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**Proportion of Heart Failure Patients who Meet Criteria for
Malnutrition upon Hospital Admission Based on ASPEN
Guidelines**

By

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A THESIS

Presented to the Faculty of
the University of Nebraska Medical Center Graduate College
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Advisory Committee: Ann Anderson-Berry Raquel Thomas Glenda Woscyna

DEDICATION

I dedicate my thesis work to my parents, Mark and Deb Johnson. Thank you for your commitment to my education, unconditional love and support, and for encouraging me to pursue my goals.

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I wish to thank my committee members for giving their time, knowledge, and expertise to support my work. Thank you Corri, Ann, Raquel, and Glenda

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ABSTRACT

Background: Current research estimates that approximately 50 percent of heart failure patients are categorized as malnourished. Heart failure patients are at increased risk of malnourishment due to increased catabolic processes that increase resting energy expenditure, decrease appetite, impair nutrient absorption, and lead to unintentional weight loss. The goal of standardized diagnostic criteria is to identify malnutrition early for more effective treatment. Current studies suggest the association of early diagnosis and nutrition intervention with increased positive patient outcomes and improved quality of life for heart failure (HF) patients. However, the proportion of patients with HF who meet criteria for malnutrition at Nebraska Medicine is unknown.

Purpose: The purpose of this study was to determine the proportion of patients with a diagnosis of HF who met criteria for malnutrition upon admission at Nebraska Medicine based on the American Society for Parenteral and Enteral Nutrition (ASPEN) guidelines. The secondary aim was to identify if patient characteristics are associated with a diagnosis of malnutrition based on ASPEN guidelines.

Methods: A retrospective chart review was conducted of 100 patients flagged with the core measure of heart failure upon admission. The patients were divided into two groups based on ASPEN guidelines for malnutrition; malnourished (meeting ≥ 2 criteria) and non-malnourished (meeting < 2 criteria). Clinical patient characteristics were collected to determine if significant differences between the groups exist.

Results: Out of 100 study participants, 39 percent of participants were categorized as malnourished by ASPEN criteria. When assessing the criteria for malnutrition, the largest

percentage of patients met diagnosis due to decreased functional status and fluid accumulation with 85 percent and 69 percent respectively. There were a larger percentage of females in the malnourished group as compared to the non-malnourished group (46% vs 26% respectively, $p=0.04$). Nutrition status was significantly different between the groups with COPD; with 18 percent in the malnourished group, and 43 percent in the non-malnourished group ($p=0.01$).

Conclusion: Our study reports, 39 percent of heart failure patients are found to be malnourished upon admission at Nebraska Medicine. Based on our results females are more likely malnourished than males and those diagnosed with COPD were less likely to be malnourished.

LIST OF ABBREVIATIONS

ACCF- American College of Cardiology Foundation

AHA- American Heart Association

ASPEN- American Society for Parenteral and Enteral Nutrition

BMI- Body Mass Index

COPD- Chronic Obstructive Pulmonary Disease

NYHA- New York Heart Association

RAA- Renin-Angiotensin-Aldosterone

TNF- Tumor Necrosis Factor

INTRODUCTION

Heart failure occurs when the heart cannot pump enough blood and oxygen to support the organs of the body. Patients with heart failure are at increased risk of malnourishment due to increased catabolic processes that increase resting energy expenditure, decrease appetite, impair nutrient absorption and can lead to rapid unintentional weight loss.³ From current research it is estimated that as many as 50% of heart failure patients are categorized to some degree as malnourished.⁴ Malnutrition has been linked to decreased functional status and quality of life, and increased morbidity, mortality, frequency and length of hospitalizations, with higher healthcare costs.³

Although malnutrition is common, it frequently goes undiagnosed. To target that issue, in 1996 The Joint Commission stated nutrition screening must be conducted within 24 hours of admission. This led to the development of many different forms of criteria to assess malnutrition. The Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition (ASPEN) recommend that institutions use a standardized protocol of diagnostic criteria to identify malnutrition in clinical practice. ASPEN recommends the identification of at least two of the following six criteria for identification of malnutrition including:

- insufficient energy intake
- weight loss
- loss of muscle mass
- loss of subcutaneous fat
- localized or generalized fluid accumulation that may sometimes mask weight loss; and
- diminished functional status as measured by hand grip strength⁵

The goal of standardized diagnostic criteria is to identify malnutrition early for more effective treatment. Current studies suggest the association of early diagnosis and nutrition intervention with increased positive patient outcomes and improved quality of life for heart failure patients.⁶

However, the proportion of patients with heart failure who meet criteria for malnutrition at Nebraska Medicine is unknown. The purpose of this study is to determine the proportion of heart failure patients who meet criteria for malnutrition upon admission based on the ASPEN guidelines. The secondary aim is to determine if patient characteristics are different between the group of patients who are malnourished and the group who are not.

REVIEW OF THE LITERATURE

Heart Failure Overview

In the United States, an estimated 5.8 million people are diagnosed with heart failure including 550,000 new cases diagnosed each year. Heart failure also places significant financial load on the nation, contributing \$39 billion dollars annually in health care services.¹ The American College of Cardiology Foundation (ACCF) and the American Heart Association (AHA) define heart failure as “a complex clinical syndrome that results from any structural or functional impairment of ventricle filling or ejection of blood”.⁷

Heart Failure cannot be diagnosed by one single test, because it is predominantly a clinical diagnosis based on assessment of history and physical examination. The measurement of ejection fraction (EF) is one of the objective measures that can be used for diagnosis. The stages of heart failure can be classified using the ACCF/AHA classes of A-D to emphasize the disease progression, and using the NYHA (New York Heart Association) Functional Classes of I-IV to categorize severity based on the symptoms of heart failure. Clinical diagnosis for advanced heart failure is an EF <30%. Symptoms of HF may include shortness of breath, fatigue, fluid retention, and edema.⁷

Risk factors for developing heart failure include older age, male gender, ethnicity, obesity, coronary artery disease, hypertension, hyperlipidemia, diabetes mellitus, ischemic heart disease, and smoking.¹ Although heart failure is prevalent in all age groups, the majority of cases are seen in the elderly population, with more than 75% of heart failure patients over the age of 65.⁸

Heart Failure and Malnutrition

Advanced heart failure is frequently associated with malnutrition due to the combination of both the pathophysiology of the disease and the effects of decreased nutritional intake. Many catabolic elements of HF including dyspnea, increased work of breathing, and chronic inflammation utilize more energy in the body. While symptoms such as ascites, nausea, decreased appetite, early satiety, diet restrictions, and weakness can contribute to decreased food intake.

Evidence shows heart failure occurs as an inflammatory condition. The initial impairment in cardiac function activates a systemic response of neurohormonal activation. Initially the response is protective, but the chronic inflammatory state initiates metabolic processes that may result in cachexia. It is believed the release of tumor necrosis factor (TNF), which was originally called cachexin, is the cytokine active in all forms of disease-related cachexia. This hormonal release leads to metabolic imbalance towards catabolism which breaks down skeletal muscle, fat, and eventually bone tissues.⁹⁻¹¹

Levine and colleagues were the first to observe elevated levels of cachectin (TNF) in patients with severe heart failure in 1990. They measured serum levels of TNF in 33 patients with chronic heart failure, levels in 33 healthy controls, and levels in 9 patients with chronic renal failure. Their results showed that patients with higher levels of TNF were more cachectic and had worsening cardiac function than those with lower levels of TNF. The patients with increased TNF also had more marked activation of renin-angiotensin-aldosterone (RAA) system as indicated by greater plasma renin measured.¹² The proposed mechanism is the activation of the RAA-system which causes peripheral vasoconstriction, retention of salt and water, increased aldosterone secretion and stimulation of the sympathetic nervous system to protect cardiac output and blood pressure.^{11,13} TNF has also been found to decrease the amount of albumin made by the liver and increase catabolism of protein stores.¹³

Many hormonal changes have also been assessed in chronic heart failure patients, with the most research on leptin, ghrelin, and insulin. Leptin is a hormone secreted by adipocytes that signals the response of satiety to control the balance of energy stores. In heart failure patients, the quantity of fat stores have been found to determine the amount of leptin produced. Ghrelin is produced mainly in the stomach and stimulates secretion of growth hormone. Ghrelin is an important factor in hunger and intake. Increases in ghrelin levels are associated with starvation, with the goal mechanism to increase nutritional intake.¹³ One study found cachectic heart failure patients had significantly higher levels of ghrelin than heart failure patients who were not cachectic. In this study, increased ghrelin levels were also found to have a negative correlation with BMI.¹⁴ Insulin is an essential hormone for utilizing glucose and facilitating anabolism. Chronic heart failure patients were found to have increased glucose utilization impairment with a prevalence of 43%.¹⁵ In these patients, the impairment of glucose metabolism and insulin resistance by the chronic inflammation and stress of heart failure diminishes the anabolic effects of insulin, contributing to further muscle wasting.⁹

In addition to the inflammatory response, is the reaction of the gastrointestinal tract. Heart failure has been found to cause ascites, or abdominal edema which can lead to hypomotility of the GI tract, decreased appetite, and constipation. Likewise, side effects of heart failure management medications can decrease appetite, produce dry mouth, and taste alterations. These effects are intensified in elderly who frequently experience the effects of constipation, decreased appetite, and taste changes as well. Complicating these changes in taste and dry mouth, are the common restrictions of low sodium diet and fluid restrictions which may contribute to decreased nutritional intake.¹⁰

Malnutrition and cachexia are often referred to interchangeably and there is no clear agreement in the definition for cachexia. It is proposed that cachexia is differentiated from malnutrition and starvation in that cachectic patients not only lose muscle mass, but lose fat mass

and bone density as well. Malnutrition and starvation are also thought to be reversible when adequate nutrition is supplied, as cachexia is thought to not be completely reversible.¹³ A study to determine the prevalence of weight loss in heart failure patients and the impact on patient outcomes identified increased hazard risk with weight loss of 6% or more, which became their recommended definition of cachexia.¹⁶ Chronic heart failure patients with cachexia have been shown to be weaker and fatigue earlier which is attributed to reduced muscle mass which impairs respiratory and cardiac function. In one study, a biopsy of heart muscle through autopsies performed on malnourished adults showed with the adults who had lost 40% of their original weight, they also had lost 35% of the weight of the heart.¹⁷

Nutrition Deficiencies in Heart Failure

Not surprisingly, heart failure patients with inadequate oral intake, have also been shown to have suboptimal intake of important micronutrients. In one study which assessed the intakes of heart failure patients using the Block Food Habits Questionnaire to examine the intake of macronutrient and micronutrients, those with inadequate caloric intake had significantly lower macronutrient and micronutrient intakes as well. An interesting finding was that the group with lower intake adhered closely to the 2 gm sodium restriction, while those with adequate calorie intake were closer to 3 gm sodium intake per day.¹⁸

The use of loop diuretics, a common treatment for heart failure patients have been shown to increase the urinary losses of water-soluble micronutrients including B vitamins potassium, magnesium, selenium, and thiamine.¹⁸ Some micronutrient deficiencies such as thiamine and selenium have been found at higher prevalence in those with heart failure.¹³ One study found as many as 30% of hospitalized patients with heart failure were found to be thiamine deficient.¹⁹ Several studies have found that thiamine supplementation has been shown to improve left ventricular ejection fraction, diuresis, and sodium excretion.^{20,21} Although some studies have

found thiamine supplementation to be beneficial, many patients do not receive adequate nutrition assessments to determine if supplementation is needed.¹⁸ In addition to diuretic therapy, other heart failure medications including angiotensin-converting-enzyme inhibitors and angiotensin II receptor blockers are known to produce zinc deficiency which can result in dysgeusia, or taste changes. Supplementation of zinc in patients with zinc deficiency present may improve oral intake.²²

Vitamin D deficiency is associated in multiple patient populations and conditions including heart failure. Vitamin D deficiency is associated with increased parathyroid hormone levels which may affect the renin-angiotensin system, contraction of the heart, and hypertrophy of heart muscle.²³ A study found that both vitamin D deficiency and increased PTH were independently associated with mortality in heart failure patients.²⁴ At this time there are no standard recommendations for supplementation in heart failure aside from replacing documented deficiencies.⁹

Witte and Clark conducted a small randomized controlled trial of multi-micronutrient supplementation including calcium, magnesium, zinc, copper, selenium, vitamin A, thiamine, riboflavin, vit B6, folate, vit B12, vit C, vit D, vit E, and coenzyme Q10. The study group was comprised of 32 patients age 70 and older with EF <35% who had been in stable, compensated HF for 3 months. Patients were randomized to receive the supplement for 9 months. At the end of the study period those receiving the supplements experienced a decrease in left ventricular volume, and increase in left ventricular ejection fraction and quality of life scores. They proposed supplementation of single nutrients would not be as beneficial as the synergistic effect of a multi-nutrient supplement.²⁵

Obesity Paradox

In the general population, elevated body mass index (BMI) is associated with increased risk of heart disease. However for those with established heart failure, increased BMI may be protective.¹⁸ An “obesity paradox” has been described in patients with chronic heart failure, with some studies showing overweight and obese patients having a better prognosis than patients with low or normal body mass index. Studies found that the risk of death was significantly lower for overweight and obese patients as compared with normal weight patients.²⁶⁻²⁸ A study by Fonarow, et al. of heart failure patients found for every five-unit increase in BMI the risk-adjusted mortality was 10% lower (95% CI 0.88-0.93, p= 0.0001).²⁷ Proposed explanation of the “obesity paradox” are that greater reserves and increased lean body mass provide protection from the catabolic burden of heart failure.²⁶⁻²⁸

Malnutrition can often be overlooked if BMI is the only measure considered. BMI measures alone do not discriminate between lean and fat mass and can be influenced by large fluctuations in fluid volume.²⁹ Multiple factors must be considered when assessing nutritional status in this patient population.

Diagnosing Malnutrition

Multiple methods of nutrition screening and assessment are utilized to assess hospitalized patients. Screening protocols vary from assessment of intake and weight loss, to more sophisticated assessment protocols utilize anthropometric and laboratory parameters. Anthropometric measures including height, weight, BMI, circumference, and skinfold thickness measurements are often used to assess and trend against standard reference values.³⁰ In patients with heart failure, the presence of edema often obscures the assessment of weight loss. In general, rapid weight variations are often due to shifts in fluid status due to heart failure or medical

therapies. Slower changes in weight are usually indicative of nutrition changes, especially when edema is stable.⁹

Evaluation of serum laboratory values are also frequently used to assess nutrition status in hospitalized patients. Although an objective tool, no single laboratory value has been shown to be an accurate predictor of malnutrition diagnosis. Laboratory data should be examined in context of overall clinical picture and trended over time. Heart failure patients often have alterations in laboratory values due to inflammation, changes in fluid status, and cardiac dysfunction. Thus far, no study has identified specific biochemical markers to diagnose malnutrition.³⁰

Studies have attempted to determine if tests of cardiac function correlate with nutrition status as an independent predictor. A study by Carr et al. found that left ventricular size, ejection fraction, cardiac index, and left sided cardiac pressures did not predict diagnosis of malnutrition. They did find severe tricuspid regurgitation and ascites had increased associations with malnutrition. This study explains no single measure of cardiac function can predict malnutrition on its own.³¹

Although malnutrition in hospitalized patients is common, it frequently goes undiagnosed. To target that issue, in 1996 The Joint Commission determined that nutrition screening must be conducted within 24 hours of admission. This led to the development of many different forms of criteria to assess malnutrition. The Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition (ASPEN) recommend that institutions use a standardized protocol of diagnostic criteria to identify malnutrition in clinical practice. ASPEN recommends the identification of at least two of the following six criteria for identification of malnutrition including:

- insufficient energy intake
- weight loss
- loss of muscle mass
- loss of subcutaneous fat
- localized or generalized fluid accumulation that may sometimes mask weight loss; and
- diminished functional status as measured by hand grip strength ⁵

Effect of Malnutrition on Patient Outcomes

Several studies have shown an association between nutritional status and length of hospital stay, hospital readmission rates, and mortality.⁹ A study of hospitalized patients conducted by Agarwal et al, examined outcomes for 3,017 patients. The outcome data showed that malnourished patients had a longer median length of stay compared to well-nourished patients, 15 days compared to 10 days respectively ($p < 0.0001$). Malnourished patients also had a significantly higher readmission rate within 90 days from initial hospitalization with 35% in the malnourished group vs 27% in the well-nourished group ($p < 0.0001$).³²

One study aimed to determine the prevalence of weight loss in chronic heart failure and to assess whether amount of weight loss predicts patient outcomes. This study assessed 1,929 patients with chronic heart failure and found that 42% of patients had weight loss of 5% or greater and found that weight loss was the strongest predictor of impaired survival when using proportional hazard analysis.¹⁶ Multiple studies also demonstrate poor prognosis in cachectic patients. In a study of patients with CHF, mortality rates were as high as 50% in those defined as cachectic compared with 17% in the noncachectic group at 18 month follow up.³³

PATIENTS AND METHODS

Participants and Study Design

This was a retrospective chart review of 100 patients who were flagged with the core measure of heart failure upon admission to Nebraska Medicine. Before the study began, approval from the Institutional Review Board at the University of Nebraska Medical Center was obtained. Adult participants over 19 years of age who were flagged with heart failure were eligible for enrollment. One hundred patients were randomly selected from compiled lists of heart failure admissions provided by the heart failure team. Electronic medical records were used to retrospectively collect clinical, demographic, and anthropometric data for the study participants. Data was collected from the patient's first admission when heart failure was flagged. No exclusion criteria were used to remove any patients from the study group.

Data Collection

Data from participants were collected during the first hospital admission when heart failure diagnosis was first flagged. Data used for ASPEN criteria for malnutrition including insufficient energy intake, unintentional weight loss, and functional status were all collected from the initial nursing screen performed within 24 hours of admission. Loss of muscle, loss of fat, fluid accumulation, and again functional status were collected from the history and physical examination (H&P) notes from the clinician upon admission. Meeting at least two of the six criteria classify the patient as malnourished. Additional demographic data was collected through retrospective review of the medical record including age, gender, race, body mass index (BMI), albumin, comorbidities including diabetes, cancer, chronic obstructive pulmonary disease (COPD), renal disease, smoking history, and history of myocardial infarction. Clinical outcomes including length of stay and death were also collected.

Data Analysis

Table 1: ASPEN Criteria

ASPEN Criteria for Malnutrition
Insufficient Energy Intake
Unintentional Weight Loss
Loss of Muscle
Loss Of Fat
Fluid Accumulation
Decreased Functional Status

Based on the six ASPEN criteria used for malnutrition diagnosis, the patients were divided into two groups; malnourished (meeting ≥ 2 criteria) and non-malnourished (meeting <2 criteria). Descriptive statistics were calculated for all variables. Continuous data are represented as mean and standard deviation. Categorical data are expressed as counts and percentages.

Clinical characteristics were compared between the malnourished and non-malnourished groups. Characteristics that were continuous variables including age, BMI, albumin, and length of stay were compared using the independent sample t-test. Subject characteristics that were categorical including gender, race, depression, diabetes, cancer, COPD, renal disease, smoking history, myocardial infarction, and death were compared between the two groups using the Chi-square test. Finally, binary logistic regression was used to analyze the significant variables gender, depression, and COPD between the two groups to determine if statistical significance remained independent of all other variables. Statistical analysis was performed using SPSS software. Statistical significance was measured at a p-value < 0.05 .

RESULTS

The number of patients in the study was 100. Overall there were more males included in the study with 66 males and 34 females. 74 % of participants were Caucasian, with 26% identified as other. Overall, the mean age was 64.5 years and mean BMI was 31.6 kg/m². Of the 100 patients included in the study, 39 percent of participants were categorized malnourished by ASPEN criteria, and 61 percent in the non-malnourished comparison group as shown in Table 2.

Table 2: Patient Groups

Malnourished vs Non-Malnourished	
Malnourished (≥ 2 criteria)	39
Non-Malnourished (<2 criteria)	61
Total Patients	100

When assessing each nutrition group by gender, the malnourished group was 54% male and 46% female, as compared to the non-malnourished group 73% male and 26% female. When comparing each group according to nutrition status, there were a larger percentage of females in the malnourished group as compared to the non-malnourished group (46% vs 26% respectively, $p=0.04$) as shown in Table 3. Nutrition status was significantly different between the groups with COPD; with 18 percent in the malnourished group, and 43 percent in the non-malnourished group ($p=0.01$). Positive depression screen had a close trend to significance with a p-value of 0.07; with 35% in the malnourished group compared to 58% in the non-malnourished group.

Table 3: Population Demographics

Variable (Total N)	Groups				P Value
	Non-Malnourished (N=61)		Malnourished (N= 39)		
	N	%	N	%	
Gender (100)					
Male	45	73	21	54	.04
Female	16	26	18	46	
Race (100)					
Caucasian	46	75	28	72	.69
Other	15	25	11	28	
Death (100)					
Living	55	90	34	87	.64
Deceased	6	10	5	13	
Depression Screen (71)					
Negative	18	42	18	64	.07
Positive	25	58	10	35	
Diabetes (100)					
Non-Diabetic	29	48	22	56	.39
Diabetic	32	52	17	44	
Cancer (100)					
No Diagnosis	52	85	31	79	.46
Diagnosed	9	15	8	21	
COPD (100)					
No Diagnosis	35	57	32	82	.01
Diagnosed	26	43	7	18	
Renal Disease (100)					
No Diagnosis	37	61	23	59	.87
Diagnosed	24	39	16	41	
Smoker (100)					
Non-Smoker	43	70	25	64	.50
History of Smoking	18	30	14	36	
Myocardial Infarction (100)					
No History	18	30	10	26	.67
History of MI	43	70	29	74	

Clinical characteristics for all participants observed at time of admission are presented in Table 4. As shown in Table 4, there was not a significant difference in age, BMI, albumin or length of stay. The mean length of stay was 9.2 days in the non-malnourished group and 11.3 in the malnourished group ($p=.34$). No other statistical significance was noted between groups when comparing other characteristics including demographics, clinical diagnoses, lab data, or patient outcomes.

Table 4: Clinical Characteristics

Variables (N)	Groups				P value
	Non-Malnourished (N=61)		Malnourished (N=39)		
	N	Mean (S.D.)	N	Mean (S. D.)	
Age, years (100)	61	63.5 (15.5)	39	65.9 (13.6)	.42
BMI, kg/m ² (100)	61	31.1 (7.8)	39	31.5 (10.7)	.84
Albumin, g/dL (94)	57	3.3 (.6)	37	3.2 (.8)	.32
Length of Stay, days (100)	61	9.2 (10.7)	39	11.3 (10.8)	.34

When assessing the criteria met for malnutrition in only the malnourished group, the largest percentage met diagnosis due to decreased functional status with 85% of the group. 69% met criteria with fluid accumulation masking weight loss, 49% with insufficient energy intake, 26% with unintentional weight loss, and 15% for both muscle loss and fat loss shown in Table 5.

Table 5: Criteria for Malnutrition

ASPEN Criteria N=39	N	%
Insufficient Energy Intake	19	49
Unintentional Weight Loss	10	26
Loss of Muscle	6	15
Loss Of Fat	6	15
Fluid Accumulation	27	69
Functional Status	33	85

Through multivariate analysis using binary logistic regression to compare the two nutritional groups, the independent variables gender, COPD, and depression were analyzed. The odds of malnutrition are 4.036 times higher for the females when controlling for COPD and depression (p-value= 0.024; 95% CI:1.203-13.538). The odds of malnutrition are 80 percent less likely in those with the diagnosis of COPD when the variables gender and depression are held constant (p-value=.01; 95% CI 0.941-0.314). The results are more clearly displayed in Table 6.

Table 6: Logistic Regression Model for Malnutrition

Variable(s)	P-value	OR	95% Confidence Interval (CI)
Gender	<i>0.024</i>	4.036	1.203-13.538
COPD	<i>0.010</i>	0.201	.059-.686
Depression	<i>0.102</i>	0.399	.133-1.200

DISCUSSION

The primary aim of this study was to determine the proportion of heart failure patients who met criteria for malnutrition upon hospital admission. To our knowledge no other study has used the ASPEN criteria to determine malnutrition in the heart failure population. Many studies have estimated malnutrition in this target population using food frequency questionnaires, percent weight loss and screening tools which have found 30-50% to be malnourished.^{4,9,10,17,30,32} However, prior to this study the proportion of patients with heart failure who meet criteria for malnutrition at Nebraska Medicine was unknown. Our study reports finding that 39 percent of our heart failure patients are malnourished upon hospital admission. This is a significant finding, as it can be used to guide clinical practice for more effective assessment and interventions for our patients.

Our secondary aim was to determine if patient characteristics are associated with a diagnosis of malnutrition based on ASPEN guidelines. Based on review of current literature, we hypothesized the malnourished group would likely be female, older, with lower BMI's, have more comorbidities, and longer length of hospitalizations. As we expected, when comparing each gender according to nutrition status, there were a larger percentage of females in the malnourished group as compared to the non-malnourished group (46% vs 26% respectively, $p=0.04$) as shown in Table 3. This was found to be statistically significant, which may be beneficial when assessing patients in clinical practice. With this knowledge, we may be more likely to assess for malnutrition in females and quicker to provide nutrition intervention.

Overall in our study population, the mean age was 64.5 years old. There was not a statistically significant difference in mean age between the two nutrition groups. In our literature review, a review article of heart failure in older adults found that the majority of cases of heart failure are seen in the elderly population, with more than 75% of heart failure patients over the

age of 65.⁸ We expected to find not only an older heart failure population, but also an older malnourished group. With the average age in our study population of less than 65, our data may be skewed lower by a younger population group.

We also hypothesized the malnourished group would have a lower BMI, as BMI is often used as a screening tool to assess for nutrition status. Multiple studies showed that for those with established heart failure, increased BMI may have a protective effect.¹⁸ The “obesity paradox” has been described in patients with chronic heart failure, with some studies showing overweight and obese patients having a better prognosis than patients with low or normal body mass index. Studies found that the risk of death was significantly lower for overweight and obese patients as compared with normal weight patients.²⁶⁻²⁸ Our study did not find an association between BMI and malnutrition, however our sample size was smaller than the majority of existing studies that show this correlation. The average BMI in our study was 31.6 kg/m², which fits the World Health Organization category for obesity.³⁴ This suggests the majority of our patients fit into the obese category which may mean we have less patients from the low and normal weight categories.

When comparing comorbidities in the nutrition groups, no significant differences were found in those with diabetes, cancer, renal disease, smoking, and myocardial infarctions. Nutrition status was significantly different between the groups with COPD; with 18 percent in the malnourished group, and 43 percent in the non-malnourished group (p=0.01). We hypothesized that those with COPD would be more likely to be malnourished due to the catabolic effect of COPD, but we were surprised to find the opposite to be true in our study. Multiple reasons may be suggested as proposed explanations for the results we did not predict. Although we often expect COPD patients to be underweight, several studies have found a large portion of COPD patients to be overweight and obese. One study on the distribution of BMI in COPD patients, found a significantly larger proportion of patients had BMI ≥ 25 kg/m² than the proportion with BMI <25 kg/m² (64.6% vs 35.4%, respectively; P<0.0001).³⁵ Weight maintenance and muscle

mass preservation has become a purposeful goal in the management of COPD, with careful observation of weight changes. New COPD rehabilitation strategies target adequate nutritional intake to prevent muscle atrophy, maintain lung function, and prolong quality of life.³⁶⁻³⁸

Positive depression screen had a close trend to significance with a p-value of 0.07; with 35% in the malnourished group compared to 58% in the non-malnourished group. This was another surprising finding, as we believed those who have depression would be more likely to have decreased intake, and therefore more likely to be malnourished. Several studies have noted a relationship with depression and malnutrition.³⁹⁻⁴⁰ Our data on depression status was collected from the nursing admission screen. This relies on the patients answering the screening questions honestly. Although a screening tool, those patients who screened positive for depression were used as our comparative depression group. We also only had depression screening information on 71 of our 100 patients which may also effect the results.

We also hypothesized the length of hospital stay would be significantly different between the two groups, due to multiple studies that showed malnourished patients had more complications and longer hospital stays. Several studies have shown an association between nutritional status and length of hospital stay, hospital readmission rates, and mortality.^{9,16,29,32,33} Results of a study of hospitalized patients conducted by Agarwal et al, showed that malnourished patients had a significantly longer median length of stay and higher readmission rate compared to well-nourished patients. Another study found that weight loss was the strongest predictor of impaired survival when using proportional hazard analysis.¹⁶ Multiple studies also demonstrate poor prognosis in cachectic patients, with mortality rates as high as 50% in those defined as cachectic compared with 17% in the noncachectic group.³³ These studies are much larger than the patient population we studied. Another factor confounding our measurement of mortality is that data was collected on the first admission when heart failure was diagnosed, with dates for each patient varying from years ago to very recent. Whether they were deceased or not was collected

up until June 30, 2015, so each patient had varying lengths of time from diagnosis to assessing whether they were alive or deceased.

The absence of many significant differences in population or clinical characteristics between the two nutrition groups shows us that each patient should be evaluated thoroughly through comprehensive nutrition assessment. No single parameter has proven to be useful in all patients when used independently. Decreased BMI, low albumin and increased age are all frequently used in attempts to predict nutrition status. In our specific population of heart failure patients at Nebraska Medicine, neither age, nor BMI, nor albumin were found to be predictive of malnutrition. This information is beneficial to prevent clinicians from overlooking patients which we do not assume to be at risk.

Limitations

Using methods of retrospective data collection contributed to some limitations as it is subject to only the information documented at the time. This resulted in some missing data for albumin and depression screening. Similarly, some of the data collected retrospectively for the ASPEN criteria documentation are contingent on the inclusivity of documentation. While insufficient energy intake, unintentional weight loss, and functional status were collected directly from the patient during the nursing screen; loss of muscle, fat, fluid accumulation, and again functional status were noted in the clinicians H&P documentation and exposed to subjectivity. Currently Nebraska Medicine does not have a routine protocol for assessing muscle and fat loss or functional status which may contribute to additional bias.

Another limitation is that nutrition status was determined on hospital admission when heart failure was first diagnosed. Further studies that assess nutritional status of advanced heart failure and examine the patient throughout hospitalizations would be beneficial for gaining insight on the progression of malnutrition in heart failure. Lastly, another limitation is the sample

size. Beginning with a larger population may have strengthened associations to identify significant clinical predictors for malnutrition.

Application to Clinical Practice

The role of a registered dietitian is to assess nutritional status, plan appropriate interventions, and implement nutrition support in patients when indicated. The goal of standardized diagnostic criteria for malnutrition is to identify patients early for more effective treatment. Moving towards implementing nutrition assessments that utilize the ASPEN criteria may improve consistent malnutrition diagnosis. In this study population, documentation of loss of muscle mass, loss of fat, and functional status were either documented through the physicians H&P or missing from the chart in retrospective review. Diminished functional status and fluid accumulation were the most common criteria met for malnutrition. This may warrant dietitians to consider evaluating those criteria during assessment and documentation in these heart failure patients.

Our findings that a significant proportion of our heart failure patients are identified as malnourished gives us valuable insight into our patient population. This information urges us to critically evaluate each patient's nutritional status and implement interventions that consider their individual nutrition needs. Further evaluation of current screening, assessment, diet restrictions, and nutrition management practices may be useful in establishing standardized protocols at Nebraska Medicine. As an institution, working towards following routine protocols for evaluating patients including physical assessments and standardized documentation in the medical record may be beneficial for the care of heart failure patients.

CONCLUSION

Our study reports that 39 percent of heart failure patients are found to be malnourished upon admission at Nebraska Medicine. We concluded that few demographic, anthropometric, or clinical data can predict likelihood of malnutrition. Based on our results females are more likely malnourished than males and those diagnosed with COPD were less likely to be malnourished. Further research should be completed to identify early predictors of malnutrition in the heart failure population.

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