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Utilizing multiple methods to classify malnutrition among elderly patients admitted to the medical and surgical intensive care units (ICU)

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Abstract

Background & Aims—The nutritional status of elderly patients requiring ICU admission is largely unknown. This study evaluated the prevalence of malnutrition in patients (>65 years) admitted to the surgical and medical ICUs, agreement between assessment techniques and associations between malnutrition and adverse outcomes.

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Methods—For this prospective cohort, nutritional status was classified concurrently using the Mini Nutrition Assessment (MNA), Subjective Global Assessment (SGA), Nutrition Risk Score 2002 (NRS 2002) and MNA-short form (MNA-SF). Demographic and relevant medical information were collected from the medical record prior to the nutrition interview and/or following hospital discharge. Descriptive statistics, inter-rater agreement and regression analyses were conducted.

Results—The average patient was 74.2 ($\pm$ 6.8) yo with a mean APACHE II score 11.9 ($\pm$ 3.6). Malnutrition was prevalent in 23–34% of patients (n=260) with excellent agreement between raters. Compared to MNA, NRS 2002 had the highest sensitivity, while SGA and MNA-SF had higher specificity. Malnutrition at ICU admission was associated with longer hospital LOS, a lower propensity for being discharged home and a greater need for hospice care or death at discharge (all p values <0.05). These relationships were diminished when controlling for severity of illness.

Conclusions—Future work in this elderly population needs to explore the role of disease acuity, inflammation and body composition in the nutrition assessment process and in the examination of outcomes.

Keywords

malnutrition; elderly; intensive care unit; nutritional status; mini nutrition assessment; nutrition risk score 2002; subjective global assessment

1. Introduction

Although not universally defined, malnutrition is broadly considered a decline in lean body mass with the potential for functional impairment.¹ It typically occurs along a continuum of inadequate intake with or without increased requirements, impaired absorption, altered transport or nutrient utilization, or a combination of these factors. While the prevalence of malnutrition is relatively low in free-living elderly persons (5–10%),^{2,3} for older individuals who are hospitalized, the risk of malnutrition increases considerably. Covinsky et al performed Subjective Global Assessment (SGA) on 311 older medical patients (aged 70 years) and found that 26% were moderately malnourished and 17% were severely malnourished⁴. A multinational evaluation of malnutrition in older adults using the Mini Nutrition Assessment (MNA) reported that malnutrition was prevalent in 38.7% of hospitalized participants.³ Using SGA and the Mini Nutrition Assessment, Persson et al reported that ~50% of older patients (>70 years of age) were malnourished or at risk of malnutrition at the time of admission to the geriatric or general medical floor⁵. These authors also reported that 1-, 2- and 3-year mortality was significantly higher for patients who were classified as malnourished compared to those classified as well nourished, demonstrating the importance of addressing nutritional status and potential therapies in this unique patient group.

Elderly patients admitted to the ICU are an exceptionally vulnerable patient population. Often these patients have several conditions that impede oral intake and impair nutritional status. When coupled with an acute disease process, it is likely elderly patients requiring ICU admission are at exceptional risk for nutritional decline; however, there is a paucity of data that has specifically explored the prevalence of malnutrition in this particular population. This is partially explained by the lack of a nutrition assessment tool that is considered the “gold standard” methodology for malnutrition classification in any hospitalized population. Therefore, the purpose of the present study was threefold: 1) to evaluate the prevalence of malnutrition for older patients (>65 years) admitted to the surgical and medical ICUs utilizing 3 widely used nutrition assessments techniques; 2) to

assess the level of agreement between these tools; and 3) to determine if malnutrition by any of these tools was predictive of adverse outcomes. We hypothesized that the majority of elderly participants would be malnourished at ICU admission and that malnutrition would be significantly associated with hospital and ICU length of stay and lower likelihood of being discharged home. Findings from this investigation will extend previous studies by broadening our recognition of these occurrences in a heterogeneous sample of elderly patients.

2. Materials and Methods

Study design and patient population

A prospective cohort study in elderly subjects admitted to either, the surgical and the medical ICU at a tertiary care hospital was conducted over a 5 month period. Patients were eligible if they spoke English, were ≥ 65 years of age, and admitted to the surgical or medical ICU for >24 hours. Patients meeting eligibility criteria were queried by Registered Dietitians (RD) as part of an enhanced nutrition screening. Inclusion in the study did not alter the standard of care and none of the data collectors were involved in decisions regarding admission to the ICU. The ethical conduct of this study was approved by the medical center's Institutional Review Board.

Demographic and medical information

Demographic and medical information including sex, race/ethnicity, age, date of hospital admission, date of ICU admission, hospital discharge, ICU discharge, mechanical ventilation, ICU diagnosis, clinical variables related to APACHE II calculations, number of prescription medications taken before admission, height, weight, current mental status and hospital disposition were collected from the electronic medical record prior to the nutrition interview and/or following discharge from the hospital.

Nutritional status methodology

Three different techniques that allow for the classification of nutritional status were included. Three RDs were involved in the nutrition status classification process. Two RDs executed the nutrition interviews concurrently. One RD asked questions in a standardized manner with another RD present; answers were recorded independently and simultaneously. This minimized the participant having to be interviewed and measured twice and provided an excellent method to test the reliability of these assessment tools. If the patient was eligible for the study but unable to communicate due to language barriers or for medical reasons (eg, sedation, mechanical ventilation, confusion), his/her appropriate proxy was approached and queried. Three attempts were made to interview the proxy. If the nutrition assessment information could not be completed within these 3 attempts, the patient was recorded as a non-participant.

Nutrition status tools

Subjective global assessment (SGA), the Mini Nutrition Assessment (MNA) and the Nutrition Risk Screening (NRS 2002), often utilized in clinical practice and clinical research efforts, were selected based on the fact that these techniques permit the classification of nutritional status (ie, normal vs. malnourished) vs. other tools that categorized nutritional risk.

Subjective global assessment—Used collectively and systematically, the SGA tool includes five components of a medical history (eg, weight change, dietary intake, gastrointestinal (GI) symptoms, functional capacity, metabolic stress) and two components

of a brief physical examination (eg, signs of fat loss and muscle wasting, alterations in fluid balance). These component results are used to classify patients as “normally nourished,” “moderately malnourished” or “severely malnourished” and reflect a reliance on clinical judgment rather than biochemical or other objective markers to categorize nutritional status.⁶ SGA was originally validated by its ability to predict outcomes in surgical patients.^{7,8} All study RDs were formally trained and well versed in its clinical application.

Mini Nutrition Assessment—The MNA was specifically developed for the elderly population^{9,10} and consists of 18 items that include body mass index (BMI), weight loss, mid-arm and calf circumference, appetite, general and cognitive health, dietary matters and a self-reflective account of overall health. Prior to study initiation, all study RDs reviewed and trained on how to obtain mid-arm and calf circumference in a standard manner using a disposable measuring tape. All measurements were taken in duplicate and recorded to the nearest 0.1 cm. Scores were tallied and used to classify patients as follows: 24–30 points = normal nutritional status, 17–23.5 points = at risk for malnutrition, or <17 points = malnourished. A validated, short form of MNA (MNA-SF), which relies on only 6 questions for nutritional status classification (12–14 points = normal nutritional status, 8–11 points = at risk of malnutrition or 7 points = malnourished) was extrapolated from the complete MNA and used in the analyses.

Nutrition Risk Screening—The Nutrition Risk Screening (NRS 2002) is a tool developed by to decipher specific nutrition and medical risk factors associated with nutrition support administration.¹¹ It contains one scale to examine nutritional status (0–3 points) and one scale to assess potential changes in stress metabolism (0–3 points.) An additional point is added for persons >70 years of age and a total score >3 indicates that nutrition support should be initiated. For this study, the nutritional status score of the NRS 2002 was used in the analyses since scores were artificially elevated based on the age of the study population and APACHE scoring. This is indicated at NRSstat.

Statistical analysis

Standard descriptive statistics were conducted for demographic variables. Non-normally distributed variables were log transformed, as appropriate. To determine the strength of association between nutrition status rankings, inter-rater reliability was assessed using the Kappa statistic to compare the agreement of the individual rankings between raters for SGA, MNA and NRSstat. A Kappa = 1.0 represents a perfect agreement; a Kappa = -1.0 represents perfect disagreement; a Kappa of 0 indicates the two raters agree only at the chance level. The parameter cut-points described by Landis and Koch¹² were used to evaluate agreement (Kappa = 0 poor; 0.01–0.2 slight; 0.21–0.4 Fair; 0.41–0.6 Moderate; 0.61–0.8 Substantial; 0.81–1.0 Almost perfect). To allow for comparisons across tools, a dichotomized version of “malnourished” was created collapsing all status categorizations except normal. Sensitivity [true positive/(true positive + false negative)] and specificity [true negative/(true negative + false positive)] were calculated using the MNA as the reference method and correlation coefficients were used to evaluate the general associations between MNA and the other assessment techniques. Linear and logistic regression was conducted to test which nutrition status tool best predicted adverse outcomes. Hospital and ICU LOS were used as proxy measures of complications, while discharge to a skilled nursing facility was used to signify functional decline. All statistical analyses were conducted using SAS (version 9.2, 2002, SAS Institute Inc., Cary, NC). A p value of <0.05 was used to denote statistical significance.

3. Results

A total of 331 participants met the eligibility criteria over the study period. Seventy-one patients were unable to participate; 58 required a proxy (n=28 MICU, n=30 SICU), but did not have one; 10 declined to participate in the interview; and 3 were discharged from the ICU prior to nutritional assessment. Thus, 260 individuals had evaluable data. Baseline characteristics are presented in Table 1 stratified by medical or surgical ICU. Demographic characteristics were similar between these ICU populations; however, the medical ICU patients had significantly higher APACHE II scores ($p<.0001$), required mechanical ventilation more often ($p=.002$) and necessitated a higher use of proxies ($p<.001$) to obtain nutritional data compared to surgical ICU patients. No differences were detected between study participants and non-participants with regard to age, sex or BMI.

Overall the prevalence of malnutrition ranged from 6–31% using originally classifications categories; however, this increased to 23–34% when using a dichotomized definition of malnutrition (Table 2). The agreement between raters for nutritional status categorization reflected almost perfect agreement between raters for all 4 tools; MNA ($k=.92$), SGA ($k=.93$), NRSstat ($k=.91$) and MNA-SF ($k=.96$). This translates to different nutritional status categorizations between raters for 10 patients using MNA, 15 patients using SGA, 14 patients using NRSstat and for 4 patients using MNA-SF. To enhance clarity, results are reported where nutritional status categorizations had 100% agreement between raters; thus the n varies between tools (Tables 3–5).

Since MNA has been specifically designed for the elderly, it was used as the “gold standard” to compare baseline characteristics between participants ranked as normally nourished (scores 24–30) vs. malnourished (scores ≤ 23). As seen in Table 3 (N=254), BMI was significantly lower in those classified as malnourished ($p<.0001$), as well as APACHE II scores ($p=.0007$), and the need for proxies to complete the nutrition interview ($p=.0001$). MNA was also used as the “gold standard” to examine the sensitivity and specificity between SGA, NRS 2002, NRSstat and the MNA-SF (Table 4.). NRS 2002 had the highest sensitivity, while SGA and MNA-SF had nearly identical specificity.

The ability to predict adverse outcomes was evaluated for four nutritional status tools, only including the nutritional status component of the NRS 2002 (Table 5). Malnourished patients classified by all four tools had significantly longer hospital LOS than the normally nourished, controlling for age and sex. Only the MNA-SF was significantly associated with ICU LOS, after controlling for age and sex. Further, all four tools found patients classified as malnourished had a lower propensity for being discharged home and a significant association for needing hospice care or death at discharge. Only the MNA-SF was significantly associated with requiring skilled nursing care at discharge. When APACHE II scores were included in the models to control for severity of illness, the contribution of malnutrition categorization for predicting adverse outcomes became less significant for all four nutrition assessment tools.

5. Discussion

The present study was specifically conducted to assess the prevalence of malnutrition in a particularly vulnerable group of patients admitted to the ICU; an environment that is associated with profound morbidity and mortality, regardless of age. In many hospitalized populations, malnutrition (used synonymously with undernutrition) has been linked with declines in functional status, muscle strength, bone mass, immune and cognitive function, wound healing, surgical recovery, and higher hospital readmission rates and mortality.¹³ Overall, we found that 29% of elderly patients were malnourished at the time of admission to the medical or surgical ICU. Direct comparisons to other studies are difficult in this

particular patient population. Using SGA classifications, previous investigators have shown that 37–50% of the patients admitted to the medical^{14,15} and surgical ICU¹⁶ were malnourished. These study populations were younger, often required mechanical ventilation and had higher average APACHE II scores than patients in the current study. More closely aligned with the current patient population, Atalay et al¹⁷ used SGA to classify the nutritional status of geriatric patients (> 65 years) admitted to the ICU (n=119) who were receiving nutrition support. Thirty-four percent (n=40) were malnourished; 28% (n=33) were moderate and 6% (n=7) were severely malnourished. Even though our prevalence estimates are consistent with these previous reports, we believe our results are conservative since 58 individuals were unable to participate because they lacked a proxy. We speculate the majority of these individuals required mechanical ventilation and thus, reflect a sicker population that was simply unable to participate.

An important aspect of our study was the ability to demonstrate excellent reliability for classifying nutrition status employing methods that minimized participant burden and allowed for simultaneous capture of multiple assessment techniques. Nutrition assessment techniques via different tools have been investigated previously in the elderly^{18–21}; however, very little attention has been given to the elderly admitted to the ICU. Agreement between raters for each question was examined for each tool (data not shown). Using the Landis and Koch criteria,¹² agreement for only one MNA question failed to meet ‘almost perfect’ agreement (*Do you live in your home or a nursing home?*, 0.7899). While only speculative, the scoring of this question is a bit counterintuitive; that is, an answer of “own home” is scored as “one,” whereas it seems intuitive to score this as “zero.” It is important to recall that higher scores are equivalent to less risk for the MNA. Two others questions were at the lower end of this substantial agreement cut-point [*Are you able to eat without any help or do you need help (opening containers, cutting meats)?*, 0.8069; *How would you describe your state of health compared to others your age?*, 0.8053.] Clearly raters hearing the same information interpret and record answers differently, even though questions are constructed to obtain concrete answers and to minimize this occurrence. For SGA, the physical exam findings were the major area of disagreement between raters, revealing only ‘moderate agreement’ (.5549). Training on the physical exam is a central component of physician and nurse curriculum while dietitians receive little or no formal instruction in this area. Our discordant findings substantiate this limited training and support the recent interest to improve these important assessment skills for Registered Dietitians.²² Finally, the lower agreement scores for the NRS 2002 were due to discrepancies in the severity of disease component (moderate agreement, 0.6067.) Previous investigators have reported that the NRS 2002 overestimates nutritional risk in the elderly.²¹ In our experience, the additional NRS point for age >70 combined with the low APACHE II threshold (>10= 3 points) falsely elevated severity of disease. As a result, we refined our analyses to examine only the nutritional status component of the NRS 2002.

Findings from this study reinforce the difficulties of disentangling the acute disease process from the physiologic changes of malnutrition. Our data indicated that when severity of disease was controlled for, the independent effects of malnutrition were diminished for most of the outcome measures (Table 5). Dardaine et al²³ performed nutritional, medical, functional, and social assessments of elderly patients (> 70 years of age) who required ICU admission and ventilator support. As anticipated, severity of illness was an important predictor of ICU- and 6 month-mortality; however, admission nutritional status also demonstrated an independent association with 6-month mortality. Because these investigators used BMI, serum albumin and transferrin to measure nutritional status, these findings are not surprising. In fact, validation of the nutrition status classification tools is largely based on similar markers. For example, Baker et al⁷, Detsky et al⁸ and Vellas et al⁹ used serum proteins (albumin, transferrin^{7,8} and transthyretin⁹) and body weight parameters

to validate the SGA and MNA tools. The current understanding of inflammation and alterations in acute phase proteins²⁴ indicate that these foundational studies were detecting and classifying degrees of the acute phase response rather than malnutrition. Recent definitions for an etiology-based diagnosis of malnutrition emphasize the importance of recognizing the presence of inflammation and distinguishing three types of malnutrition syndromes: *starvation-related* (eg, anorexia nervosa), *chronic disease-related* (eg, organ failure) or *acute disease- or injury-related* (eg, trauma).^{1,25,26} This group advocates that nutrition assessment should take into consideration history and clinical diagnosis, physical exam and clinical signs, anthropometric data, laboratory data and food/nutrient intake. Inherent in all of these clinical characteristics is the recognition of adverse body composition changes and functional impairment along the malnutrition spectrum. With the growth of imaging diagnostics it is now possible to quantify changes in lean and fat tissue compartments in a variety of patient populations, as demonstrated by Prado^{27,28} and Tan.²⁹ Specifically, future studies should seek to determine if the classification of malnutrition by any of these nutrition status tools is indeed associated with lower levels of lean body mass through the exploitation of computed tomography (CT) images. While exposure to this level of radiation is difficult to justify in healthy populations, CT imaging is a common occurrence in ICU populations for diagnostic purposes. Although this requires specialized training and software for body composition assessment, it presents future opportunities to advance the field of nutrition assessment more readily in ICU populations. Further, to build upon our current models that classify nutritional status, the creation of biomarker repositories are needed to help us explore the associations with current and future markers of inflammation along the age spectrum and in conjunction with body composition assessment.

This study has limitations that warrant consideration. First, a dichotomized definition of malnutrition was created to allow for comparisons across tools. We opted to include those “at risk” per MNA as “malnourished” to better align with SGA and NRS 2002 nutritional status categorizations. This may have elevated the prevalence of malnutrition and the associations with outcomes for MNA; however, it did not modify these relationships for the other tools. Additionally, it may have impacted sensitivity and specificity differentially. Second, because the nutrition assessment interviews were led by one RD with the other RD present, reliability may be overestimated. This study was specifically designed to minimize participant burden due to the length of the MNA questionnaire and the acuity of the study environment; however, we recognized that it may have also minimized the variation in how questions were asked. To reduce this risk, the interviewers alternated taking the lead in asking questions between subjects. Third, we did not examine the potential associations with conventional serum markers (ie, albumin, transthyretin); instead APACHE II scores were used to more globally capture disease acuity. Fourth, 15 patients were admitted from a SNF to the ICU. We did exclude these individuals when we examined the disposition variables because 6 persons went home, 6 persons returned to a SNF and 3 required hospice or died. We retained these individuals reasoning that admission from a SNF does not necessarily mean discharge to a SNF. Finally, these results cannot be extrapolated to elderly patients admitted to any ICU since only the medical and surgery ICUs environments were evaluated. Considering that 18% (n=58) of the eligible study participants did not have a proxy to obtain vital nutrition assessment information, other ICU populations may experience different prevalence estimates and associated clinical outcomes. For example, the lower APACHE II scores, short ICU LOS and decreased number of participants requiring mechanical ventilation at surgical ICU admission reflects a “healthier” surgical population than most would consider typical in this environment³⁰.

Conclusions

Elderly patients require contextual tailoring when classifying malnutrition. This group may consume “suboptimal calories” and exhibit body weight that is “less than ideal,” warranting consideration of weight stability, independence and functional well-being.²⁶ This study supports previous investigations and extends our understanding further to demonstrate that malnutrition was evident in 23–34% of elderly patients at the time of medical or surgical ICU admission, using a variety of nutrition status tools. We demonstrated excellent reliability among raters across tools and found adverse associations between malnutrition at the time of ICU admission with hospital LOS, ICU LOS and disposition; however, these associations were tempered by illness acuity. Historically, clinicians and researchers have strived to parse out malnutrition from the disease process in order to demonstrate causality and the independent effects of nutrition therapies and nutrition interventions. While we did not directly measure inflammation or design this study to quantify the nutrition interventions initiated with the study population, our findings underscore the need for future work to consider the role of disease acuity, inflammation and body composition in the nutrition assessment process and in the examination of outcomes.

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Table 1

Baseline characteristics for elderly (>65 years of age) patients admitted to the medical or surgical intensive care units

Variable	Medical ICU Mean ($\pm$ SD) or Count (%) n= 149	Surgical ICU Mean ($\pm$ SD) or Count (%) n= 111	P-value
Age	74.6 (7.1)	73.8 (6.4)	0.3588
Sex			
Female	74 (50%)	58 (52%)	0.6797
Male	75 (50%)	53 (48%)	
Race/Ethnicity			
White	73 (49%)	82 (74%)	0.0003
Black	59 (40%)	22 (20%)	
Hispanic	12 (8%)	2 (1%)	
Other	5 (3%)	5 (5%)	
Body mass index on admission			
	28.5 (8.4)	28.4 (6.5)	0.9110
Underweight (<18.5)	8 (5%)	3 (3%)	0.7110
Normal weight (18.5–24.9)	46 (31%)	32 (29%)	
Overweight (25.0–29.9)	48 (32%)	38 (34%)	
Obese (>30.0)	47 (32%)	38 (34%)	
Admission diagnosis			
Fever/sepsis	20 (13.42%)	0 (0%)	<.0001
Gastrointestinal	23 (15.44%)	1 (1%)	
Respiratory	48 (32.21%)	8 (7%)	
Cardiac	24 (16.11%)	0 (0%)	
Renal	7 (4.70%)	1 (1%)	
Other	27 (16.78%)	1 (1%)	
General surgery	-	58 (52%)	N/A
Cardiovascular surgery	-	36 (32%)	
Transplant surgery	-	6 (5%)	
Apache II scores	13.5 (4.4)	10.2 (2.7)	<.0001
Mechanical Ventilation			
No	133 (89%)	110 (99%)	0.0015
Yes	16 (11%)	1 (1%)	
Source of information			
Patient	123(82.55%)	107(96.40%)	0.0005
Proxy	26(17.45%)	4(3.60%)	
Hospital length of stay (days)	9.1 (8.7)	8.4 (9.7)	0.5486

Variable	Medical ICU Mean ($\pm$ SD) or Count (%) n= 149	Surgical ICU Mean ($\pm$ SD) or Count (%) n= 111	P-value
ICU length of stay (days)	3.3 (5.6)	2.6 (4.1)	0.2412
DISPOSITION ^a			
Home	90 (67%)	90 (84%)	0.0017
Skilled Nursing Facility	36 (27%)	17 (16%)	
Hospice	9 (7%)	0 (0%)	
Discharge Status			
Alive	136 (91%)	107(97%)	0.0475
Dead	13 (9%)	3(3%)	

P-value:

*
< 0.1,

**
<0.05,

<0.01;

^a excludes those who died and 1 person with missing data

Table 2

Agreement between nutrition status categorizations for MAN, SGA, NRSstat and MNA-SF (N=260)

Nutrition Status Categories Count (%)	MNA n=250		SGA n=245		NRSstat n=246		MNA-SF n=256	
	Normal	164 (66%)	Normal	188 (77%)	Normal	171 (70%)	Normal	190 (74%)
	Risk of malnutrition	61 (24%)	Moderate	53 (21%)	Mild	26 (11%)	Risk of malnutrition	51 (20%)
	Malnourished	25 (10%)	Severe	4 (2%)	Moderate	12 (5%)	Malnourished	15 (6%)
					Severe	37 (15%)		
Kappa	0.9249		0.9275		0.9137		0.9632	

Abbreviations used: MNA=mini nutrition assessment, SGA=subjective global assessment, NRS stat= nutrition risk score 2002 nutritional status only, MNA-SF- mini nutrition assessment short form

Table 3

Baseline characteristics for elderly (>65 years of age) patients admitted to medical or surgical intensive care units using MNA for nutritional status classification (N=254)

Variable	Normal (MNA Final Score 24) Mean (± SD) or Count (Per) n=164	Malnourished (MNA Final Score 23) Mean (± SD) or Count (Per) n=90	P-value
Age	73.8 (± 6.3)	74.9 (± 7.7)	0.2287
Sex			
Female	86 (52%)	42 (47%)	0.9610
Male	78 (48%)	48 (53%)	
Race/Ethnicity			
White	101 (62%)	50 (56%)	0.3733
Black	48 (29%)	31 (34%)	
Hispanic	7 (4%)	7 (8%)	
Other	8 (5%)	2 (2%)	
Body mass index on admission	30.5 (7.4)	24.5 (5.8)	<.0001
Underweight (<18.5)	0 (0%)	11 (12%)	0.3261
Normal weight (18.5–24.9)	33 (20%)	43 (48%)	
Overweight(25.0–29.9)	63 (38%)	22 (24%)	
Obese (>30.0)	68 (42%)	14 (16%)	
Admission diagnosis			
Fever/sepsis	8 (5%)	10 (11%)	0.0461
Gastrointestinal	13 (8%)	9 (10%)	
Respiratory	33 (20%)	23 (26%)	
Cardiac	19 (12%)	5 (6%)	
Renal	4 (2%)	4 (4%)	
Other	13 (8%)	11 (12%)	
General surgery	40 (3%)	20 (7%)	
Cardiovascular surgery	28 (17%)	8 (9%)	
Transplant surgery	6 (4%)	0 (0%)	
Apache II	11.4 (3.8)	13.2 (4.4)	0.0007
Mechanical Ventilation			
No	157 (96%)	81 (90%)	0.0721
Yes	7 (4%)	9 (11%)	
Source of information			
Patient	155 (95%)	71 (79%)	0.0001
Proxy	9 (5%)	19 (21%)	

Sensitivity and specificity between the MNA and SGA, NRS 2002, NRSstat and the MNA-SF tools for dichotomized nutrition status

Table 4

	SGA		NRS 2002		NRSstat		MNA-SF	
	Normal	Maln	Normal	Maln	Normal	Maln	Normal	Maln
MNA	Normal	160	65	82	152	6	161	3
	Maln	24	11	74	16	69	25	64
	Sensitivity	0.71		0.87		0.81		0.72
	Specificity	0.99		0.44		0.96		0.98
	Pearson Correlation	0.78		0.32		0.70		0.76
n		244		232		243		253

Abbreviations used: MNA=mini nutrition assessment, SGA=subjective global assessment, NRS 2002= nutrition risk score 2002, MNA-SF- mini nutrition assessment short form; NRSstat= nutrition risk score 2002 nutritional status only, Maln=malnourished

Table 5
Associations between outcomes and nutritional status using the MNA, Mini MNA, SGA and NRSstat

Variable	MNA				MNA-SF			
	Normal n=164	Malnourished n=90	P-value ^a	P-value ^b	Normal n=190	Malnourished n=69	P-value ^a	P-value ^b
Hospital LOS (mean ± SD days)	7.8 (7.8)	10.8 (11.1)	0.008	0.067	8.2 (7.8)	10.6 (12.0)	0.03	0.182
ICU LOS (mean ± SD days)	2.7 (4.9)	3.7 (5.3)	0.09	0.170	2.7 (4.6)	4.1 (5.9)	0.03	0.063
DISPOSITION^c								
Home	125 (77%)	51 (57%)	0.002	0.189	146 (77%)	33 (49%)	0.002	0.189
SNF	28 (17%)	23 (26%)	0.12	0.155	33 (17%)	20 (29%)	<.0001	0.0002
Hospice/dead	10 (6%)	15 (17%)	0.014	0.090	10 (5%)	15 (22%)	0.0005	0.004
Variable	SGA				NRSstat			
	Normal n=188	Malnourished n=61	P-value ^a	P-value ^b	Normal n=171	Malnourished n=77	P-value ^a	P-value ^b
Hospital LOS (mean ± SD days)	8.0 (7.8)	11.3 (12.6)	0.011	0.077	8.0 (8.0)	11.1 (11.5)	0.016	0.080
ICU LOS (mean ± SD days)	2.7 (4.7)	4.1 (6.2)	0.067	0.110	2.8 (4.9)	3.8 (5.6)	0.155	0.227
DISPOSITION^c								
Home	143 (77%)	29 (48%)	<.0001	0.001	128 (75%)	41 (54%)	0.009	0.011
SNF	35 (18%)	17 (28%)	0.114	0.171	32 (19%)	20 (26%)	0.195	0.256
Hospice/dead	9 (5%)	14 (23%)	0.0002	0.003	10 (6%)	15 (20%)	0.002	0.026

^a controlling for age and sex;

^b controlling for APACHE II;

^c 1 person with missing data

Abbreviations used: MNA=mini nutrition assessment, SGA=subjective global assessment, NRS 2002= nutrition risk score 2002, MNA-SF= mini nutrition assessment short form, NRSstat= nutrition risk score 2002 nutritional status only, LOS=length of stay, SNF= skilled nursing facility