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I, Sara Glanz, hereby submit this original work as part of the requirements for the degree of Master of Science in Nutrition.

It is entitled:

Comparison of Screening Tools to Assess Risk of Malnutrition

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Comparison of Screening Tools to Assess Risk of Malnutrition

A thesis submitted to the
Graduate School of the University of Cincinnati
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Nutritional Sciences

College of Allied Health Sciences

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ABSTRACT

Objective. The purpose of this research was to (a) determine the concurrent validity of the criteria used by nurses at University of Cincinnati Medical Center (UCMC) for nutrition screening as compared to the Malnutrition Universal Screening Tool (MUST) as a reference tool; (b) evaluate the merit of diagnosis-based nutrition screening to identify patients at risk for malnutrition; and (c) determine the association between risk for malnutrition or referral to a dietitian and hospital length of stay (LOS).

Subjects. Adult patients who were admitted to UCMC in 2015 with a completed nutrition screen at admission were used to create two unique cohorts. Cohort 1 included 292 patients restricted by 15 categories of diagnoses that were identified in the Academy of Nutrition and Dietetics, Nutrition Care Manual as benefitting from early nutrition intervention. In Cohort 1, the merit of diagnosis-based screening was assessed. Cohort 2 was used as a comparison group and included 299 patients not restricted by diagnosis. Patients who received palliative or hospice care were excluded.

Methods. This study was a retrospective chart review. The extracted data were from (a) completed UCMC nurse's nutrition screens and (b) documentation from nutrition assessments completed by Registered Dietitian Nutritionists. From these data, the MUST was applied to "screen" the patients. Referral to the dietitian was also pulled from the chart. LOS was calculated from admission and discharge date.

Analysis. Convergent validity of UCMC and MUST were assessed by Kappa (κ), sensitivity, and specificity. Within each diagnostic category, the proportion of patients at-risk or not-at- risk for malnutrition was compared using the Chi-Square (X^2) test. In all patients, the proportion of at-risk patients that were or were not referred to the dietitian was compared via X^2. Mean LOS was compared in two groups – at-risk or not-at-risk

patients – using an independent t-test. In nutritionally-at-risk patients, mean LOS was compared to the hospital average LOS using a one-sample t-test.

Results. In Cohort 1, significantly more patients (58.8%) were identified at risk for malnutrition using the UCMC criteria compared to 31.8% using MUST (X^2 =13.2; P <0.0001). The methods had poor validity (κ= 0.172; sensitivity = 73.2%; specificity = 47.9%). In only two of the diagnosis groups (pressure ulcer and pancreatitis) was there a significant difference in being more likely to be identified at risk of malnutrition using UCMC screen. The MUST identified patients at risk in only one diagnosis group – malnutrition. Of the patients identified by the UCMC screen to be at risk for malnutrition, 63.4% of them received a referral to a dietitian (p<0.0001). Patients at risk for malnutrition based on the UCMC screen had significantly longer LOS than patients not at risk (p=0.002); this did not hold true for the MUST. Patients identified at risk for malnutrition by both screens had significantly longer LOS compared to the UCMC average LOS (p<0.0001).

Conclusions. Neither tool met standards for validity. Diagnosis-based screening was not found to be meritorious except for three diagnoses. Dietitian referrals for UCMC patients at risk for malnutrition could be improved. This study confirmed that patients at risk for malnutrition have longer LOS.

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I would like to acknowledge and thank the following individuals for their contributions to this project. To Kathryn Chiles, Amy DeMage, and Sharon Lent, the Aramark dietitians who assisted in the creation of the diagnosis-based screening policy and shared the story of its development with me. To Kiley Asher, Stacie Chapman, and the dietitians at UCMC, with whom I collaborated on the development and execution of this project. To Lisa Bowman, the nurse manager of the neuro ICU at UCMC, who spent an afternoon explaining the nursing side of the UCMC nutrition screen. To Cyndie Miculan, who works with the UCMC Informatics team and provided insight into the history and workings of the UCMC screen. To Dave Hoskins and Brett Harnett, analysts for CCTST, who so brilliantly created our patient database. To Dr. Nick Ollberding, biostatistician, who provided assistance to remedy our missing data problems. And to Dr. Debra Krummel and Dr. Sarah Couch, my thesis committee members, for their assistance and instruction.

This project is a testament to the wonderful collaboration that exists within healthcare teams. It truly takes the whole team to provide the best care to our patients. Teamwork makes the dream work.

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INTRODUCTION

Nutrition status is often compromised in acutely-ill patients. In a review of published nutrition screening tools, the estimated prevalence of adult malnutrition was between 15-60%, depending on the patient population and the tool used for screening.[1]

Early identification of hospitalized patients who are at risk for malnutrition is of vital importance, as these patients often have poor clinical outcomes. Nutritionally at-risk patients have longer lengths of stay,[2-8] higher hospital readmission rates, [7-10] and greater risk of mortality.[3,4,7,8,11,12] Poor nutrition status is also associated with higher hospitalization costs.[13-16] In fact, hospitalization costs for undernourished patients have been estimated to be 45-102% higher than for their well-nourished counterparts.[14]

Nutrition screening is "the process of identifying characteristics known to be associated with nutrition problems, with a goal of identifying individuals who are malnourished or at nutritional risk and are in need of intervention and/or education from a [R]egistered [D]ietitian [N]utritionist."[17] In the acute care setting, the Registered Dietitian Nutritionist ("dietitian") will do a comprehensive nutrition assessment for nutritionally at-risk patients to confirm or refute risk. If patients are determined to be at risk, then the dietitian will use the Nutrition Care Process to develop a nutrition care plan. Steps of the Nutrition Care Process include assessment, nutrition diagnosis, intervention, monitoring, and evaluation of the intervention.[18] Because it is rarely feasible for a dietitian to assess every hospitalized patient, the accurate identification of patients who would benefit most from nutrition intervention ensures a wise use of valuable resources.

This study will explore two approaches for identifying nutritional risk in hospitalized patients at the University of Cincinnati Medical Center (UCMC).

LITERATURE REVIEW

Nutrition Screening

The screening of hospitalized patients to identify patients who are at risk for malnutrition is a requirement for accreditation by The Joint Commission and for reimbursement for services by the Centers for Medicare & Medicaid Services.[19,20] The Joint Commission requires nutrition screenings to be completed within 24 hours of admission. Because of this expectation, nurses generally complete nutrition screening. Neither The Joint Commission nor the Centers for Medicare & Medicaid Services specifies the criteria to be used to determine nutritional risk. However, both entities mandate that nutritionally at-risk patients receive nutrition assessment and therapy. [19,20]

In the Evidence Analysis Library of the Academy of Nutrition and Dietetics, the validity and reliability of 11 nutrition screening tools were compared. For acute-care patients, one tool had Grade I (good) evidence to support its use and four tools had Grade II (fair) supporting evidence for use of the use of the tool. These were the Nutrition Risk Screening-2002 (Grade I) and the Simple Two-Part Tool, Malnutrition Screening Tool, Mini Nutritional Assessment-Short Form, and Malnutrition Universal Screening Tool (all Grade II).[21] Only the Malnutrition Screening Tool and the Mini Nutritional Assessment-Short Form had sensitivity and specificity levels above 90%, which is indicative of good validity. Of these, only the Malnutrition Screening Tool had almost perfect inter-rater reliability ($\kappa = 0.83$ to 0.88).[21]

One nutrition screening tool that has been validated in patients with varying medical diagnoses is the Malnutrition Universal Screening Tool. The MUST was developed by a multidisciplinary team of healthcare professionals from the Malnutrition

Advisory Group, a committee of the British Association of Parenteral and Enteral Nutrition.[22] Because there is no gold standard for screening tools, they have to be validated against another reference method.[23] The MUST was first validated for use with hospital inpatients and outpatients in 2004.[24] The validity of the MUST as compared to other published screening tools in shown in Table 1.

Table 1 Concurrent Validity of MUST to Reference Screening Tools

Reference Tool	Patient Population	Kappa	Interpretation
SGA[24]	medical inpatients	0.78	Good Validity
MST[24]	medical inpatients	0.71	Good Validity
MNA[24]	surgical inpatients	0.61	Good Validity
MNA[24]	elderly medical inpatients	0.55	Fair Validity

SGA: Subjective Global Assessment, MST: Malnutrition Screening Tool, MNA: Mini Nutritional Assessment

The MUST has also been validated in specific patient populations that mimic those of this study, as shown in Table 2.

Table 2 MUST Validation by Disease Category

Patient Population	Reference Tool	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Interpretation of Validity
Geriatric inpatients[25]	Combined index of MNA-SF, GNRI, MUST, NRS-2002	81%	99%	98%	87%	Good
Surgical inpatients[26]	SGA	85%	93%	89%	99%	Good
Liver transplant inpatients[27]	Accurately-predicted death	82%	61%	N/A	N/A	Fair
Adult medical-surgical inpatients[28]	SGA	64%	92%	65%	92%	Fair
Cardiac surgery inpatients[29]	Fat-free mass as measured by bioelectrical impedance	59%	83%	24%	96%	Fair
Renal inpatients[30]	MST	54%	78%	74%	60%	Fair

MNA-SF: Mini Nutritional Assessment Short Form, GNRI: Geriatric Nutritional Risk Index, NRS-2002: Nutrition Risk Screening-2002, SGA: Subjective Global Assessment, MST: Malnutrition Screening Tool

Clinical Outcomes for Patients at Risk for Malnutrition

Negative clinical outcomes are often observed in patients who are at risk for malnutrition. Compared to adequately-nourished patients, malnourished patients have longer lengths of stay (LOS) in the hospital,[1-8] higher hospitalization costs,[13-16] higher incidence of hospital readmission,[7-10] and higher rates of mortality.[3,4,7,8,11,12] Therefore, the accurate and timely identification of patients who are at risk for malnutrition is imperative so that dietitians can provide nutrition interventions to improve nutritional status and clinical outcomes.

The MUST is able to predict LOS for patients at risk for malnutrition. In cardiopulmonary surgery patients, nutritional risk as determined by the MUST was a

predictor of longer hospitalizations, defined as greater than twenty[5] or twenty-one days.[4] Similar results were found in general hospital patients; poor nutritional status based on the MUST score, appetite deterioration, low quantity of food intake, artificial diet (enteral or parenteral nutrition), and recent weight loss was the strongest predictor of a longer LOS.[6] Longer LOS have also been measured and documented for general medical-surgical patients with risk factors for malnutrition. These patients had mean hospital LOS ranging from 1.4 to 11.8 days longer than the average LOS within their study cohorts.[2,3,7,8] In contrast, two studies completed with pulmonology inpatients and geriatric patients in an elderly care center failed to show an association between nutritional risk, as determined by the MUST, and LOS.[11,12]

Due to longer hospital stays, patients who are at risk for malnutrition often require more resources to care for them and have higher hospitalization costs. For hospital inpatients, including critical care populations, malnourished patients had significantly longer hospital LOS and increased hospitalization costs, up to 102% higher than non-malnourished patients.[14,15] Intuitively, it is expected that longer LOS would yield higher costs. However, one of the aforementioned studies by Tangvik et al. statistically adjusted for LOS, and the observed effect of malnutrition on hospitalization costs remained.[15] This suggests that the higher hospitalization costs are not due solely to longer LOS. Instead, malnourished patients require more resources to care for them, resulting in more costly hospital stays. Another consideration is the inclusion of critical care patients in these studies, as the higher echelon of care provided in intensive care units is associated with higher costs. Although a valid concern, hospitalization costs are still demonstrably higher in nutritionally at-risk patients when critical care patients are excluded.[13]

Despite longer hospitalizations, malnourished patients are often readmitted for additional care. Poor nutritional status increases hospital readmissions in both the short- and long-term. General medical-surgical inpatients who were classified as malnourished by the Subjective Global Assessment were more likely to be readmitted to the hospital after 15 days (RR:1.6, 95% CI: 1.1-2.3), 90 days (RR: 1.6, 95% CI: 1.3-2.0), and even after six months (RR: 1.5, 95% CI: 1.2-1.9).[8] These results have been duplicated in similar cohorts of general medical-surgical inpatients.[7,9,10] Even patients who are identified with risk factors for malnutrition by the validated Malnutrition Screening Tool have higher rates of 90-day readmission compared to patients with no risk for malnutrition.[9] Thus, the effects of a poor nutrition status are long-lasting and detrimental.

Mortality rates are also higher in patients who are at risk for malnutrition. Patients who are simply at risk for malnutrition based on their MUST scores are more likely to die during hospitalization (OR: 2.72, 95% CI: 1.48-4.97)[11] as well as one month after hospital discharge (OR: 3.8, 95% CI: 1.5-9.4).[4] Likewise, patients who are actually classified as malnourished by the Subjective Global Assessment have higher mortality rates at 90 days (OR: 1.91, 95% CI: 1.09-3.34),[7] one year (RR: 8.3, 95% CI 5.4-12.6),[8] two years (RR: 6.3, 95% CI 4.5-8.9),[8] and three years (RR: 4.8, 95% CI: 3.7-6.5)[8] after hospital discharge. This influence of malnutrition on patient mortality has been observed in a variety of patient populations, including general medical-surgical,[3,7,8] cardiac surgical,[4] pulmonary,[11] and geriatric patients.[12] Likewise, the association holds true for in-hospital[3,4,7,9] and post-discharge[8,10] mortality. Thus, it seems that nutrition status affects patient outcomes both during and after hospitalization.

Current Practice at the University of Cincinnati Medical Center

UCMC is an academic medical center located in Cincinnati, Ohio. It is a Level 1 trauma center and houses seven intensive care units. UCMC has approximately 500 licensed patient beds and has an average daily census of approximately 465-470 patients (K. Asher, oral communication, October 2015). The average patient length of stay in 2015 was 3.33 days.

At present, UCMC nurses screen all newly admitted patients for nutritional risk using nine criteria shown in (shown in the Methods Section Table 4). Six of these criteria are contained on other nutrition screening tools;[24,25-30] the validity and reliability of the other criteria are unknown.

In accordance with The Joint Commission's accreditation standards, the nutrition screen is completed within 24 hours of admission to the hospital. After screening a patient, the nurse determines whether to refer the patient to a dietitian or not, based on his or her clinical judgment (L. Bowman, oral communication, February 2016). If a patient is referred to a dietitian, the dietitian must respond to the referral and complete a full nutrition assessment within 48 hours (S. Chapman, email communication, June 2016). The admission nutrition screen is the only screening procedure currently in practice at UCMC.

PURPOSE

The purpose of this research was to

1. Determine the concurrent validity of the criteria used by nurses at UCMC for nutrition screening as compared to the MUST as a reference tool;

2. Evaluate the merit of diagnosis-based nutrition screening to identify patients at risk for malnutrition; and
3. Determine the association between risk for malnutrition or referral to a dietitian and hospital LOS.

HYPOTHESES

Null (H_0)

1. There is no difference in the number of patients identified as at risk for malnutrition by the UCMC criteria versus the MUST.
2. There is no difference in the percentage of patients identified to be not-at-risk or at-risk for malnutrition within each diagnosis.
3. There is no relationship between risk of malnutrition as determined by the UCMC criteria and referral to a dietitian.
4. There is no relationship between risk of malnutrition as determined by the UCMC criteria or the MUST and length of stay during hospitalization.
5. There is no agreement between the UCMC nutrition screening criteria and the MUST.

METHODS

This study is a retrospective chart review of medical records from patients admitted to the UCMC between the dates of January 1, 2015 to December 31, 2015. A Health Insurance Portability and Accountability Act (HIPAA) waiver was used in lieu of participant informed consent, as all patients included in the study had already been

discharged from the hospital at the time the study took place. The University of Cincinnati Institutional Review Board approved the study.

Diagnosis-Based Screening

The rationale for using diagnosis-based screening is that patients with certain diagnoses are associated with an inherent risk for malnutrition, as a function of the disease state. With this method, dietitians would complete a nutrition assessment on all patients admitted with these diagnoses instead of waiting on the results from the nutrition screen from nursing. The merit of this method has not been previously reported. Diagnosis-based screening originated from Aramark, a food and nutrition management company that services numerous food and nutrition departments in hospitals including the Department of Food and Nutrition Services at UCMC. For this screening method, a list of 15 diagnoses (Table 3) was generated from the AND Nutrition Care Manual as those affecting nutritional status such that the patients would likely need and benefit from early nutrition intervention (K. Chiles, phone communication, October 2015).[38-57] Not all of the facilities that Aramark manages use this diagnosis-based screening method. At UCMC, the dietitians are not currently utilizing diagnosis-based screening.

Table 3 Diagnoses Used by Aramark for Diagnosis-Based Screening

Medical Diagnosis
Acute/Chronic Kidney Disease
Anorexia/Bulimia
Aspiration Pneumonia
Bariatric Surgery
Burns
Chronic Diarrhea
Cirrhosis
Current Organ Transplant
Cystic Fibrosis
Diabetes (newly diagnosed or gestational)
Heart Failure
Malnutrition
Pressure Ulcer (stage II or greater)
Severe Acute Pancreatitis
Short Bowel Syndrome

To identify patients admitted with these fifteen medical diagnoses, a list of corresponding ICD-9 and ICD-10 codes was generated (Appendix A). In addition to the researchers' clinical judgment, coders from UCMC were asked to help identify the ICD codes that seemed to be most reflective of the broader diagnostic category. Because UCMC transitioned from ICD-9 to ICD-10 codes during the 2015 calendar year, a website called www.icd10data.com was used to convert the ICD-9 codes to their ICD-10 counterparts.

Creating the Patient Database

A data analyst from the University of Cincinnati's (UC), Center for Clinical and Translational Science and Training accessed electronic medical records to create a patient database that was imported to Excel for use in this study. In the first extraction, patients included in the database were admitted to UCMC on or between the dates of January 1, 2015 and August 8, 2016. All patients were at least 18 years of age at the time of

admission. The patients were retained in the sample if these data were available: (a) nutrition screen by nurses, (b) nutrition assessment by a dietitian, and/or (c) referral from nursing to an inpatient dietitian. Patients were removed from the sample if they were receiving palliative or hospice care. Per university policy, one patient was excluded from the database at the outset as he/she was enrolled as a student at UC.

Sample Selection

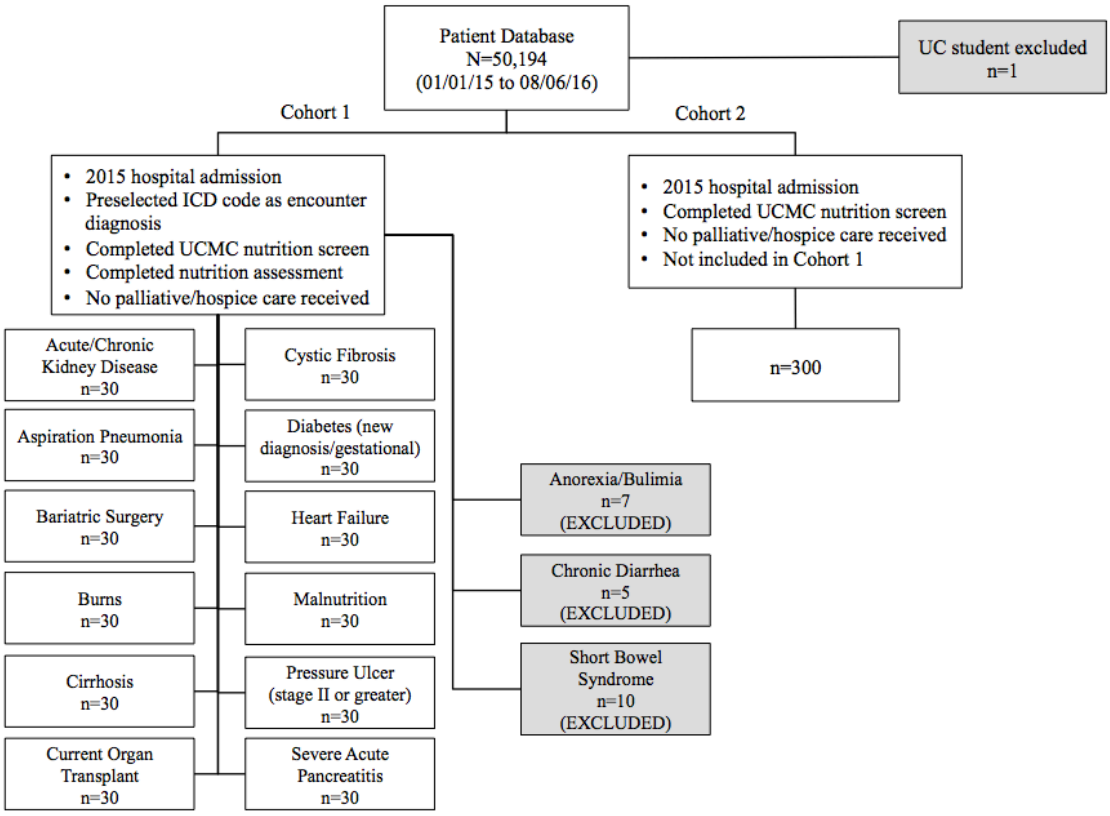
From the above database, to be included in this study, patients had to be admitted to the hospital on or between the dates of January 1, 2015 and August 6, 2016. Next, patients were divided into two cohorts (Figure 1). Cohort 1 was restricted by the 15 pre-selected nutritionally at-risk diagnoses. Cohort 2 was not restricted by diagnosis and served as a comparison group.

Cohort 1

To be in Cohort 1, patients had one of the 15 pre-selected ICD codes (Appendix A). Because many patients had multiple encounter diagnoses, the decision was to use the primary diagnosis at admission. Using the patient encounter ID (a uniquely identifying number created for each hospital admission), the sample was checked to verify that the patient was admitted during 2015, and had a nutrition screen and nutrition assessment completed.

To create a manageable sample and increase the likelihood of significance, a decision was made to select the first 30 patients meeting the aforementioned criteria for each diagnosis group. Of the 15 diagnostic groups, three groups, Anorexia/Bulimia, Chronic Diarrhea, and Short Bowel Syndrome, were deleted due to sample sizes less than 30 patients (Figure 1).

Figure 1 Sample Selection Organized by Cohort



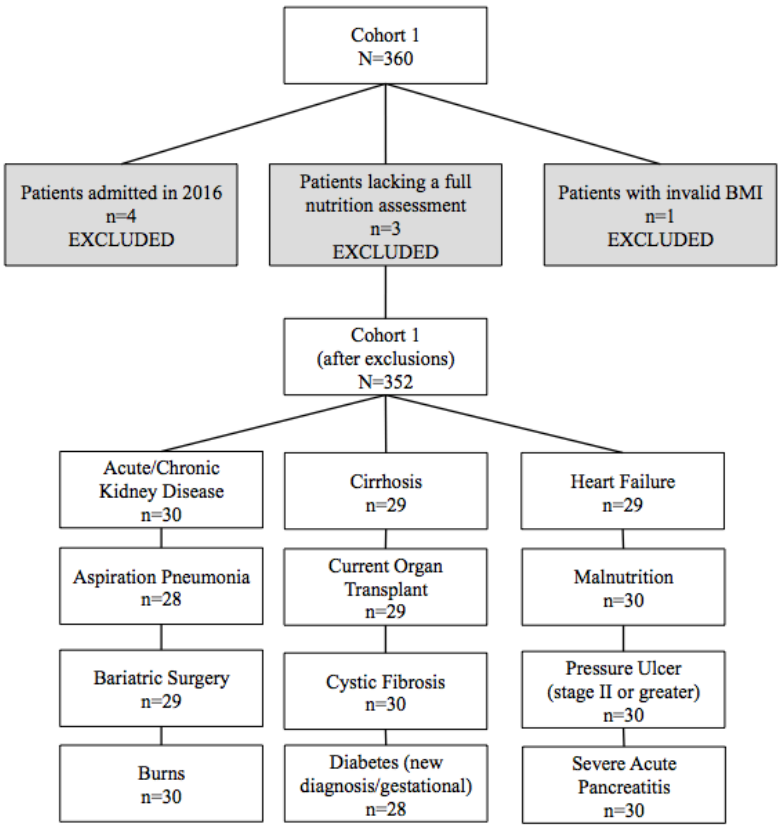
Cohort 2

Cohort 2 was not restricted by diagnosis. To be included, there were two criteria: (a) a completed nutrition screen and (b) not be included in Cohort 1 (Figure 1). A convenience sample of the first 300 patients meeting these criteria was generated.

Excluded Subjects after the Generation of the Cohorts

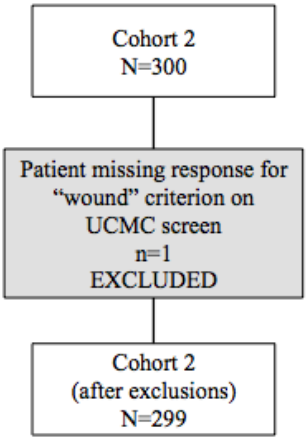
Eight patients were excluded from Cohort 1 (Figure 2) for not meeting the inclusion criteria or having an invalid body mass index (BMI). This BMI was checked by reviewing the height and weight of the patient from the original database. The patient's height had been documented incorrectly and was not available in any other area within the medical record.

Figure 2 Excluded Patients from Cohort 1



For Cohort 2, one patient was excluded for an incomplete nutrition screen (Figure 3).

Figure 3 Excluded Patient from Cohort 2



Determination of Nutritional Risk

Using UCMC Criteria

The criteria currently used at UCMC to determine nutritional risk are presented in Table 4. Currently, there is no protocol guiding the use of these criteria, i.e., how many criteria need a positive response to define risk of malnutrition or when to refer patients to a dietitian. For this study, patients were deemed at risk for malnutrition if they were identified as having a "yes" response for any criterion.

Table 4 Current UCMC Nutrition Screening Criteria

Nutrition Screen Criterion	Patient Response
Unplanned weight loss in last three months	Yes / No / Unable to assess
Unplanned weight gain in last three months	
Poor oral intake for four or more days prior to admission	
Difficulty chewing or swallowing	
Pressure ulcer of non-healing wound	
Vomiting/diarrhea/nausea greater than three days	
Home tube feeding or total parenteral nutrition (TPN)	

Using the MUST

Using patient data from the medical record, a MUST score was calculated for each patient. Criteria and scoring are shown in Table 5. The BMI was obtained directly from the medical record. The five highest and lowest BMIs (outliers) were verified by reviewing the patients' heights and weights. These outliers had ICD diagnosis codes that could explain the BMI – diagnosis of malnutrition, abnormal weight loss, or morbid obesity. Unplanned weight loss and acute disease effect score were determined by reviewing information documented in the dietitians' assessment notes. Patients with previous hospital admissions to UCMC had those body weights pre-populated in the nutrition assessment notes. Otherwise, the dietitian would have documented any significant weight changes, as reported by the patient or caregiver. Previous or expected nutritional intake was inferred based on the diet or nutrition support order listed in the medical record. Dates of follow-up assessments were considered to track the duration of *nil per os* (NPO) orders in an effort to estimate time without nutritional intake. The researchers' (both Registered Dietitian Nutritionists) clinical judgment was used in obtaining this information, given the retrospective nature of the study.

Table 5 MUST Scoring[24]

BMI score	**Weight loss score** (unplanned in 3-6 months)	**Acute disease effect score**
BMI >20 or >30 kg/m^2 = 0 BMI 18.5-20 kg/m^2 = 1 BMI <18.5 kg/m^2 = 2	Weight loss < 5% = 0 Weight loss 5-10% = 1 Weight loss > 10% = 2	If there has been or is likely to be no nutritional intake for > 5 days = 2
Total Score = 0-6		
0: Low Risk	1: Medium Risk	≥ 2: High Risk

Additional Data

Sensitivity and Specificity

Sensitivity and specificity were calculated for the UCMC screen as compared to the MUST.

Referrals to the Dietitian

Referrals to the inpatient dietitians were recorded as either present or absent without regard to the dates or times of the referral.

Length of Stay

Hospital length of stay (LOS) was calculated by subtracting the admission date from the discharge date. Average LOS was calculated within the database by gathering all patients with recorded admission and discharge dates (totaling 49,972), subtracting admission dates from discharge dates, and averaging these LOS.

Number of Diagnoses

Total number of diagnoses was determined by tallying all unique ICD diagnosis codes for each patient. The total number of distinct ICD diagnosis codes was used as an indicator of acuity level.

STATISTICAL ANALYSIS

Statistical analyses were performed using the Statistical Packages for Social Sciences (SPSS, IBM, Chicago, IL, USA, version 23, 2016) with a significance level set at $P < 0.05$. All assumptions were met for each test unless otherwise noted.

Missing Data Imputation

Two variables on the screening tools had missing data. The first variable was the criterion regarding recent weight gain on the UCMC screen. Of the total sample of 651 patients, 184 patients had missing data for this variable (28%). The researchers decided to retain the weight gain variable in the data set (as it factored into participants' risk for malnutrition as determined by the UCMC screen), but exclude it from analysis. The second variable was the criterion on the MUST regarding recent weight loss. This variable was present in Cohort 1 only; 65 of 352 patients in Cohort 1 had missing data for this variable (18%). Data for the weight loss variable were imputed using SPSS imputation function. Consultation with a biostatistician set the parameters for the imputation. Results are reported using values from the first imputation. Patients in the burns and acute pancreatitis diagnosis groups were excluded from analyses related to the MUST score because they had high concentrations of missing data (57% and 33%, respectively) that led to inaccurate imputations.

Hypothesis Testing

Hypothesis 1. There is no difference in the number of patients identified as at risk for malnutrition by the UCMC criteria versus the MUST. The proportion of patients identified to be not-at-risk or at-risk for malnutrition was compared using the Chi-Square (X^2) test for independence with the Yates Continuity Correction to prevent overestimation of the X^2 statistic in a 2 X 2 table.[58]

Hypothesis 2. There is no difference in the percentage of patients identified to be not-at-risk or at-risk for malnutrition within each diagnosis. Using the screening tools, patients were classified into two categories (at-risk or not-at-risk for malnutrition). A Chi-square test for independence with Yates Continuity Correction was conducted for

each diagnosis group. When identifying the prevalence of patients at risk for malnutrition, Phi values were used for effect size. Effect size explains the differences in data regardless of sample size and illustrates the practical impact of the relationship between the independent and dependent variables.[59] Phi levels were interpreted using the cut points shown in Table 6.[60] This allowed insight into the merit of diagnosis-based screening.

Table 6 Interpretation of Phi Levels

Phi Level	Interpretation
0.1	Small
0.3	Medium
0.5	Large

Hypothesis 3. There is no relationship between risk of malnutrition as determined by the UCMC criteria and referral to a dietitian. A Chi-square test for independence (with Yates Continuity Correction) was conducted to determine how many of the nutritionally at-risk patients received a referral to an inpatient dietitian during their hospital admissions.

Hypothesis 4. There is no relationship between risk of malnutrition as determined by the UCMC criteria or the MUST and length of stay during hospitalization. The mean LOS was compared in two groups – at-risk or not-at-risk patient using an independent samples t-test. This test was conducted for both the UCMC criteria and the MUST. In nutritionally at-risk patients, mean LOS was compared to the hospital average LOS using a one-sample t-test. Since the LOS data were skewed to the right, the P values for "equal variances not assumed" were used. Cohen's d was calculated to assess the effect size of

risk of malnutrition on LOS using the following website: http://www.socscistatistics.com/effectsize/Default3.aspx. Cohen's d levels were interpreted using the cut points shown in Table 7.[60]

Table 7 Interpretation of Cohen's d Levels

Cohen's d Level	Interpretation
0.2	Small
0.5	Medium
0.8	Large

Hypothesis 5. There is no agreement between the UCMC nutrition screening criteria and the MUST. A Kappa statistic (κ) was used to determine the proportion of agreement between the two screening tools. The cut-points for evaluating Kappa were published in a Systematic Review of Malnutrition Screening Tools (Table 8).[23]

Table 8 Interpretation of Kappa Values[23]

Kappa Value	Interpretation
< 0.4	Poor Validity
0.4-0.6	Fair Validity
> 0.6	Good Validity

Sensitivity and Specificity are also criteria used to determine validity of screening tools for malnutrition.23 For this analyses, sensitivity and specificity were interpreted using cut-points published in a systematic review (Table 9). [23]

Table 9 Interpretation of Sensitivity and Specificity

Sensitivity and/or Specificity Value	Interpretation
Sensitivity AND Specificity > 80%	Good
Sensitivity OR Specificity < 80%, but both > 50%	Fair
Sensitivity OR Specificity < 50%	Poor

RESULTS

Sample Characteristics

Characteristics of the patients are shown in Table 10. Approximately half of the sample was male and half female with no significant difference in the cohorts. The range of ages for the total sample was 18 to 99 years. There was no significant difference in the mean age of patients in Cohort 1 or Cohort 2. The BMI of patients ranged from 10.56 kg/m^2 to 81.15 kg/m^2 with no significant difference between the cohorts. Hospital LOS ranged from 0.35 days to 103.93 days with significantly higher LOS observed for patients in Cohort 1. Patients' total distinct ICD codes ranged from 1 diagnostic code to 63 diagnostic codes. Patients in Cohort 1 had significantly more distinct ICD codes when compared to Cohort 2. Information about race and ethnicity were not reported in the original dataset and thus not included.

Table 10 Characteristics of Patients by Cohort

Variable	Total	Cohort 1	Cohort 2	P
	N=651	N=352	N=299	
Gender Male (%) Female (%)	 50.2 49.8	 48.9 51.1	 51.8 48.2	0.50
	Mean ± SD			
Age (years)	53.77 ± 16.59	53.62 ± 15.93	53.94 ± 17.36	0.80
Body mass index (kg/m^2)	29.19 ± 9.51	29.32 ± 10.26	29.03 ± 8.50	0.71
Length of stay (days)	7.94 ± 7.8	10.63 ± 8.92	4.79 ± 4.56	<0.001
Total distinct ICD codes	8.21 ± 8.08	10.49 ± 9.21	5.52 ± 5.40	<0.001

Cohorts were compared via independent t-test.

Prevalence of Risk of Malnutrition

In the total sample, 48.6% of patients were identified to be at risk for malnutrition according to the UCMC screen. Table 11 shows the proportion of patients in each cohort identified as being at risk for malnutrition. Cohort 1 had a significantly higher rate.

Table 11 Positive UCMC Nutrition Screen by Cohort

	Positive Screen		
	N	%	P
Cohort 1	207	58.8	<0.001
Cohort 2	110	36.8	
Total	317	48.6	

For each criterion on the nutrition screen at UCMC, the proportion of the sample with a positive risk is shown in Table 12. “Poor oral intake for four or more days prior to admission” was the most prevalent criterion and “home tube feeding or total parenteral nutrition” was the least prevalent.

Table 12 Proportion of Patients Meeting UCMC Criteria (N=651)

Nutrition Screen Criterion	Patients with Positive Risk (N)	Patients with Positive Risk (%)
Unplanned weight loss in last three months	102	15.7
Poor oral intake for four or more days prior to admission	143	22.0
Difficulty chewing or swallowing	65	10.0
Pressure ulcer or non-healing wound	68	10.4
Vomiting/diarrhea/nausea greater than three days	111	17.1
Home tube feeding or total parenteral nutrition (TPN)	24	3.7

The proportion of patients in Cohort 1 meeting the criteria of the MUST are shown in Table 13. A BMI in the range of > 20.0 or > 30.0 kg/m^2 was the most prevalent positive criterion and a BMI in the range of 18.5 to 20.0 kg/m^2 was the least prevalent.

Table 13 Proportion of Patients Meeting MUST Criteria (n=292)

Nutrition Screen Criterion	Cut Points	N	Patients Meeting Criterion (%)
BMI Score	20.0 or > 30.0 kg/m^2	290	82.4
	18.5 to 20.0 kg/m^2	23	6.5
	< 18.5 kg/m^2	39	11.1
Weight Loss Score	< 5%	235	66.8
	5-10%	60	17.0
	> 10%	57	16.2
Acute Disease Effect Score	No nutritional intake for > 5 days	27	7.7

A comparison of the number of patients identified at nutritional risk using UCMC or MUST is shown in Table 14. The UCMC screening method rated a significantly higher proportion of patients at risk for malnutrition than the MUST with a small to medium effect size (X^2 =13.2, φ=0.2).

Table 14 Patients in Cohort 1 at Risk for Malnutrition based on UCMC Screen and MUST (N=292)

Criteria	At-Risk for Malnutrition (%)	P	Phi
UCMC Screen	58.8	<0.0001	0.2
MUST	31.8		

For each diagnosis, the proportion of patients identified at-risk for malnutrition using the UCMC screen is shown in Table 15. Patients in the pressure ulcer group had the highest prevalence for a positive screen with a small effect size (φ=0.17), and patients in the bariatric surgery group had the lowest prevalence with a small to medium effect size (φ= -0.23). The four diagnoses of bariatric surgery, burns, pressure ulcer, or severe acute pancreatitis were not independent of risk categorization for malnutrition. For bariatric surgery and burns, there were significantly higher proportions of patients who were not at risk for malnutrition than at risk. For example, the proportion of patients undergoing bariatric surgery who were not at risk for malnutrition (79.3%) was significantly higher than those at risk (20.7%). Phi indicates small to medium effect sizes for both diagnosis groups (φ= -0.23 $_{\text{bariatric surgery}}$ and -0.16$_{\text{burns}}$). For the pressure ulcer and pancreatitis diagnosis groups, there were significantly higher proportions of patients at risk for malnutrition than not at risk. Phi indicates small effect sizes for both diagnosis

groups (φ= 0.17 and 0.15, respectively). Thus, in only two of the diagnosis groups was there a significant difference in being more likely to be at risk of malnutrition.

Table 15 Patients Identified at Risk for Malnutrition within Each Diagnosis Group using the UCMC Screen (N=352)

Diagnosis Group	Patients at Risk for Malnutrition			
	N	(%)	P	Phi
Acute or chronic kidney disease	22	73.3%	0.14	0.09
Aspiration pneumonia	18	64.3%	0.68	0.03
Bariatric surgery	6	20.7%	<0.001	-0.23
Burns	10	33.3%	0.006	-0.16
Cirrhosis	15	51.7%	0.54	-0.04
Current organ transplant	16	55.2%	0.83	-0.02
Cystic fibrosis	13	43.3%	0.11	-0.10
Diabetes (new onset or gestational)	19	67.9%	0.42	0.05
Heart failure	15	51.7%	0.54	-0.04
Malnutrition	22	73.3%	0.14	0.09
Pressure ulcer (stage II or greater)	26	86.7%	0.002	0.17
Severe acute pancreatitis	25	83.3%	0.008	0.15

For each diagnosis, the proportion of patients identified at risk for malnutrition using the MUST is shown in Table 16. Patients with a diagnosis of malnutrition had the highest prevalence for a positive screen with a small to medium effect size (φ=0.21). None of the patients with a diagnosis of bariatric surgery were identified as being at risk for malnutrition (φ= -0.21); this was the lowest prevalence. For patients diagnosed with

cirrhosis, there was a higher proportion not at risk than at risk for malnutrition (φ= -0.12), between a small and medium effect size.

Table 16 Patients Identified at Risk for Malnutrition within Each Diagnosis Group using the MUST (n=292)

Diagnosis Group	**Patients at Risk for Malnutrition**			
	N	**(%)**	**P**	**Phi**
Acute or chronic kidney disease	12	40%	0.42	0.05
Aspiration pneumonia	10	35.7%	0.80	0.03
Bariatric surgery	0	0	0.001	-0.21
Cirrhosis	4	13.8%	0.05	-0.12
Current organ transplant	6	14.3%	0.26	-0.07
Cystic fibrosis	15	50%	0.83	0.02
Diabetes (new onset or gestational)	4	20.7%	0.62	-0.11
Heart failure	9	31%	1.00	-0.005
Malnutrition	19	63.3%	0.0001	0.21
Pressure ulcer (stage II or greater)	14	46.7%	0.11	0.10

A comparison of the number of patients within each diagnosis group identified to be at risk for malnutrition based on the UCMC screen or the MUST is shown in Table 17. There were no significant differences in the proportion of patients identified to be at risk for malnutrition between the screens.

Table 17 Comparison of Patients Identified at Risk for Malnutrition by UCMC Screen and MUST by Diagnosis Groups (n=292)

Diagnosis Group	Patients at Risk for Malnutrition				
	UCMC		MUST		
	N	%	N	%	P
Acute or chronic kidney disease	22	73.3%	12	40%	0.15
Aspiration pneumonia	18	64.3%	10	35.7%	1.00
Cirrhosis	15	51.7%	4	13.8%	1.00
Current organ transplant	16	55.2%	6	14.3%	0.27
Cystic fibrosis	13	43.3%	15	50%	1.00
Diabetes (new onset or gestational)	19	67.9%	4	20.7%	1.00
Heart failure	15	51.7%	9	31%	0.90
Malnutrition	22	73.3%	19	63.3%	0.18
Pressure ulcer (stage II or greater)	26	86.7%	14	46.7%	1.00

Relative Validity of the Tools

The relative validity of the UCMC screen as compared to the MUST is shown in Table 18. Based on the Kappa values, screening on the UCMC versus the MUST were not significantly different. When combining all diagnoses, there was poor agreement between the tools (κ=0.172).

Table 18 Relative Validity between UCMC Screen and MUST

Diagnosis	Kappa Value	P	Sensitivity %	Specificity %
Acute or chronic kidney disease	0.268	0.06	91.7	38.9
Aspiration pneumonia	-0.057	0.72	60	33.3
Cirrhosis	-0.009	0.94	50	48
Current organ transplant	0.220	0.12	83.3	52.2
Cystic fibrosis	0.067	0.71	46.7	60
Diabetes (new onset or gestational)	0.033	0.74	75	33.3
Heart failure	-0.089	0.60	44.4	45
Malnutrition	0.315	0.08	84.2	45.5
Pressure ulcer (stage II or greater)	-0.017	0.89	85.7	12.5
All diagnoses	0.172	<0.0001	73.2	47.9

Based on sensitivity and sensitivity calculations, there was poor agreement between the tools.

Dietitian Referrals for Patients at Risk for Malnutrition

Table 19 shows the number of patients at risk for malnutrition based on the UCMC screen that received a referral to a dietitian. Patients with a positive nutrition screen were significantly more likely to be referred to the dietitian than not (φ= -0.28).

Table 19 Referrals to the Dietitian at UCMC (N=651)

Criteria	Patients with a Dietitian Referral %	P	Phi
At risk for malnutrition per UCMC screen	63.4	<0.0001	-0.28

Comparing LOS for Patients at Risk for Malnutrition

A comparison of LOS for patients with and without risk of malnutrition as identified by the UCMC screen and the MUST is shown in Table 20. Mean LOS was significantly higher for patients at risk for malnutrition, as identified by the UCMC screen, but not by the MUST. This relationship between nutritional risk and LOS for the UCMC screen had a small to medium effect size.

Table 20 Comparing LOS for Patients with and without Risk for Malnutrition

Criteria	At risk for malnutrition	No risk for malnutrition	P	Cohen's d
	LOS (days) Mean ± SD			
UCMC screen N=651	8.9 ± 7.07	7.0 ± 8.35	0.002	0.24
MUST N=352	10.5 ± 6.78	10.6 ± 9.77	0.89	0.02

Table 21 shows a comparison of LOS between patients at risk for malnutrition, as identified by both screens, and UCMC's average LOS. Patients at risk for malnutrition based on both screens had significantly longer LOS compared to the UCMC average LOS.

Table 21 Comparing LOS for Patients at Risk for Malnutrition and UCMC Average LOS

Criteria	Mean LOS (days)	P
UCMC screen N=651	8.9	<0.0001
MUST N=352	10.5	
UCMC average N=49,972	3.33	

DISCUSSION

Prevalence of Risk of Malnutrition

In this study, the prevalence of risk of malnutrition based on the UCMC screening criteria was 48.6% for both cohorts. In Cohort 1, 58.8% of patients were at risk for malnutrition, while only 36.8% were at risk in Cohort 2. The most closely related published screening tool to the UCMC criteria is the Mini Nutritional Assessment, with four to five of the UCMC screening criteria present.[33] Still, comparisons are difficult to make, as the Mini Nutritional Assessment was designed for elderly patients, which is dissimilar to this study's sample. With that in mind, the prevalence of risk of malnutrition as identified by the UCMC screen is similar to estimations made by the Mini Nutritional Assessment in elderly hospitalized patients, which range from 38% to 60%.[61-63]

In contrast, only 31.8% of patients in Cohort 1 were at risk for malnutrition as determined by the MUST. In the MUST's original validation study, rates of nutritional risk for general medical, general surgical, and elderly inpatients were 28%, 19%, and 44%, respectively, which is in line with this study's results.[24] Importantly, the rate reported from the MUST validation study represent both the medium-risk (1 point) and high-risk (2+ points) groups together, whereas the present study reported high-risk patients only.

Agreement Between UCMC Screen and MUST

When evaluating the validity of the UCMC nutrition screen, this study observed poor agreement between the hospital's screening criteria and the MUST. In contrast, the

MUST has demonstrated moderate to fair to good when compared to other nutrition screening tools.[24]

The UCMC screen had a sensitivity of 73.2% and a specificity of 47.9%. This indicates poor validity.[23] The clinical implications include an under-identification of nutritionally at-risk patients, coupled with an increased selection of false positives, that is, patients who are truly not at risk.

The lack of standardized protocol for interpreting the UCMC screen may have contributed to the poor validity and poor agreement with the MUST. Due to this lack of protocol, the researchers decided *a priori* to classify patients at risk for malnutrition if at least one positive criterion was present on the UCMC screen. In doing so, this may have over-represented the patients who were truly at risk for malnutrition. On the other hand, 28% of patients had missing data on the "weight gain" criterion on the UCMC screen. Because the researchers felt weight gain had little bearing on risk of malnutrition, this missing data for this parameter was ignored. Thus, this decision may have under-identified patients who would have been classified at risk for malnutrition by our own use of the UCMC screen.

Within Diagnosis Groups

UCMC Screen

For the UCMC screen, the bariatric surgery and burns groups had a significantly higher number of patients *not* at risk for malnutrition. It is logical that patients who are admitted for bariatric surgery would not be at risk for malnutrition, as they are presenting for elective surgery and generally do not have undernutrition-related concerns. Similarly, burns are an acute medical condition and do not share any symptoms with malnutrition,

as represented on the UCMC screen (i.e., unintentional weight loss, poor oral intake, difficulty chewing or swallowing, etc.). So although patients with severe burns are likely in need of nutrition intervention due to their high caloric needs,[45] they are unlikely to present with an pre-existing nutritional risk. Malnutrition would be more likely to occur after admission.

In contrast, the pressure ulcer and severe acute pancreatitis groups had a significantly higher number of patients identified to be at risk for malnutrition. For the former group, it is not surprising given one of the criteria on the UCMC is presence of "pressure ulcer or non-healing wound." Likewise, patients presenting with acute pancreatitis are likely to be identified at risk for malnutrition with the questions on the UCMC screen asking about poor oral intake and recent nausea and vomiting, as these are typical symptoms associated with pancreatitis. The high prevalence rates of nutritional risk observed in this study is in concert with studies that report malnourished patients are more likely to develop pressure ulcers and high MUST scores (indicating risk of malnutrition) influence chronic wound healing.[6,64]

MUST

When the MUST was used, the bariatric surgery and cirrhosis groups had a significantly higher number of patients *not* at risk for malnutrition, whereas the malnutrition group had a significantly higher number of patients at risk for malnutrition. When evaluating the prevalence of malnutrition within the above diagnosis groups, it is no surprise that bariatric surgery patients were without risk of malnutrition. In reviewing the MUST criteria, these patients would earn no points for their BMI, unplanned weight loss (any required weight loss leading up to surgery is intentional), or expected poor

nutritional intake. Similarly, it would be expected that patients diagnosed with malnutrition would meet the MUST criteria, particularly those related to unplanned weight loss and poor nutritional intake.

However, it is quite surprising that patients in the cirrhosis diagnosis group were more often identified *without* risk of malnutrition, given that cirrhosis is a hypermetabolic condition often associated with muscle wasting and weight loss.[47] There were no studies found using the MUST to estimate the prevalence of risk of malnutrition for cirrhosis patients. However, a seven-year longitudinal study that reviewed all patients admitted with diagnosis codes for cirrhosis and portal hypertension found that the incidence of diagnosed protein-calorie malnutrition was significantly higher for cirrhosis patients versus general medical inpatients.[65] For our study, it is possible that these patients did not earn sufficient points on the MUST to be classified at-risk due to another common feature of cirrhosis—edema. Lower extremity edema and ascites can contribute to falsely elevated body weight, thereby masking a low BMI or recent unintentional weight loss. These patients may also be receiving enteral or parenteral nutrition, which would nullify the MUST's acute disease effect score.

There have not been any studies published that utilize the MUST to evaluate the prevalence of risk of malnutrition specifically for patients receiving bariatric surgery (pre-operative assessment, not post-operative) or admitted with cirrhosis. Likewise, no studies were found that involved the nutritional screening of patients already diagnosed with malnutrition.

Looking closer into the other diagnosis groups' rates of nutritional risk, there is little representation in the literature, particularly when using the MUST. Only one study

was found that used the MUST to evaluate risk of malnutrition in patients with acute or chronic renal failure or who were post-kidney transplant; 38% of patients were estimated to be at risk for malnutrition when using the MUST.[30] This is lower than the rate of nutritional risk estimated by the UCMC screen, but rather similar to what was reported by the MUST (UCMC: 73%, MUST: 40%). This discrepancy with the UCMC screen supports the lack of validity and the low specificity of this set of criteria, which appears to lead to over-estimation of nutritionally at-risk patients.

Regarding the pulmonary diagnosis groups, the rates of nutritional risk observed in this study for aspiration pneumonia (UCMC: 64.2%, MUST: 34.1%) and cystic fibrosis (UCMC: 43.3%, MUST: 50%) are higher than what was noted for a sample of patients with nondescript lung diseases (25-30%).[2] This may be due to our isolation of higher-risk pulmonary disease states compared to the inclusion of all lung-related diseases.

Likewise, comparisons of nutritional risk in our organ transplant group are difficult to make due to a heterogeneous sample. Patients included in this diagnosis category were at different stages of their transplantation process, including pre- and post-transplant. There were also different sub-populations, including kidney, liver, and pancreas transplant patients. Despite this, the rates of nutritional risk observed for the organ transplant diagnosis group (UCMC: 55.2%, MUST: 20.6%) are reasonable when compared to rates identified in a 2015 study in pre- and post-liver transplant patients, who were evaluated with the MUST. Using the same threshold to categorize nutritional risk as was done in this study, 57.6% of pre-transplant patients were identified as at risk for malnutrition. At the time of hospital discharge, the rate of nutritional risk had

dropped to 33.4%. Long-term post-operative rates of nutritional risk continued to fall at three months (15.6%), six months (6.5%), and twelve months (0%).[27] Literature that uses the MUST to identify risk of malnutrition for patients receiving other types of organ transplants is lacking.

Like organ transplant, heart failure is a broad term that may encompass many different cardiovascular diseases. In this study, the rates of nutritional risk (UCMC: 51.5%, MUST: 30.6%) are higher compared to other samples of cardiology and cardiac surgery patients, when using the MUST. Other studies targeting this diagnosis group have observed rates of nutritional risk ranging from 8.3% to 20.9%.[2,4-6,29] Our higher rates of nutritional risk may be explained by the ICD codes chosen to represent this diagnosis group, as most of them seemed to represent congestive heart failure, rather than any cardiac surgery-related conditions. Congestive heart failure is a chronic conditions, often associated with several other comorbidities and frequent hospitalizations for acute exacerbations of the condition.

Regarding the remaining diagnoses of diabetes (newly diagnosed or gestational) and malnutrition, there were no studies found that estimated prevalence of risk of malnutrition in these patient populations.

Comparison Between UCMC Screen and MUST

There were no significant differences in the number of patients identified to be at risk for malnutrition by the UCMC screen versus the MUST for any of the individual diagnosis groups. With the exception of cystic fibrosis, the UCMC screen identified a higher number of patients at risk in all of the diagnosis groups as compared to the MUST. The lack of statistical significance may be due, in part, to the diagnosis groups' small

sample sizes. Given the low level of agreement between the UCMC screen and the MUST, larger sample sizes may have yielded statistically significant differences between the groups.

Diagnosis-Based Screening

This study provides insufficient evidence to make any recommendations regarding diagnosis-based screening for several reasons. First and foremost, our process for selecting patients for inclusion could have limited inclusion in the sample. Patients were selected for inclusion into Cohort 1 based on their encounter diagnoses. Unbeknownst to the researchers, the encounter diagnosis does not represent the sole primary, admitting diagnosis (which we were targeting). Instead, it includes all billable diagnoses and is more analogous to the patient's medical history. The effects of this on the results are unknown.

Furthermore, the power for the study was not calculated a priori. Only a few diagnostic categories achieved statistical significance and effect sizes were small.

Referrals to a Dietitian

In reviewing the hospital's dietitian referral practices, there is minimal frame of reference for this information. This study found that 63.4% of patients with at least one positive criterion on the UCMC nutrition screen had a referral to an inpatient dietitian during that hospital admission. This rate of referral in incongruent with recommendations made by the Centers for Medicare & Medicaid Services that state, "Once a patient is identified as having an altered nutritional status, a nutritional assessment should be performed on the patient…[and] the patient should be re-evaluated as necessary to ensure their ongoing nutritional needs are met."[20] The Joint

Commission's Standards of Patient Care also iterate the importance of nutrition screening and appropriate referral processes mandating, "Patients at nutrition[al] risk receive nutrition therapy."[19]

LOS

The results of this study related to LOS are both expected and surprising. This study demonstrated that patients who are at risk for malnutrition, as identified by the UCMC nutrition screen and the MUST, had significantly longer LOS when compared to the hospital's average inpatient LOS. Previous studies have reported this same clinical outcomes.[2-4,6-8] However, this study failed to show that nutritionally at-risk patients, as identified by their MUST scores, had longer LOS than patients without nutritional risk. One possible explanation for this may be that only Cohort 1 was retrospectively screened using the MUST. This cohort was restricted by diagnosis, containing only patients admitted with one of the presumed high nutritional risk diagnoses. Thus, it may be that this cohort houses patients with a higher "baseline" or inherent nutritional risk as compared to the study's sample as a whole. Another possible explanation may be that these diagnoses, which include those centered on organ system failure, are higher acuity. A higher acuity often leads to longer LOS, which may have acted as a confounder and polluted the results. This was observed in our study, as Cohort 1 had significantly higher LOS and number of distinct ICD diagnosis codes compared to Cohort 2. A higher number of ICD codes lends credence to the idea that Cohort 1 was a sicker group of patients.

Strengths

Among the most important strengths of this study, it was developed with input from and collaboration with the clinical team at UCMC. The clinical dietitians identified the need for this study based on their perceived shortcomings in the current nutrition screening practices. Nursing leadership described the nutrition screening workflow within the electronic health record and at the bedside. And experts trained in retrieving information from the electronic health record created a database that was tailored to our needs. As a result, the knowledge gained from this study has the potential to improve the care provided to patients at UCMC.

The participants included in the study gave a diverse snapshot of hospitalized patients in an urban, Level 1 trauma center. The participants' ages ranged from 18 to 99 years, and there were admission dates spanning nearly the entire year. There were also a variety of diagnoses represented with varying levels of acuity. The heterogeneous nature of the sample helps to increase the generalization of the study's results.

Limitations

Despite its strengths, this study has several notable limitations. First, the retrospective study design limited the available data to whatever was originally documented in the patient's medical record. Furthermore, the lack of standardization for documentation led to weaknesses in the data. Despite a standardized nutrition assessment template, details contained in the assessment notes varied between dietitians. The same was observed with the UCMC nutrition screen; although a standardized list of questions/prompts is available, some questions were not answered or asked at different times during the patient's hospital admission.

In the same way, this study operates on the assumption that all of the data contained in the medical records are accurate. Based on the researchers' experience working in the field, it is fairly common to observe errors in patients' medical records. For example, it is assumed that the heights and weights of the participants in the study are accurate. However, it is unknown whether one or both of these anthropometrics were actually measured or merely estimated. The BMIs are calculated from these measurements, and a portion of the MUST score is based on the BMI. So even simple discrepancies in height and weight may have created errors in classifying patients' nutritional risk status based on the MUST. Likewise, when determining risk for malnutrition based on the UCMC screen, a patient's response of "3" indicates the condition or risk was "unable to be assessed." When completing data analysis, all responses of "3" were recoded as "not present." This process may have underestimated the participants who had a positive nutritional risk on the UCMC screen.

As alluded to previously, another limitation came from an early decision regarding medical diagnoses. One of the purposes of the study is to assess risk of malnutrition for certain admitting diagnoses; in other words, we attempted to target certain medical diagnoses that were the primary reason the patient was admitted to UCMC. UCMC has several different types of diagnoses within the electronic medical record, including an "admitting" diagnosis, "encounter" diagnosis, and "primary" diagnosis. Even after consulting with UCMC health informatics experts, it was unclear which would best represent a patient's sole admitting diagnosis, rather than his/her medical history. We decided to proceed using the encounter diagnosis, which seemed to include all diagnoses for which patients were billed during their hospital admissions.

Efforts were taken to identify the primary diagnosis and classify patients into the diagnosis groups based on that information. However in some cases, this allowed for patients to meet criteria for inclusion in the study based on a technicality and did not always capture the patients we intended. If this study is to be repeated in the future, the "primary" diagnosis should be used to better identify patients with certain admitting diagnoses.

Similarly, diagnosing style may vary between physicians. Consider, for example, a patient suffering from exacerbation of congestive heart failure (CHF). Such a patient may present with shortness of breath and edema, among other symptoms. When the patient is admitted to the hospital, what becomes the admitting diagnosis—acute on chronic CHF, shortness of breath, or volume overload? In this case, only an admitting diagnosis directly related to CHF would have met inclusion criteria; if the patient received 'shortness of breath' or 'volume overload' as an admitting diagnosis, he/she would have been excluded from the study, even though the clinical condition is exactly what we were targeting.

Tracking referral orders to the inpatient dietitians posed another concern. We attempted to identify how many patients who were identified to be at risk for malnutrition based on the UCMC screen received a referral to the dietitian. Unfortunately, our database did not contain any information regarding who placed the referral order or why; only the date and time of the referral were available. Thus, there was no way to determine if patients received a dietitian referral because they were found to be at increased nutritional risk. The referrals may have be ordered by another provider for any other reason—diet education, management of nutrition support, or a routine assessment.

We were unable to determine a "cause and effect" relationship between identification of nutritional risk and a referral to a dietitian.

Implications for UCMC

Despite its limitations, this study provides a snapshot of the importance of appropriately identifying patients who are at risk for malnutrition.

CONCLUSION

This study was designed to evaluate the current nutrition screening practices at UCMC compared to a reference tool. The criteria were found to have poor validity. The dietitian referrals were suboptimal. The importance of appropriate nutritional risk screening and referral to a dietitian was emphasized as we observed significantly longer LOS for nutritionally at-risk patients compared to UCMC's average inpatient LOS. Diagnosis-based screening was not supported by this study, but more research should be done with larger samples for each disease category.

REFERENCES

1. Academy of Nutrition and Dietetics Evidence Analysis Library. UWL: screening and assessment methods (2009). Available at: https://www.andeal.org/topic.cfm?cat=5445&evidence_summary_id=250950&highlight=nutrition%20screening&home=1. Accessed March 24, 2017.
2. Kruizenga H, van Keeken S, Weijs P, et al. Undernutrition screening survey in 564,063 patients: patients with a positive undernutrition screening score stay in hospital 1.4 d longer. *Am J Clin Nutr*. 2016.
3. Ben-Ishay O, Gertsenzon H, Mashiach T, Kluger Y, Chermesh I. Malnutrition in surgical wards: a plea for concern. *Gastroenterol Res Pract*. 2011;2011:10.1155/2011/840512. Epub 2010 Aug 3.
4. Chermesh I, Hajos J, Mashiach T, et al. Malnutrition in cardiac surgery: food for thought. *Eur J Prev Cardiol*. 2014;21:475-483.
5. Lomivorotov VV, Efremov SM, Boboshko VA, Nikolaev DA, Vedernikov PE, Deryagin MN, et al. Prognostic value of nutritional screening tools for patients scheduled for cardiac surgery. *Interactive Cardovascular and Thoracic Surgery*. 2013;16:612-618.
6. Tsaousi G, Panidis S, Stavrou G, Tsouskas J, Panagiotou D, Kotzampassi K. Prognostic indices of poor nutritional status and their impact on prolonged hospital stay in a Greek university hospital. *Biomed Res Int*. 2014;2014:924270.
7. Agarwal E, Ferguson M, Banks M, Batterham M, Bauer J, Capra S, et al. Malnutrition and poor food intake are associated with prolonged hospital stay,

frequent readmissions, and greater in-hospital mortality: results from the Nutrition Care Day Survey 2010. *Clinical Nutrition.* 2013;32:737-745.

8. Lim SL, Ong KCB, Chan YH, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. *Clinical Nutrition.* 2012;31:345-350.
9. Ulltang M, Vivanti AP, Murray E. Malnutrition prevalence in a medical assessment and planning unit and its association with hospital readmission. *Aust Health Rev*. 2013;37:636-641.
10. Jeejeebhoy KN, Keller H, Gramlich L, et al. Nutritional assessment: comparison of clinical assessment and objective variables for the prediction of length of hospital stay and readmission. *Am J Clin Nutr*. 2015;101:956-965.
11. Maia I, Xara S, Dias I, Parente B, Amaral TF. Nutritional screening of pulmonology department inpatients. *Rev Port Pneumol*. 2014;20:293-298.
12. Henderson S, Moore N, Lee E, Witham MD. Do the malnutrition universal screening tool (MUST) and Birmingham nutrition risk (BNR) score predict mortality in older hospitalised patients? *BMC Geriatr*. 2008;8:26-2318-8-26.
13. Amaral TF, Matos LC, Tavares MM, et al. The economic impact of disease-related malnutrition at hospital admission. *Clin Nutr*. 2007;26:778-784.
14. Gastalver-Martin C, Alarcon-Payer C, Leon-Sanz M. Individualized measurement of disease-related malnutrition's costs. *Clin Nutr*. 2015;34:951-955.
15. Tangvik RJ, Tell GS, Eisman JA, et al. The nutritional strategy: four questions predict morbidity, mortality and health care costs. *Clin Nutr*. 2014;33:634-641.

16. Guerra RS, Sousa AS, Fonseca I, et al. Comparative analysis of undernutrition screening and diagnostic tools as predictors of hospitalisation costs. *J Hum Nutr Diet*. 2014:1-9.
17. Phillips W, Zechariah S. Minimizing False-Positive Nutrition Referrals Generated from the Malnutrition Screening Tool. *J Acad Nutr Diet*. 2016.
18. Nutrition care process. Academy of Nutrition and Dietetics Evidence Analysis Library website. https://www.andeal.org/ncp. Updated 2017. Accessed March 23, 2017.
19. Joint Commission International. Joint Commission International accreditation standards for hospitals. 5th ed. 2014.
20. Department of Health & Human Services and Centers for Medicare & Medicaid. State operations manual, appendix A—survey protocol, regulations and interpretive guidelines for hospitals. Revised October 2008.
21. NSCR: Summary of all tools evaluated. Academy of Nutrition and Dietetics Evidence Analysis Library website. https://www.andeal.org/topic.cfm?menu=4305&cat=5437. Accessed March 25, 2017.
22. Elia M, Chairman and Editor. Screening for Malnutrition: A Multidisciplinary Responsibility. Development and Use of the 'Malnutrition Universal Screening Tool' ('MUST') for Adults. Malnutrition Advisory Group (MAG), a Standing Committee of BAPEN. Redditch, Worcs.: BAPEN. 2003.

23. van Bokhorst-de van der Schueren MAE, Guaitoli PR, Jansma EP, de Vet HCW. Nutrition screening tools: Does one size fit all? A systematic review of screening tools for the hospital setting. *Clin Nutr.* 2014;33:39-58.
24. Stratton RJ, Hackston A, Longmore D, et al. Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. *Br J Nutr*. 2004;92:799-808.
25. Baek MH, Heo YR. Evaluation of the efficacy of nutritional screening tools to predict malnutrition in the elderly at a geriatric care hospital. *Nutr Res Pract*. 2015;9:637-643.
26. Almeida AI, Correia M, Camilo M, Ravasco P. Nutritional risk screening in surgery: valid, feasible, easy! *Clin Nutr*. 2012;31:206-211.
27. Lim HS, Kim HC, Park YH, Kim SK. Evaluation of Malnutrition Risk after Liver Transplantation Using the Nutritional Screening Tools. *Clin Nutr Res*. 2015;4:242-249.
28. Olivares J, Ayala L, Salas-Salvado J, et al. Assessment of risk factors and test performance on malnutrition prevalence at admission using four different screening tools. *Nutr Hosp*. 2014;29:674-680.
29. van Venrooij LM, van Leeuwen PA, Hopmans W, Borgmeijer-Hoelen MM, de Vos R, De Mol BA. Accuracy of quick and easy undernutrition screening tools--Short Nutritional Assessment Questionnaire, Malnutrition Universal Screening Tool, and modified Malnutrition Universal Screening Tool--in patients undergoing cardiac surgery. *J Am Diet Assoc*. 2011;111:1924-1930.

30. Lawson CS, Campbell KL, Dimakopoulos I, Dockrell ME. Assessing the validity and reliability of the MUST and MST nutrition screening tools in renal inpatients. *J Ren Nutr*. 2012;22:499-506.
31. Detsky AS, McLaughlin JR, Baker JP, et al. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr*. 1987;11:8-13.
32. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition*. 1996;12:S15-9.
33. Guigoz Y, Vellas B, Garry PJ. Assessing the Nutritional Status of the Elderly: The Mini Nutritional Assessment as Part of the Geriatric Evaluation. *Nutr Rev*. 01;54:S59; S59-S65; S65.
34. Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). *Journal of Gerontology*. 2001;56A:M366-M372.
35. Kaiser MJ, Bauer JM, Ramsch C, et al. Validation of the Mini Nutritional Assessment Short-Form (MNA-SF): a practical tool for identification of nutritional status. *The journal of nutrition, health & aging*. 2009;13:782-788.
36. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. *Nutrition*. 1999;15:458-464.
37. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z, Ad Hoc ESPEN Working Group. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr*. 2003;22:321-336.

38. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Acute renal failure. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=23011. Accessed March 23, 2017.
39. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Chronic kidney disease (CKD) Stage 1-5 non-dialysis. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=23081. Accessed March 23, 2017.
40. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Chronic kidney disease (CKD) Stage 5 dialysis. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=255666. Accessed March 23, 2017.
41. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Anorexia nervosa. https://www.nutritioncaremanual.org/topic.cfm?ncm_toc_id=21689. Accessed March 23, 2017.
42. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Bulimia. https://www.nutritioncaremanual.org/topic.cfm?ncm_toc_id=21829. Accessed March 23, 2017.
43. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Aspiration pneumonia. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=36819. Accessed March 23, 2017.

44. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Bariatric surgery. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=16927. Accessed March 23, 2017.
45. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Burns. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&lv1=5512&ncm_toc_id=5512&ncm_heading=&. Accessed March 23, 2017.
46. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Diarrhea. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&lv1=5522&lv2=19099&ncm_toc_id=19099&ncm_heading=&. Accessed March 23, 2017.
47. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Cirrhosis. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&lv1=5522&lv2=18609&ncm_toc_id=18609&ncm_heading=&. Accessed March 23, 2017.
48. Academy of Nutrition and Dietetics. Nutrition Care Manual®. General guidelines for organ transplant. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=272985. Accessed March 23, 2017.
49. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Cystic fibrosis. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=36818. Accessed March 23, 2017.
50. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Gestational diabetes. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=18188. Accessed March 23, 2017.

51. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Type 1. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&lv1=5517&lv2=18399&ncm_toc_id=18399&ncm_heading=&. Accessed March 23, 2017.
52. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Type 2. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=18469. Accessed March 23, 2017.
53. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Heart failure. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=8585. Accessed March 23, 2017.
54. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Malnutrition. https://www.nutritioncaremanual.org/content.cfm?ncm_content_id=111000. Accessed March 23, 2017.
55. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Pressure ulcers. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&ncm_toc_id=16668. Accessed March 23, 2017.
56. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Pancreatitis. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&lv1=5522&lv2=19869&ncm_toc_id=19869&ncm_heading=&. Accessed March 23, 2017.
57. Academy of Nutrition and Dietetics. Nutrition Care Manual®. Bowel resection. https://www.nutritioncaremanual.org/topic.cfm?ncm_category_id=1&lv1=5522&lv2=144839&ncm_toc_id=144839&ncm_heading=&. Accessed March 23, 2017.
58. Pallant, J. *SPSS Survival Manual.* 3rd ed. Open University Press; 2007.

59. Fort Collins Science Center. Statistical interpretation. Available at: https://www.fort.usgs.gov/sites/landsat-imagery-unique-resource/statistical-interpretation. Accessed March 25, 2017.
60. Cohen, J. Statistical power and analysis for the behavioral sciences (2nd ed.) Hillsdale, N.J.: Lawrence Erlbaum Associates, Inc.; 1988.
61. Calvo I, Olivar J, Martinez E, Rico A, Diaz J, Gimena M. MNA(R) Mini Nutritional Assessment as a nutritional screening tool for hospitalized older adults; rationales and feasibility. *Nutr Hosp*. 2012;27:1619-1625.
62. Schrader E, Baumgartel C, Gueldenzoph H, et al. Nutritional status according to Mini Nutritional Assessment is related to functional status in geriatric patients--independent of health status. *J Nutr Health Aging*. 2014;18:257-263.
63. Young AM, Kidston S, Banks MD, Mudge AM, Isenring EA. Malnutrition screening tools: comparison against two validated nutrition assessment methods in older medical inpatients. *Nutrition*. 2013;29:101-106.
64. Park KH. A retrospective study using the pressure ulcer scale for healing (PUSH) tool to examine factors affecting stage II pressure ulcer healing in a Korean acute care hospital. *Ostomy Wound Manage*. 2014;60:40-51.
65. Sam J, Nguyen GC. Protein-calorie malnutrition as a prognostic indicator of mortality among patients hospitalized with cirrhosis and portal hypertension. *Liver Int*. 2009;29:1396-1402.

APPENDIX A: ICD-9 AND ICD-10 DIAGNOSIS CODES

	2015	Effective October 1, 2015
Aramark Diagnosis	**ICD-9**	**ICD-10**
Acute/Chronic Kidney Disease		
	584 ACUTE KIDNEY FAILURE	N17 ACUTE KIDNEY FAILURE
	584.5	N17.0
	584.6	N17.1
	584.7	N17.2
	584.8	N17.8
	584.9	N17.9
	585 CHRONIC KIDNEY DISEASE (CKD)	N18 CHRONIC KIDNEY DISEASE (CKD)
	585.1	N18.1
	585.2	N18.2
	585.3	N18.3
	585.4	N18.4
	585.5	N18.5
	585.6	N18.6
	585.9	N18.9
	586 RENAL FAILURE, UNSPECIFIED	N19 UNSPECIFIED RENAL FAILURE
Anorexia/Bulimia		
		F50 EATING DISORDERS
	307.1 Anorexia nervosa	F50.0 anorexia nervosa
		F50.00 …unspecified
		F50.01 …restricting type
	307.50 Eating disorder, unspecified	F50.02…binge eating/purging type
	307.51 Bulimia nervosa	F50.2 Bulimia nervosa
		F50.8 Other eating disorders
		F50.9 Eating disorder, unspecified
Aspiration Pneumonia		
	507 PNEUMONITIS DUE TO SOLIDS AND LIQUIDS	J69 PNEUMONITIS DUE TO SOLIDS AND LIQUIDS
	507.0 Pneumonitis due to inhalation of food or vomitus	J69.0 Pneumonitis due to inhalation of food and vomit
	507.8 Pneumonitis due to other soids and liquids	J69.8 Pneumonitis due to inhalation of other solids and liquids
Bariatric Surgery		
	278.01 Morbid obesity	E66.01 Morbid (severe) obesity due to excess calories
Burns		

941 Burn of face head and neck (941.00-941.59)	T20.00XA-20.39XA
	T20.319A
	T26.40XA
942 Burn of trunk (942.00-942.59)	T21.00XA-21.39XA
943 Burn of upper limb except wrist and hand (943.00-943.59)	T22.00XA
	T22.019A-T22.099A
	T22.10XA
	T22.119XA-T22.169XA
	T22.199A
	T22.20XA
	T22.219A-T22.269A
	T22.299A
	T22.30XA
	T22.319A-T22.369A
	T22.399A
944 Burn of wrist and hand (944.00-944.58)	T23.009A-T23.079A
	T23.109A-T23.179A
	T23.209A-T23.279A
	T23.299A
	T23.309A-T23.379
	T23.399A
945 Burn of lower limb (945.00-945.59)	T24.009A
	T25.019A-T25.039A
	T24.099A
	T25.099A
	T24.109A-T24.139A
	T24.199A
	T25.199A
	T24.209A-T24.239A
	T24.299A
	T25.299A
	T24.309A-T24.339A
	T24.399A
	T25.299A
946 Burn of multiple specific sites (946.0-946.5)	T30.0 Burn of unspecified body region, unspecified degree
948 Burns classified according to extent of body surface involved (948.00-948.99)	T31.0-31.99 Burns involving XX% of body surface with X degree burns
949 Burns unspecified site (949.0-949.5)	T30.0
Chronic Diarrhea	
564.5 Functional diarrhea	K59.1 Functional diarrhea

		K52.9 Chronic diarrhea
Cirrhosis		
	571.2 Alcoholic cirrhosis of liver	K70.30 Alcoholic cirrhosis of liver without ascites
		K70.31 …with ascites
	571.5 Cirrhosis of liver without mention of alcohol	K74.0 Hepatic fibrosis
		K74.60 Unspecified cirrhosis of liver
		K74.69 Other cirrhosis of liver
	571.6 Biliary cirrhosis	K74.3 Primary biliary cirrhosis
		K74.4 Secondary biliary cirrhosis
		K74.5 Biliary cirrhosis, unspecified
Current Organ Transplant		
	V42.1 Heart replaced by transplant	Z94.1 Transplant, heart
	V42.6 Lung replaced by transplant	Z94.2 Transplant, lung
	V42.7 Liver replaced by transplant	Z94.4 Transplant, liver
	V42.83 Pancreas replaced by transplant	Z94.83 Transplant, pancreas
	V42.0 Kidney replaced by transplant	Z94.0 Transplant, kidney
Cystic Fibrosis		
	277.00 Cystic fibrosis without mention of meconium ileus	E84.9 Cystic fibrosis, unspecified
	277.01 Cystic fibrosis with meconium ileus	E84.11 Meconium ileus in cystic fibrosis
	277.02 Cystic fibrosis with pulmonary manifestations	E84.0 Cystic fibrosis with pulmonary manifestations
	277.03 Cystic fibrosis with gastrointestinal manifestations	E84.19 Cystic fibrosis with other intestinal manifestations
	277.09 Cystic fibrosis with other manifestations	E84.8 Cystic fibrosis with other manifestations
Diabetes (newly diagnosed or gestational)		
	250.00 Diabetes mellitus without mention of complication, type II or unspecified type, not stated as uncontrolled	E11.9 Type 2 diabetes mellitus without complications
	250.01 Diabetes mellitus without mention of complication, type I, not stated as uncontrolled	E10.9 Type 1 diabetes mellitus without complications
	250.02 Diabetes mellitus without mention of complication, type II or unspecified type, uncontrolled	E11.65 Type 2 diabetes mellitus with hyperglycemia
	250.03 Diabetes mellitus without mention of complication, type I, uncontrolled	E10.65 Type 1 diabetes mellitus with hyperglycemia
	250.10 Diabetes with ketoacidosis, type II or unspecified type, not stated as uncontrolled	E11.69 Type 2 diabetes mellitus with other specified complication
	250.11 Diabetes with ketoacidosis, type I, not stated as uncontrolled	E10.10 Type 1 diabetes mellitus with ketoacidosis without coma
	250.12 Diabetes with ketoacidosis, type II or unspecified type, uncontrolled	E13.10 Other specified diabetes mellitus with ketoacidosis without coma

250.13 Diabetes with ketoacidosis, type I, uncontrolled	
250.20 Diabetes with hyperosmolarity, type II or unspecified type, not stated as uncontrolled	E11.00 Type 2 diabetes mellitus with hyper osmolarity without nonketotic hyperglycemic-hyperosmolar coma (NKHHC)
250.21 Diabetes with hyperosmolarity, type I, not stated as uncontrolled	E10.69 Type 1 diabetes mellitus with other specified condition
250.22 Diabetes with hyperosmolarity, type II or unspecified type, uncontrolled	
250.23 Diabetes with hyper osmolarity, type I, uncontrolled	
649.80 Abnormal glucose tolerance of mother, unspecified as to episode of care or not applicable	099.810 Abnormal glucose complicating pregnancy
648.81 Abnormal glucose tolerance of mother, delivered, with or without mention of antepartum condition	024.419 Gestational diabetes mellitus in pregnancy, unspecified control
	024.429 Gestational diabetes mellitus in childbirth, unspecified control
	099.814 Abnormal glucose complicating childbirth
648.82 Abnormal glucose tolerance of mother, delivered, with mention of postpartum complication	099.815 Abnormal glucose complicating the puerperium
648.83 Abnormal glucose tolerance of mother, antepartum condition or complication	
648.84 Abnormal glucose tolerance of mother, postpartum condition or complication	024.439 Gestational diabetes mellitus in the puerperium, unspecified control
Heart Failure	
428.0 Congestive heart failure, unspecified	I50.9 Heart failure, unspecified
428.1 Left heart failure	I50.1 Left ventricular failure
428.20 Systolic heart failure, unspecified	I50.20 Unspecified systolic (congestive) heart failure
428.21 Acute systolic heart failure	I50.21 Acute systolic (congestive) heart failure
428.22 Chronic systolic heart failure	I50.22 Chronic systolic (congestive) heart failure
428.23 Acute on chronic systolic heart failure	I50.23 Acute on chronic systolic (congestive) heart failure
428.30 Diastolic heart failure, unspecified	I50.30 Unspecified diastolic (congestive) heart failure
428.31 Acute diastolic heart failure	I50.31 Acute diastolic (congestive) heart failure
428.32 Chronic diastolic heart failure	I50.32 Chronic diastolic (congestive) heart failure
428.33 Acute on chronic diastolic heart failure	I50.33 Acute on chronic diastolic (congestive) heart failure
428.40 Combined systolic and diastolic heart failure, unspecified	I50.40 Unspecified combined systolic (congestive) and diastolic (congestive) heart failure
428.41 Acute combined systolic and diastolic heart failure	I50.41 Acute combined systolic (congestive) and diastolic (congestive) heart failure

428.42 Chronic combined systolic and diastolic heart failure	I50.42 Chronic combined systolic (congestive) and diastolic (congestive) heart failure
428.43 Acute on chronic combined systolic and diastolic heart failure	I50.43 Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure
428.9 Heart failure, unspecified	
Malnutrition	
262 Other severe protein-calorie malnutrition	E43 Unspecified severe protein-calorie malnutrition
263.0 Malnutrition of moderate degree	E44.0 Moderate protein-calorie malnutrition
263.1 Malnutrition of mild degree	E44.1 Mild protein-calorie malnutrition
263.8 Other protein-calorie malnutrition	E46 Unspecified protein-calorie malnutrition
263.9 Unspecified protein-calorie malnutrition	
Pressure Ulcer (stage II or greater)	
707.00 Pressure ulcer, unspecified site	L89.002-L89.004 Stage II-IV Pressure ulcer of unspecified elbow
707.01 Pressure ulcer, elbow	L89.012-L89.014 Stage II-IV Pressure ulcer of right elbow
	L89.022-L89.024 Stage II-IV Pressure ulcer of left elbow
707.02 Pressure ulcer, upper back	L89.102-L89.104 Stage II-IV Pressure ulcer of unspecified part of back
	L89.112-L89.114 Stage II-IV Pressure ulcer of right upper back
	L89.122-L89.124 Stage II-IV Pressure ulcer of left upper back
707.03 Pressure ulcer, lower back	L89.132-L89.134 Stage II-IV Pressure ulcer of right lower back
	L89.142-L89.144 Stage II-IV Pressure ulcer of left lower back
	L89.152-L89.154 Stage II-IV Pressure ulcer of sacral region
707.04 Pressure ulcer, hip	L89.202-L89.204 Stage II-IV Pressure ulcer of unspecified hip
	L89.212-L89.214 Stage II-IV Pressure ulcer of right hip
	L89.222-L89.224 Stage II-IV Pressure ulcer of left hip
707.05 Pressure ulcer, buttock	L89.302-L89.304 Stage II-IV Pressure ulcer of unspecified buttock
	L89.312-L89.314 Stage II-IV Pressure ulcer of right buttock
	L89.322-L89.324 Stage II-IV Pressure ulcer of left buttock
	L89.42-L89.44 Stage II-IV Pressure ulcer of contiguous site of back, buttock, and hip
707.06 Pressure ulcer, ankle	L89.502-L89.504 Stage II-IV Pressure ulcer of unspecified ankle
	L89.512-L89.514 Stage II-IV Pressure ulcer of right ankle

		L89.522-L89.524 Stage II-IV Pressure ulcer of left ankle
	707.07 Pressure ulcer, heel	L89.602-L89.604 Stage II-IV Pressure ulcer of unspecified heel
		L89.612-L89.614 Stage II-IV Pressure ulcer of right heel
		L89.622-L89.624 Stage II-IV Pressure ulcer of left heel
	707.09 Pressure ulcer, other site	L89.812-L89.814 Stage II-IV Pressure ulcer of head
		L89.892-L89.894 Stage II-IV Pressure ulcer of other site
		L89.92-L89.94 Stage II-IV Pressure ulcer of unspecified site
	707.22 Pressure ulcer, stage II	
	707.23 Pressure ulcer, stage III	
	707.24 Pressure ulcer, stage IV	
	707.25 Pressure ulcer, unstageable	
Severe Acute Pancreatitis		
	577.0 Acute pancreatitis	K85.9 Acute pancreatitis, unspecified
		K85.2 …alcohol induced
		K85.1 …biliary/gallstone
		K85.3 …drug induced
		K85.0 …idiopathic
		K85.8 …specified NEC
Short Bowel Syndrome		
	579.3 Other and unspecified postsurgical nonabsorption	K91.2 Postsurgical malabsorption, not elsewhere classified
	579.8 Other specified intestinal malabsorption	K90.4 Malabsorption due to intolerance, not elsewhere classified
		K90.89 Other intestinal malabsorption
	579.9 Unspecified intestinal malabsorption	K90.9 Intestinal malabsorption, unspecified
Palliative/Hospice Care (excluded)		
	V66.7 Encounter for palliative care	Z51.5 Encounter for palliative care