher NYHA class at discharge. Volume overload and NT-proBNP levels were the only independent variables associated with an increased risk of readmission or death. In fact, patients with a greater than or equal to 30% increase in NT-proBNP during the course of their hospitalization had the most adverse prognosis. This suggests NT-proBNP could be used as an indicator of the efficacy of therapy because neurohormonal deactivation in patients with HF was associated with better outcomes than patients who maintained activation of the system. Increases in neurohormone levels indicate progression of the disease (Bettencourt et al., 2004).

Medical and Socioenvironmental Factors

Patients with HF are frequently readmitted to the hospital with rates that have been reported to be as high as 30% to 50%. Therefore, several studies have aimed to investigate risk factors and identify HF patients at a higher risk for readmission. Several

associations have been identified in previous studies between advanced age, prior hospital admission, severity of illness and medical comorbidities, and readmission in patients with HF. Few studies have focused primarily on characteristics such as occupation, financial resources, home living situation, social support, and follow up visits. One study (Tsuchihashi et al., 2001) suggested interventions to decrease readmission rates should also target social management of HF patients based on the results of their investigation. This study not only investigated medical characteristics that predicted risk of readmission post discharge, but socioenvironmental factors that were possible strong predictors for HF readmission. Heart failure patients with occupations were less likely to be readmitted and not having an occupation was also determined to be an independent predictor of increased risk for readmission. The implications of this study indicate that hospital readmission is caused by the interplay between medical and social factors in the patient, family, and caregivers and the importance of effective discharge planning and education to establish post discharge social support and medical follow up (Tsuchihashi et al., 2001).

CHAPTER III

METHODOLOGY

Purpose of Study

The primary objective of this retrospective study was to investigate the effect of low sodium diet education in the prevention of hospital readmission for patients admitted to Magnolia Regional Health Center with a primary or secondary diagnosis of HF based on rate of any-cause readmission up to 30 and 45 days post discharge. Sex, age in years, race, BMI level, and living status were collected as these characteristics have been associated with risk for incidence of HF. Serum sodium and NT-proBNP levels at discharge were also collected because volume overload and NT-proBNP levels were identified in the literature as independent variables associated with increased risk of readmission or death in HF patients (Bettencourt et al., 2004). The secondary objective of this study was to investigate the ability of age, BMI level, serum sodium level, NT-proBNP level, and low sodium diet education to predict readmission among patients hospitalized for HF within 30 and 45 days post discharge.

Research Questions

The following four research questions were investigated: (1) Will there be a difference in the incidence of readmission up to 30 days post discharge among patients admitted with a primary or secondary diagnosis of HF who received low sodium diet

education and those that did not? (2) Will there be a difference in the incidence of readmission up to 45 days post discharge among patients admitted with a primary or secondary diagnosis of HF who received low sodium diet education and those that did not? (3) Are there differences in age, sex, race, living status, BMI, serum sodium levels, and NT-proBNP levels between participants readmitted within 30 and 45 days and those not readmitted? (4) Can age, sex, race, living status, BMI level, serum sodium level, NT-proBNP level, or low sodium diet education predict the likelihood of hospital readmission among patients admitted with a primary or secondary diagnosis of HF up to 30 and 45 days post discharge?

Participants

The participants for this study consisted of inpatients at Magnolia Regional Health Center who were admitted with a primary or secondary diagnosis of HF. All participants were identified within 24 hours of admission through the nutrition screening process initiated by nursing staff and completed by the Food and Nutrition Service Department at Magnolia Regional Health Center. Magnolia Regional Health Center is located at 611 Alcorn Drive, Corinth, Mississippi.

Institutional Review Board Approval

Project approval was obtained prior to starting this study from the Institutional Review Board (IRB) through the Mississippi State University Regulatory Compliance Office, Mississippi State, Mississippi (Appendix A). All data collection occurred at Magnolia Regional Health Center in Corinth, Mississippi. Approval and permission for this study to be conducted at Magnolia Regional Health Center was obtained from their

Medical Executive Committee contingent on approval from the IRB of Mississippi State University. All ethical and HIPAA guidelines pertaining to the use of healthcare information were adhered to in this study.

Procedure

It is current policy at Magnolia Regional Health Center for a clinical dietitian to conduct a low sodium diet education session with patients who are admitted to the hospital with a primary or secondary diagnosis of HF, and whose diet order indicates sodium restriction. This study focused exclusively on participants who were inpatients and admitted with a primary or secondary diagnosis of HF. Patients admitted to Magnolia Regional Health Center with a primary or secondary diagnosis of HF whose diet order indicated sodium restriction received nutrition education and counseling on a dietary sodium restriction of 2 gm per day. All education sessions included written client education materials for low sodium medical nutrition therapy provided by the Academy of Nutrition and Dietetics Nutrition Care Manual (Academy of Nutrition and Dietetics, 2012).

The staff that provided diet education consisted of four clinical registered dietitians. All education sessions were conducted individually in the patient's hospital room with or without a family member and/or caretaker present. Education included basic nutrition information, foods recommended and not recommended for consumption on a low sodium diet, instruction on the nutrition facts label to determine sodium content of foods as well as customized application of recommendations based on patient preferences and lifestyle factors. Specifically, foods and food groups known to have high sodium content were identified and patients were advised to limit and/or avoid these

foods. Patients were also instructed on how to interpret a nutrition facts label to select foods lower in sodium and therefore, fit within their 2 gm daily sodium restriction. Recommendations for avoiding excess use of salt and/or sodium consumption and alternative methods for flavoring food with minimal or no salt were suggested, as well as strategies for reducing current sodium consumption specific to each patient. Patients are encouraged to ask questions about any of the topics discussed, or other questions about managing their daily dietary sodium restriction. Written materials used during education sessions and the dietitian's contact information are then left in the room for patients, their family, and/or caretaker to take home. A summary of each patient's education is then documented in the electronic medical record by the dietitian who completed the education.

Data Collection

Weight, height, sex, race, age in years, living status, serum sodium, NT-proBNP levels, and documentation of low sodium diet education were entered onto an Excel spreadsheet (Microsoft Corp., 2007, Redmond, WA) using information from patients' electronic medical records. No personal information or identifiers were used or recorded. Patients were selected for this study if they had a primary or secondary diagnosis of HF upon admission into the hospital. The BMI of each patient was calculated using the equation BMI = kg/m^2. Serum sodium and NT-proBNP levels were analyzed in the hospital's laboratory and recorded in the individual's medical record during the patient's hospitalization. The last recorded serum sodium and NT-proBNP laboratory values were used for the purpose of this study as laboratory levels were not consistently collected and analyzed on the same day during a patient's course of treatment.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences software, version 20 (SPSS, Inc., Chicago, IL). Descriptive statistics summarized demographic, social, and laboratory values. Chi-square tests were performed to test for significant relationships between low sodium diet education and incidence of readmission up to 30 and 45 days post discharge from the hospital among patients with HF. Correlation coefficients were used to investigate relationships between variables. Independent t-tests were conducted to compare differences between those who were readmitted and those not readmitted for both 30 and 45 days post discharge for normally distributed data. The Mann-Whitney U test was used for data that did not exhibit normality.

Logistic regression was performed with the dichotomous categorical dependent variable of (1) not being readmitted and (2) being readmitted to the hospital within 30 days post discharge, and the independent variables of low sodium diet education, sex, age, race, living status, NT-proBNP, serum sodium, and BMI. Logistic regression was repeated for 45 days post discharge with the same variables. All available data were used for analysis. A control group, patients admitted with a primary or secondary diagnosis of HF and did not receive low sodium diet education, was available. The median values are reported for data exhibiting a non-normal distribution. Continuous variables are reported as means ± standard deviations (SD) for data with normal distributions. Significance was set at $P \leq 0.05$.

CHAPTER IV

RESULTS AND DISCUSSION

Abstract

Heart failure (HF) costs the United States billions of dollars in health care services and lost productivity each year. Readmission rates of HF patients are being used as an indicator of the quality and efficiency of care. Even though there is no consensus on the optimal level of dietary sodium restriction, a low sodium diet is a component of the accepted treatment for managing chronic HF. Non-compliance with dietary sodium and fluid restriction is among the most common precipitating factors of HF exacerbation. Analysis of the effect of low sodium diet education on hospital readmission at 30 and 45 days post discharge of patients (N=52) diagnosed with HF was conducted. Chi-square analysis determined that low sodium diet education did not affect re-admittance within 30 days ($\chi^2 = 2.142$, $P = .143$) or 45 days ($\chi^2 = 0.514$, $P = .474$). However, t-tests determined that patients readmitted within 30 days post discharge were older (P=.005). Men were more likely to be readmitted than women within 30 days (P=.021) and 45 days (P=.019). Higher NT-proBNP levels were also observed in individuals who were readmitted within 30 days (P = .011) and 45 days (P = .010). While low sodium diet education did not affect readmission, older age, male sex, and higher NT-proBNP values increased the rate of readmission.

Introduction

It is estimated that approximately 5.1 million Americans 20 years and older have heart failure (HF), also known as congestive heart failure (Go et al., 2013). It is estimated that by 2030 the prevalence of HF will increase by 25% and the cost of HF will increase to $77.7 billion compared to $24.7 billion in 2010 (Heidenriech et al., 2011). Heart failure is the most common diagnosis-related group (Masoudi et al., 2002) as well as the cause for hospital admission and readmission among Medicare patients (Jencks et al., 2009). More Medicare dollars are spent on the diagnosis and treatment of HF than for any other diagnosis (Masoudi et al., 2002). Readmission rates of patients with HF after hospital discharge are attracting considerable attention from the Institute of Medicine, Medicaid Services, and the Medicare Payment Advisory Commission as an indicator of the quality and efficiency of care (Ross et al., 2008).

In July 2009, The Centers for Medicare and Medicaid Services (CMS) began publicly reporting hospital readmission rates (CMS, 2009). Jencks et al. (2009) reported that 19.6% of Medicare beneficiaries were readmitted within 30 days of hospital discharge. Nearly $17.4 billion could be saved annually by preventing readmissions. Previously, hospitals were financially rewarded for readmissions. In an effort to reverse financial incentives, hospitals will be evaluated and differentiated payments will be generated on the basis of 30-day periods. Therefore, proposals to reduce hospital readmission have gained prominence in health care reform discussions. The 30-day readmission rates that the CMS publicly reports include acute myocardial infarction, congestive heart failure, and pneumonia (Jencks et al., 2009). The U.S. Senate Finance Committee policy option called for withholding up to 20% of a hospital's inpatient

payments on the basis of comparative readmission rates (U.S. Senate Finance Committee, 2009). Original U.S. House of Representatives' options called for penalties of up to 5% of hospital payments for facilities with higher-than-expected readmission rates (U.S. House of Representatives, 2009). However, little attention has been given to the potential for unintended consequences on hospitals serving vulnerable communities (Bhalla & Kalkut, 2010).

After age 65, the incidence of HF is close to 10 per 1000 population and 75% of those with HF have antecedent hypertension (Lloyd-Jones et al., 2002). One in nine deaths has HF mentioned on the death certificate. The number of any-mention deaths attributable to HF was almost as high in 2009 (275,000) as it was in 1995 (287,000) (Go et al., 2013). Survival after onset of HF has improved (Baker et al., 2006). Among Medicare beneficiaries, the overall 1-year mortality rate has declined slightly over the last decade; however, the death rate remains high (Chen et al., 2011).

After HF hospitalization, changes in survival may have changed the denominator of HF patients at risk for recurrent hospitalization. A relative decline of 29.5% from 1998 to 2008 was observed in the rate of hospitalization for HF adjusted for age, sex, and race. In all race-sex categories, age-adjusted HF hospitalization rates declined but at a slower rate for black men. A savings of $4.1 billion in fee-for-service Medicare can be attributed to this decline in rate of HF hospitalization (Chen et al., 2011).

Heart failure is when the heart cannot pump enough blood and oxygen to support the metabolic needs of the body (Parker et al., 2008) and is the result of any structural or functional disorder that affects the ability of the ventricle to fill or eject blood (Hunt et al., 2009; Wells et al., 2009). Typically, an index event such as an acute myocardial

infarction (MI) or chronic hypertension will result in a decrease in the pumping capacity of the heart leading to various compensatory responses to maintain adequate output (Parker et al., 2008). However, for a substantial proportion of the Western world, CAD and hypertension, and dilated cardiomyopathy are causes for HF (Francis & Pierpont, 1988). Although, nearly any form of heart disease may ultimately lead to the HF syndrome (Hunt et al., 2009). Initially, hemodynamic changes in HF patients were thought to lead to progression of the disease but more recent research indicates hemodynamic changes and neurohormonal activation are responsible for the progression of HF. Therefore, pharmacological and non-pharmacological treatments are aimed at maintaining hemodynamic homeostasis as well as decreasing neurohormonal activation (Hoyt & Bowling, 2001).

Heart failure is defined as a clinical syndrome, characterized by specific symptoms in the medical history and on physical examination of the patient. A single diagnostic test does not exist for HF. Cardinal manifestations of HF are fluid retention, pulmonary congestion, and/or peripheral edema (Hunt et al., 2009). Decreased blood flow through the organs, also known as hypovolemic shock, may occur in severe cases. Primary symptoms of HF include dyspnea and fatigue which can lead to exercise intolerance. Factors that may precipitate or exacerbate HF include negative changes in the way that the heart contracts, direct cardiotoxicity, and increases in sodium and/or fluid retention, resulting in symptoms associated with volume overload. What is evident is that many of the precipitating factors of HF are preventable (Parker et al., 2008).

Prevention is critical due to poor long-term survival rates of HF patients. Appropriate patient counseling should help to decrease the most common reasons for

exacerbation of HF: non-compliance with dietary sodium and fluid restrictions, drug therapy, or both (Parker et al., 2008). Primary prevention in the early stages of HF focuses on the aggressive treatment of underlying risk factors such as dyslipidemia, hypertension, and DM (Parker et al., 2008; Hunt et al., 2009). Lifestyle changes, including adopting a heart-healthy diet, weight maintenance, increased physical activity as tolerated as well as tobacco and alcohol cessation, in conjunction with pharmacotherapy treatment can optimize primary preventative strategies for HF (Parker et al., 2008).

Even though there is no consensus on the optimal level of dietary restriction of sodium, a low sodium diet is an accepted treatment for managing sodium and fluid retention in patients with acute and chronic HF (Parker et al., 2008). Optimally, recommendations for low sodium diets should be the least restrictive while still achieving desired outcomes. Adherence to dietary sodium restrictions can be problematic for patients with HF. However, nutrition counseling administered by a registered dietitian has resulted in a reduction in dietary sodium intake in patients with stable HF, which supports the dietitian's role as part of a multidisciplinary team that aims to help patients achieve and adhere to their sodium restricted diet (Arcand et al., 2005).

This study evaluated the effect of low sodium diet education in the prevention of hospital readmission among patients hospitalized for HF. The primary objective of this retrospective study was to investigate the difference between the prevalence of any-cause readmission up to 30 and 45 days post discharge when the patient was admitted with a diagnosis of HF for those that received low sodium diet education and those that did not. The secondary objective of this study was to investigate the ability of age, sex, race,

living status, BMI, serum sodium, NT-proBNP, and low sodium diet education to predict readmission among patients hospitalized for HF within 30 and 45 days post discharge.

Methods

Participants and Institutional Review Board Approval

The participants for this study consisted of those who were admitted with a primary or secondary diagnosis of HF. All participants were identified within 24 hours of admission through the nutrition screening process initiated by nursing staff and completed by the Food and Nutrition Service Department at a community hospital in northeast Mississippi. Approval for this research study was obtained from the hospital's Medical Executive Committee and was contingent on approval obtained from the university's Institutional Review Board for the Protection of Human Subjects prior to beginning the study. All ethical and HIPAA guidelines pertaining to the use of healthcare information were adhered to in this study.

Procedure

Low sodium diet education was conducted with patients who were admitted to the hospital with a primary or secondary diagnosis of HF whose diet order indicated a sodium restriction. These patients received nutrition education and counseling on a dietary sodium restriction of 2 gm per day. All education sessions included written client education materials for low sodium medical nutrition therapy provided by the Academy of Nutrition and Dietetics Nutrition Care Manual (Academy of Nutrition and Dietetics, 2012). Diet education was administered by one of four full-time clinical registered dietitians. All education sessions were conducted individually in the patient's hospital

room with or without a family member and/or caretaker present. Education sessions included basic nutrition information, foods recommended and not recommended for consumption on a low sodium diet, instruction on the nutrition facts label to determine sodium contents of foods, as well as customized recommendations based on patient preferences and lifestyle factors. Specifically, foods and food groups known to have high sodium content were identified and patients were advised to limit and avoid these foods.

Recommendations for avoiding excess use of salt and/or sodium consumption and alternative methods for flavoring food with minimal to no salt were suggested, as well as strategies for reducing current sodium consumption. Written materials used during the education session and the dietitian's contact information were left in the room for patients, their family, and/or caretaker to take home. A summary of each patient's education was documented in the patient's electronic medical record by the dietitian who completed the education session.

Research Questions

The purpose of this study was to investigate four research questions: (1) Will there be a difference in the incidence of readmission up to 30 days post discharge among patients admitted with a primary or secondary diagnosis of HF who received low sodium diet education and those that did not? (2) Will there be a difference in the incidence of readmission up to 45 days post discharge among patients admitted with a primary or secondary diagnosis of HF who received low sodium diet education and those that did not? (3) Are there differences in age, sex, race, living status, BMI, serum sodium levels, and NT-proBNP levels between participants readmitted within 30 and 45 days and those not readmitted? (4) Can age, sex, race, living status, BMI, serum sodium, NT-proBNP, or

low sodium diet education predict the likelihood of hospital readmission among patients admitted with a primary or secondary diagnosis of HF up to 30 and 45 days post discharge?

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences software, version 20 (SPSS, Inc., Chicago, IL). Descriptive statistics were used to summarize demographic, social, and laboratory values of participants. Chi-square tests were performed to test for significant relationships between low sodium diet education and incidence of readmission up to 30 and 45 days post discharge among patients with HF. Independent t-tests were used to compare differences between those who were readmitted and those not readmitted for both 30 days and 45 days post discharge for normally distributed data. Mann-Whitney U Tests were used for comparisons for data that did not exhibit normality. Correlation coefficients were examined to investigate relationships between variables. Logistic regression was performed with the dichotomous categorical dependent variable of (1) not being readmitted and (2) being readmitted to the hospital within 30 days post discharge, and the independent variables of low sodium diet education, sex, age, race, living status, NT-proBNP, serum sodium, age, and BMI. Logistic regression was repeated with the same variables for 45 days post discharge. All available data were used for analysis. A control group, patients admitted with a primary or secondary diagnosis of HF and did not receive low sodium diet education, was available. The median values are reported for data exhibiting a non-normal distribution. Continuous variables are reported as means ± standard deviations (SD) for data with normal distributions. Significance was set at $P \leq 0.05$.

Results

The study sample consisted of 52 participants. Demographical information indicated that over half of the participants were men (57.7%, n = 30) and 42.3% (n = 22) were women. Six participants were residents of assisted living to varying levels of care, while 46 were living on their own or with family. Most of the participants were Caucasian (n= 42) and the remainder were African American (n=10). The mean age of participants was 74.3 ± 13.0 years (Table 4.1). Only two participants were less than 50 years old, four were 50 to 59 years, five were 60 to 69 years, eight were 70 to 79 years, and 12 were 80 years and older. The mean weight was 89 ± 26.1 kg with a range of 46.4 to 159.3 kg. Height ranged from 152.4 to 187.96 cm with a mean of 172.1 ± 10.7 cm (Table 4.1).

The mean BMI was 30 kg/m^2, which according to the Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults indicates obesity (NHLBI, 1998). One participant was classified as underweight, 14 had normal BMI values, 14 were overweight, and 21 were classified as obese. Nine were Class I obese, six were class II obese, and six were class III with BMIs ranging from 41.2 to 66.2 kg/m^2 (Table 4.2).

The t-test determined that age was significantly different (P = .005) between those readmitted within 30 days and those not readmitted (Table 4.3). Those individuals that were readmitted within 30 days had a mean age of 81.5 ± 6.3 years and those not readmitted within 30 days had a mean age 72.6 ± 13.6 years. Age was not significant for those readmitted in 45 days (P > .05) (Table 4.4).

Chi-square analysis determined that men were more likely to be readmitted within 30 days compared to women ($\chi^2 = 5.295$, P = .021, Table 4.3). Nine men were readmitted within 30 days compared to only one woman. Similarly, men were more likely to be readmitted within 45 days compared to women ($\chi^2 = 6.163$, P = .013, Table 4.4). Twelve men were readmitted and only two women were readmitted within 45 days. There were no differences (P > .05) between races for individuals readmitted within 30 days and 45 days.

Thirty-seven of the 52 participants received low sodium diet education from a registered dietitian and 15 did not receive low sodium diet education. Chi-square analysis determined that low sodium diet education did not affect readmittance within 30 days ($\chi^2 = 2.142$, P = .143) or within 45 days ($\chi^2 = 0.514$, P = .474). Mean sodium and BMI levels were not significantly different between those readmitted and those not readmitted for 30 days or 45 days (P > .05). However, NT-proBNP values were higher for those readmitted within 30 days (P = .011, Table 4.3) and 45 days (P = .010, Table 4.4). A significant negative correlation was observed between age and BMI (r = -.421, P = .002). There was a trend for BMI to decrease as age increased.

Results from logistic regression indicated that sex (P = .041), age (P = .045), NT-proBNP (P = .045), and low sodium diet education (P = .030) were predictor variables for participants to be readmitted to the hospital within 30 days post discharge. Being male, older, and having higher NT-proBNP levels showed higher rates of being readmitted to the hospital within 30 days post discharge. Low sodium diet education was a predictor variable in the regression model; however, those results should be interpreted cautiously as there was only one individual in the 30 day re-admittance group who did not receive

low sodium diet education while there were nine individuals who received diet education and were readmitted. For the 45 day re-admittance, the only significant predictor variables were male sex (P = .018) and living status (P = .046). Men and free living individuals were more likely to be readmitted 45 days post discharge than women and residents in assisted living facilities.

Discussion

Participants readmitted within 30 days were significantly older than those not readmitted and men were more likely than women to be readmitted within 30 and 45 days. Krumholz et al. (1997) aimed to identify patient and hospital characteristics associated with a higher likelihood of readmission for elderly patients discharged after an episode of HF and observed the male sex to be a significant predictor of readmission. However, the study did not find age to be a significant predictor of readmission. Readmission among those 65 years of age or older with a principle discharge diagnosis of HF included prior admission within one year, having diabetes, and a creatinine level greater than 2.5 mg/dl at discharge (Krumholz et al., 1997).

The mean NT-proBNP level in the present study was significantly higher in those readmitted and those not readmitted for 30 or 45 days (P < .05). Bettencourt et al. (2004) evaluated the value of NT-proBNP levels in predicting death or hospital readmission after discharge of HF patients. Analysis of variables such as length of stay, heart rate, indicators of volume overload, no use of ACE inhibitors, higher NYHA class at discharge, and variation in levels of NT-proBNP were used to identify variables associated with an increased hazard of death and/or hospital readmission. Variation in levels of NT-proBNP was the strongest predictor of an adverse outcome. Variables

associated with an increased risk of readmission or death were signs of volume overload and changes in NT-proBNP levels. The median NT-proBNP value was 4137 pg/ml at discharge (Bettencourt et al., 2004). The present study observed a similar median discharge NT-proBNP value of 4280 pg/ml (Table 4.1). The NT-proBNP values for those readmitted and those not readmitted differed greatly and values were higher in those readmitted (Tables 4.3 and 4.4). Van Kimmenade et al. (2006) reported participants with HF and diagnostically elevated NT-proBNP levels had the highest mortality rates in their international multicenter study of 1256 dyspneic patients.

Hallerbach et al. (2011) assessed medical, socioeconomic, and demographic predictors of hospital readmission in patients with HF and five variables were identified as possible predictors for readmission using logistic regression analysis. Four of five variables were observed to be significant independent predictors of hospital readmission in patients with HF. These were previous admission for HF, no occupation, longer hospital stay, and hypertension (Hallerbach et al., 2011). This research supports the importance of medical and socioenvironmental factors in deterioration of HF; therefore, interventions to decrease readmission should also target social management in all hospitalized patients.

Hallerbach et al. (2011) also aimed to determine if there were specific characteristics common to HF patients readmitted within 30 days. They indicated that half of all patients readmitted for HF exacerbation were incorrectly labeled, raising doubt about reliance on administrative data alone to determine overall quality performance. Also, 45% of all patients readmitted had underlying chronic renal insufficiency/chronic

renal failure compared to 26% of HF patients who were not readmitted within 30 days (Hallerbach et al., 2011).

The present study observed that low sodium diet education did not affect the rate of readmission when comparing participants who were readmitted and those not readmitted. Improvements in pharmacological and non-pharmocological treatment in HF patients has made the HF therapeutic regimen complex. Non-compliance with medication and other lifestyle recommendations is a recognized problem in patients with HF, which can result in worsening of HF symptoms, sometimes leading to hospitalization. However, evidence based interventions to improve compliance in patients with HF are scarce (Van der Wal, Jaarsma, & Van Veldhuisen, 2005). Expert opinion and research support dietary sodium restrictions as an accepted treatment for managing sodium and fluid retention in patients with acute and chronic HF (Meadows & Johnson, 2002). The current guidelines of the AHA/ACC states that for management of HF, dietary sodium intake of 2 gm or less per day can assist in the maintenance of volume balance (Hunt et al., 2009).

A negative correlation between BMI and age was identified among participants in this study. BMI was also observed to be independently associated with age among males in northeast India by Mungreiphy, Kapoor, and Sinha (2011). Participants were divided into those 20-29 yr, 30-39 yr, 40-49 yr, 50-59 yr, and 60-70 yr with mean BMI (kg/m^2) of 20.1±1.78, 21.3±1.93, 22.3±2.62, 9±3.20, and 20.3±2.37, respectively. Body weight increased until the age of 49 and decreased thereafter but difference between age groups was statistically significant between all age groups except for 40-49 yr and 50-59 yr age groups (Mungreiphy et al., 2011). Studies by Pavlovic, Milkovic-Kraus, Jovanovic, and

Hercigonja-Szekeres (2012) and Guo, Zeller, Chumlea, and Siervogel (1999) also support age related decreases in BMI.

Although the logistic regression model showed that low sodium diet education was a predictor variable for 30 day readmission, it should be noted that only one individual in the 30 day re-admittance group did not receive low sodium diet education while there were nine individuals who received diet education. Hummel, DeFranco, Skorcz, Montoye, and Koelling (2009) had a large sample of 1700 patient admissions and determined using logistic regression that a documented sodium restricted diet recommendation for HF patients with preserved systolic function significantly decreased the odds of 30 day combined death and readmission. They concluded that selected HF patients who received advice for sodium restricted diets may have improved short-term outcomes after hospital discharge (Hummel et al., 2009).

Limitations

There are limitations that should be noted in the present study. This study was conducted with a small sample size in a single acute care facility located in the southern region of the United States; therefore, findings are not reflective of the entire United States population. Also, participants for this study were selected based on a primary or secondary admitting diagnosis of HF per the hospital nutrition screening policy and a patient's discharge diagnosis may have differed from the admitting diagnosis. Therefore, admitting diagnosis may not be the most accurate way to identify this patient subset for intervention within the acute care setting. Additionally, this study addressed instances of readmission based on the occurrence of previous low sodium diet education. Compliance to a low sodium diet was not measured. Future research may also investigate differences

in knowledge, beliefs, and behaviors regarding sodium consumption pre- and post-education. Recommendations for HF patients regarding dietary sodium intake are based on general consensus and not conclusive scientific evidence; therefore, further research is also needed regarding the effect of restricted dietary sodium consumption on clinical outcomes in HF patients.

Implications

The results of this study indicated that low sodium diet education had no effect on the likelihood of any-cause readmission within 30 or 45 days post discharge from the hospital. However, this study did find that men were more likely than women for readmission within 30 and 45 days of discharge from a hospitalization in which they were admitted for HF. Also, the average age of participants who were readmitted within 30 or 45 days of discharge was significantly different. Those readmitted were older than those not readmitted.

This study suggests that inpatient low sodium diet education is not an effective intervention for reducing any-cause hospital readmission among HF patients. Further research may be needed to establish evidence based recommendations beyond current general consensus regarding dietary sodium consumption for the nutritional management of HF. Dietitians may need to readdress interventions in this patient population. For example, poor intake and appetite, loss of lean body mass masked by fluid fluctuations and shortness of breath are common manifestations of HF that threaten the nutrition status of patients with HF. Perhaps dietitians should focus primarily on improving the typically poor nutritional status of the HF patient population prior to discharge.

Future research should investigate relationships between indicators of nutrition status in hospitalized HF patients at various points in time throughout their hospitalization and readmission rates. This can be challenging considering one of the hallmarks of nutrition status is weight, and significant weight losses are often masked by significant gain in fluid for patients with HF. Further research is also required to develop evidence based multidisciplinary interventions to prevent readmission in this patient population as there are various medical and socioenvironmental factors in addition to dietary sodium intake that contribute to hospital readmissions for HF patients (Tsuchihashi et al., 2001).

Table 4.1 Characteristics of Participants

Characteristic	Participants (N=52)
Age (yrs)	74.3 ± 13.0 (43-93)[a]
Weight (kg)	89 ± 26.1 (46.4-159.3)
Height (cm)	171.8 ± 10.9 (152.4-188.0)
BMI[b] (kg/m^2)	30 ± 9 (16-66.2)
Serum Sodium (mmol/L)	139.1 ± 5.1 (123-152)
NT-proBNP (pg/mL) (n=50)	4280[c] (189-57600)
Sex	30 men 22 women
Race	10 African Americans 42 Caucasians

[a]Mean ± standard deviation (range)
[b]Body mass index
[c]Median (range) is reported for this value due to a non-normal distribution

Table 4.2 Body Mass Index Classification of Participants

BMI[a] Category	Men (n=30)	Women (n=22)
Underweight Less than 18.5	0	1 Caucasian
Normal 18.5-24.9	1 African Americans 5 Caucasians	2 African Americans 8 Caucasians
Overweight 25.0-29.9	2 African Americans 8 Caucasians	4 Caucasian
Class I Obesity 30.0-34.9	1 African American 7 Caucasians	1 Caucasian
Class II Obesity 35.0-39.9	1 African American 3 Caucasians	2 Caucasians
Class III Obesity 40 or higher	1 African American 1 Caucasian	2 African Americans 2 Caucasians

[a]Body mass index, calculated as kg/m^2

Table 4.3 Results comparing participants not readmitted and those readmitted within 30 days post discharge.

Variables	Not readmitted within 30 days post discharge (n=42)	Readmitted within 30 days post discharge (n=10)	P value
Age (yrs)	72.6 ± 13.6 (43-93)[a]	81.5 ± 6.3 (74-91)	.005*
BMI[b]	30.6 ± 9.8 (16.0-66.16)	27.6 ± 4.4 ((19.9-35.4)	.348
Serum sodium (mmol/L)	139.0 ± 5.5 (123-152)	139.1 ± 3.4 (131-143)	.977
NT-proBNP (pg/mL)	3380[c] (189-57600) (n=41)	11100 (663-22200) (n=9)	.011*
Received low sodium diet education	14 no[d] 28 yes	1 no 9 yes	.143
Sex	21 men 21 women	9 men 1 woman	.021*
Race	8 African Americans 34 Caucasians	2 African Americans 8 Caucasians	.945
Living status	4 assisted living 38 free living	2 assisted living 8 free living	.351

[a]Continuous data compared by compared by Independent t-tests for normally distributed data and Mann-Whitney U Tests for non-normal data
[b]Body mass index, calculated as kg/m^2
[c]Median (range) reported for this variable due to a non-normal distribution
[d]Categorical data compared by chi-square tests
*Significant difference between the two groups (P<.05)

Table 4.4 Results comparing participants not readmitted and those readmitted within 45 days post discharge.

Variables	Not readmitted within 45 days post discharge (n=38)	Readmitted within 45 days post discharge (n=14)	P value
Age (yrs)	73.6 ± 13.2 (43-93)[a]	76.4 ± 12.5 (47-91)	.487
BMI[b]	31.0 ± 9.9 (18.5-66.16)	27.2 ± 5.6 (16.0-36.6)	.174
Serum sodium (mmol/L)	139.1 ± 5.7 (123-152)	139.0 ± 3.0 (131-143)	.961
NT-proBNP (pg/mL)	3190[c] (189-57600) (n=37)	10400 (663-22200) (n=13)	.010*
Received low sodium diet education	12 no[d] 26 yes	3 no 11 yes	.474
Sex	18 men 20 women	12 men 2 women	.013*
Race	7 African Americans 31 Caucasians	3 African Americans 11 Caucasians	.807
Living status	3 assisted living 35 free living	3 assisted living 11 free living	.175

[a]Continuous data compared by Independent t-tests for normally distributed data and Mann-Whitney U Tests for non-normal data
[b]Body mass index, calculated as kg/m^2
[c]Median (range) reported for this variable due to a non-normal distribution
[d]Categorical data compared by chi-square tests
*Significant difference between the two groups ($P<.05$)

CHAPTER V

CONCLUSION

The purpose of this study was to evaluate the effect of low sodium diet education in the prevention of hospital readmission among patients hospitalized for HF. Additional information regarding age, sex, race, living status, BMI level, serum sodium level, NT-proBNP level, and low sodium diet education were collected during each participant's hospitalization to investigate the ability of these variables to predict readmission among patients hospitalized for HF within 30 and 45 days post discharge. The participants for this study consisted of those admitted to the hospital with a primary or secondary diagnosis of HF.

This study indicated that low sodium diet education did not have an effect on the likelihood of readmission within 30 or 45 days post discharge from the hospital. However, men were more likely than women for readmission within 30 and 45 days of discharge from a hospitalization in which they were admitted for HF. Also, the mean age of those readmitted was higher than those not readmitted.

This study suggested that inpatient low sodium diet education was not an effective intervention for reducing any-cause hospital readmission among HF patients. Nutrition counseling administered by a registered dietitian has resulted in a reduction in dietary sodium intake in patients with stable HF, which supports the dietitian's role to aid patients with adherence to sodium restricted diets (Arcand et al., 2005). Therefore, further

research is needed to establish evidence based recommendations beyond current general consensus regarding dietary sodium consumption for the nutritional management of HF.

Based on this study, dietitians may need to readdress interventions in this patient population. For example, poor intake and appetite, loss of lean body mass masked by fluid fluctuations, and shortness of breath are common manifestations of HF that threaten the nutritional status of patients with HF. Dietitians should focus primarily on improving nutritional status of a HF patient prior to discharge and diet education. Future research should investigate relationships between indicators of nutrition status, such as food intake, weight history, and loss of lean body mass and readmission rates in patients with HF in order to identify patients most at risk for readmission. This can be challenging considering one of the hallmarks of nutrition status is weight, and significant weight losses are often masked by significant gains in fluid for patients with HF. Further research is also required to develop evidence based multidisciplinary interventions to prevent readmission in this patient population as there are various medical and socioenvironmental factors, in addition to dietary sodium intake that contribute to hospital readmissions for HF patients (Tsuchihashi et al., 2001).

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APPENDIX A

MISSISSIPPI STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD APPROVAL

August 7, 2012

Lindsey Doxtater
FSN&HP
Mail Stop 9805
MS State, MS

RE: IRB Study #12-245: The Effect of Low-Sodium Diet Education in the Prevention of Hospital Readmission for Congestive Heart Failure

Dear Ms. Doxtater:

This email serves as official documentation that the above referenced project was reviewed and approved via administrative review on 8/7/2012 in accordance with 45 CFR 46.101(b)(4). Continuing review is not necessary for this project. However, any modification to the project must be reviewed and approved by the IRB prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project. The IRB reserves the right, at anytime during the project period, to observe you and the additional researchers on this project.

Please note that the MSU IRB is in the process of seeking accreditation for our human subjects protection program. As a result o! f these efforts, you will likely notice many changes in the IRB's policies and procedures in the coming months. These changes will be posted online at http://www.orc.msstate.edu/human/aahrpp.php.

Please refer to your IRB number (#12-245) when contacting our office regarding this application.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact me at cwilliams@research.msstate.edu or call 662-325-5220.

In addition, we would greatly appreciate your feedback on the IRB approval process. Please take a few minutes to complete our survey at http://www.surveymonkey.com/s/YZC7QQD.

Sincerely,

Christine Williams, MPPA, CIP
IRB Compliance Administrator

cc: Tidwell, Diane