

Original Article

Nutritional Indices to Predict 1-Month Mortality or Readmission and the Need for Nutritional Support in Patients With Acute Decompensated Heart Failure

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ABSTRACT

Background: Malnutrition is a common condition related to poor prognosis in patients with heart failure (HF). The present study aimed to investigate the impacts of nutritional indices on short-term clinical outcomes and elucidate risk factors associated with the need for nutritional supplementation in patients with acute decompensated heart failure (ADHF).

Methods: To evaluate the nutrition index at the beginning of hospitalization, we completed the Mini Nutritional Assessment (MNA) questionnaire and calculated the Nutritional Risk Index (NRI) and the Controlling Nutritional Status (CONUT) score in patients with ADHF.

Results: Over 40% of hospitalized patients with ADHF had moderate-to-severe nutritional disturbances determined by the NRI, the MNA, and the CONUT score. During a 1-month follow-up, hospitalization was reported in 8 patients, of whom 3 died. Twenty-five of 58 patients (43%) were categorized as needing nutritional support. Lower body mass indices and total albumin levels were independent predictors of the need for nutritional support (OR, 0.35; 95% CI, 0.13 to 0.97; $P=0.044$ and OR, 0.36; 95% CI, 0.15 to 0.88; $P=0.0250$, respectively).

Conclusions: Over 40% of hospitalized patients with ADHF had moderate-to-severe nutritional disturbances and needed nutritional support. The assessment of nutritional status may provide additional prognostic information and, thus, could be useful in the risk stratification of patients with ADHF. (*Iranian Heart Journal 2023; 24(2): 14-22*)

KEYWORDS: Malnutrition, Heart failure, Prognosis

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Malnutrition has been a significant risk factor in various cardiovascular disorders. A large body of evidence suggests that nutritional conditions influence the development of heart failure (HF) and its related outcomes. Malnutrition may increase the production of catabolic cytokines, such as TNF- α , interleukin-6, and interleukin-1 β , which may lead to inflammation, impact cardiac remodeling, and worsen HF.^{1,2} An imbalance between anabolic and catabolic conditions in patients with HF can cause malnutrition.³ Despite such close relationships between nutritional conditions and HF, it is difficult to diagnose malnutrition and cachexia in patients with HF because of body weight gain due to edema or excessive extracellular fluids in these patients.⁴

Many researchers have shown that albumin and body mass index (BMI), which can be markers of nutritional status, are related to adverse clinical outcomes in various cardiovascular disorders.⁵⁻⁸ Nonetheless, assessing nutritional status by an item such as albumin or BMI may not accurately reflect nutritional status. To overcome the limitations of a 1-parameter approach to the assessment of nutritional status, investigators have suggested several indicators and scoring systems. Nevertheless, the role of some scores, including the Nutritional Risk Index (NRI) in patients with acute decompensated heart failure (ADHF) has been poorly evaluated.

The ability to reliably identify patients who may need nutritional supplementation, either enteral or parenteral, may enable caregivers to improve the time to initiation.

Therefore, in the current study, we sought to investigate the impacts of nutritional indices on short-term clinical outcomes and to elucidate risk factors associated with the need for nutritional supplementation in patients with ADHF.

METHODS

Subjects and Study Protocol

The present retrospective study enrolled 58 adult patients who had been initially hospitalized for ADHF treatment at Rajaie Cardiovascular Medical and Research Center and then discharged between October 2020 and April 2021. The diagnosis of ADHF was made based on HF guidelines. All necessary laboratory tests, including complete blood count, hemoglobin level, lipid profile (triglyceride, total cholesterol, low-density lipoprotein, and high-density lipoprotein), blood urea nitrogen, creatinine, serum calcium, uric acid, liver function test (alanine aminotransferase, aspartate aminotransferase [AST], alkaline phosphatase, and total and direct bilirubin), serum albumin, serum total protein, and thyroid stimulating hormone, were performed at our laboratory on admission and/or after 12 to 14 hours of overnight fasting if needed.

A limited transthoracic echocardiographic examination was performed for all the patients on admission according to international echocardiography guidelines.

Evaluation of Nutritional Status

To evaluate the nutrition index at the beginning of hospitalization, we completed the Mini Nutritional Assessment (MNA) questionnaire for these patients. We also calculated the Nutritional Risk Index (NRI) and the Controlling Nutritional Status (CONUT) score. Additionally, we obtained the information required to determine scores from the patients' records and tests. Patients lacking data regarding 1 or more of the components of these scores (eg, serum albumin, serum total cholesterol, total lymphocyte count, and body weight), those who had acute coronary syndromes, patients who received dialysis, those who had distinct advanced cancer, and patients who refused to fill out a consent form to participate in the study were excluded.

Outcomes

The outcome of interest was early all-cause mortality or early readmission, and all the patients were followed up for 1 month in that regard. We were able to follow up all the patients. The study protocol was carried out in accordance with the principles outlined in the Declaration of Helsinki. The reporting of the study conforms to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE), along with references to STROBE and the broader Enhancing the QUALity and Transparency Of Health Research guidelines.¹⁵ The study protocol was approved by the ethics committee of our institution (IR.IUMS.FMD.REC.1399.790) before the enrollment of any patient, and written consent forms were obtained from the patients before study inclusion. In addition, the patients were ensured regarding the confidentiality of their information.

Definition of Commodities

Hypertension was defined as the recent use of antihypertensive drugs, systolic blood pressure ≥ 140 mm Hg, and/or diastolic blood pressure ≥ 90 mm Hg. Diabetes was defined as the recent use of insulin or antidiabetic drugs, fasting blood glucose >126 mg/dL, and/ or hemoglobin A1c $>6.5\%$.

Chronic kidney disease was defined as an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 cm². BMI was calculated as weight (kg) divided by height (m²).

Nutritional Assessment and Classifications

We used the Persian version of the full MNA provided by Societe des Pro-Duits Nestle S. A., Vevey, Switzerland, Trademark Owners, which holds the copyright of the instrument.²

The MNA is a simple and noninvasive clinical scale containing 2-steps nutritional screening of the elderly in different settings. The full MNA is a nutritional summated tool

containing 18 items, with a total score of 30. MNA scores ≥ 24 indicate that the individual is well-nourished, scores $=17-23.5$ indicate that the individual is at risk of malnutrition, and scores <17 indicate that the individual is undernourished in terms of protein-calorie.⁵

The NRI was originally derived from the serum albumin concentration and the ratio of present to usual weight. The NRI uses objective measurements to calculate a score from the following formula⁹:

$$1.519 \times \text{serum albumin} + 41.7 \times \text{current weight/usual body weight}$$

From NRI values, we defined 4 grades of nutrition-related risk: (i) severe risk (NRI <83.5); (ii) moderate risk (NRI=83.5–97.5); (iii) mild risk (NRI=97.5–100); and (iv) no risk (NRI >100). NRI cutoff values were determined according to weight losses of 5%, 10%, or 20%. Weight loss norms of 5% and 10% have already been validated by the European Society of Parenteral and Enteral Nutrition (ESPEN) Guidelines for Nutritional Screening.³ Ideal body weight is estimated based on height and does not take into account age, racial origin, or muscle mass. The Devine formula is used for males and the Robinson formula for females.^{4,8}

The CONUT score was calculated using serum albumin and total cholesterol levels, and the total lymphocyte count was measured in accordance with previous reports.¹⁰ Patients with a CONUT score of 0–1 have a normal nutritional status, those with a CONUT score of 2–4 are at mild risk of malnutrition, those with a CONUT score of 5–8 are at moderate risk, and those with a CONUT score of 9–12 are at severe risk.⁶

Statistical Analysis

The analyses were performed using the SPSS software (version 24.0, IBM Corp, Armonk, NY, USA). The Kolmogorov–Smirnov test was used to identify the normality of continuous variables. Normally and non-

normally distributed variables were presented as the mean (the standard deviation [SD]) and the median (the interquartile range [IQR]), respectively. Between-group differences for categorical variables were analyzed using the χ^2 or Fisher exact test as appropriate. The independent *t* test and the Mann–Whitney *U* test were used for the analysis of the normally and non-normally distributed variables, respectively. Correlations between nutritional scores were assessed using the Spearman correlation analysis. For the assessment of each nutritional index to predict 1-month mortality or rehospitalization, the areas under the curve (AUC) of the receiver operating characteristic (ROC) curve was estimated. For the estimation of the need for nutritional support, a multivariate logistic regression model was drawn upon. The adjusted odds ratio (OR) and the 95% confidence interval (CI) were calculated. A *P* value <0.05 was considered statistically significant for all comparisons.

RESULTS

The demographic, laboratory test, and echocardiographic data of the present study subjects (mean age =46 y, males =55.2%, and mean left ventricular ejection fraction =11%) are summarized in Table 1.

Over 40% of hospitalized patients with ADHF had moderate-to-severe nutritional disturbances determined by the NRI, the MNA, and the CONUT score (the NRI

grade =37.9%, the MNA score =53%, the CONUT score =43%, and the NRI grade =37.9). During the 1-month follow-up, 8 patients were hospitalized, and 3 of them died. The patterns of nutritional indices in patients with or without the early outcome are depicted in Table 2. In addition, the ROC curves and the AUC of nutritional indices for 1-month mortality or hospitalization are presented in Figure 1.

Correlation analysis showed that the MNA score was correlated with the NRI grade (*r*, 0.281, *P*=0.032). The CONUT score was correlated with the NRI grade (*r*, 0.739; *P*<0.001).

Nutritional support was defined as the presence of a high-risk MNA grade, accompanied by 1 of the other 2 malnutrition indices (ie, the CONUT score or the NRI). Twenty-five of 58 patients (43%) were categorized as needing nutritional support. The comparison analyses concerning the need for nutritional support and other parameters are presented in Table 3.

Patients who needed nutritional support had lower BMI, total albumin, lymphocyte count, and hemoglobin, but higher AST and total bilirubin. Table 4 shows the predictors of the need for nutritional support in multivariate analysis. Lower BMI and total albumin were independent predictors of the need for nutritional support (OR, 0.35; 95% CI, 0.13 to 0.97; *P*=0.044 and OR, 0.36; 95% CI, 0.15 to 0.88; *P*=0.0250, respectively).

Table 1: Demographic, clinical, and laboratory tests results, as well as the outcomes and echocardiographic characteristics, of the study population (N=58)

Characteristic, N=58	Value
Age, y; mean (SD); range	46(17); 21-75
Sex (male); n (%)	32(55.2)
Body mass index, kg/m ² ; median (IQR)	22.3(20-26.4)
Etiology	
Ischemic cardiomyopathy; n (%)	21(36.2)
Nonischemic cardiomyopathy; n (%)	37(63.7)
Comorbidity	
Hypertension; n (%)	11(19)
Diabetes mellitus; n (%)	13(22.4)

Smoking; n (%)	10(17.2)
Coronary artery disease; n (%)	21(36.2)
Valvular heart disease; n (%)	16(27.6)
Chronic kidney disease; n (%)	15 (25.9)
Symptom and Sign	
Dyspnea; n (%)	58(100)
NYHA III; n (%)	20(34.5)
NYHA IV; n (%)	38(65.5)
Orthopnea; n (%)	58(100)
Peripheral edema; n (%)	50(86.2)
Ascites; n (%)	46(79.3)
Elevated jugular venous pressure; n (%)	58(100)
Atrial fibrillation rhythm	14(24.1)
QRS duration \geq 120 ms	40(69)
Echocardiography	
Left ventricular ejection fraction; mean (SD); range	11(3.6);5-25
Left ventricular enlargement; n (%)	56(96.6)
Right ventricular enlargement; n (%)	49(84.5)
Right ventricular dysfunction; n (%)	58(100)
Decreased inferior vena cava collapse; n (%)	49(84.5)
Dilated inferior vena cava; n (%)	55(94.8)
Outcome	
Early readmission or mortality; n (%)	8(13.8)
Laboratory Test	
Hemoglobin; g/L; median (IQR)	11.4(9.6-13)
White blood cell count; 1000/mm ³ ; median (IQR)	7500(6150-9800)
Platelet count; 1000/mm ³ ; median (IQR)	303000(173000-350000)
Lymphocyte count ; 1000/mm ³ ; median (IQR)	1450(987-2125)
Blood urea nitrogen; mg/dL; median (IQR)	18.5(13.7-26.5)
Creatinine; mg/dL; median (IQR)	1.1(0.9-1.5)
Calcium; mg/dL; median (IQR)	8(7.6-8.2)
Uric acid; mg/dL; median (IQR)	7.6(6-9)
Total bilirubin; mg/dL; median (IQR)	1(0.8-1.62)
Albumin; mg/dL; median (IQR) g/L	40(29-42)
Aspartate transaminase; IU/L; median (IQR)	40(23-62)
Alanine transaminase; IU/L; median (IQR)	38(23-57)
Alkaline phosphatase ; IU/L; median (IQR)	269(189-333)
Cholesterol; mg/dL; median (IQR)	129(110-157)
Thyroid-stimulating hormone; microlU/ml; median (IQR)	2.1(1.1-3.9)

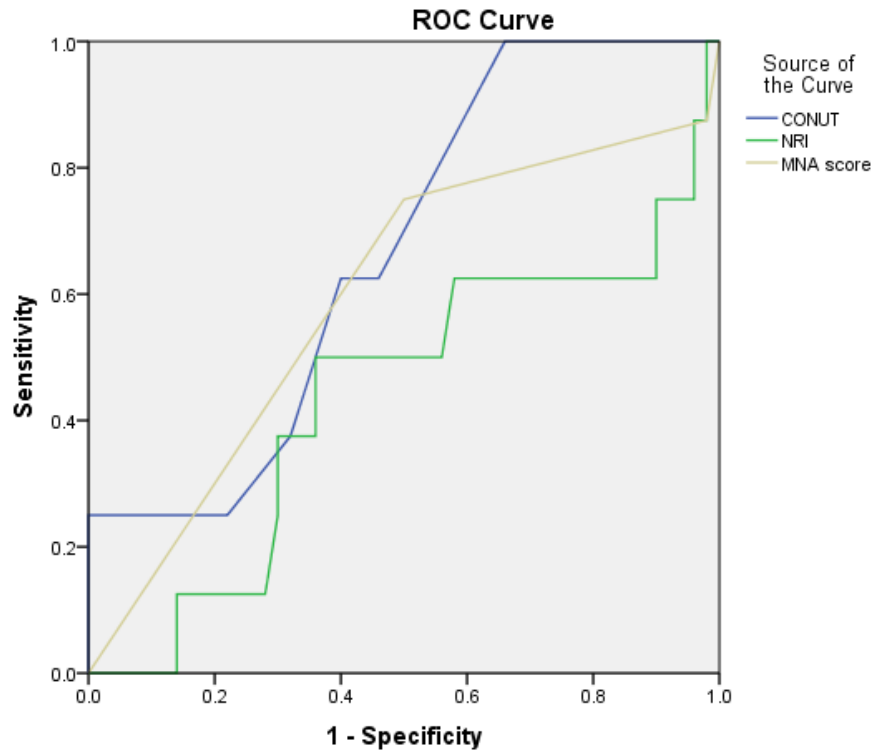
IQR, Interquartile range; NYHA, New York Heart Association functional classification; SD, Standard deviation

Table 2: Correlations between nutritional indices and the outcome (early readmission and mortality <1 mon)

	All Patients	Early Readmission or Mortality		P value
	N=58	Yes N=8	No N=50	
CONUT Score				
High-risk	25 (43%)	5 (62.5%)	20 (40%)	0.2
Low-risk	33 (57%)	3 (37.5%)	30 (60%)	
MNA Score				
Normal	2 (3.4%)	1 (12.5%)	1 (2%)	0.08
At risk of malnutrition	25 (43%)	1 (12.5%)	24 (48%)	
	31 (53%)	6 (75%)	25 (50%)	
NRI Grade				
No risk	29 (50%)	4 (50%)	25 (50%)	0.6

Mild risk	7 (12.1%)	1 (12.5%)	6 (12%)	
Moderate risk	8 (13.8%)	0 (%)	8 (16%)	
Severe risk	14 (24.1%)	3 (37.5%)	11 (22%)	
Need for Nutritional Support*				
Yes	25 (43.1%)	4 (%)	21 (42%)	0.7
No	33 (56.9%)	4 (%)	29 (58%)	

CONUT, Controlling Nutritional Status; MNA, Mini Nutritional Assessment questionnaire; NRI, Nutritional Risk Index
 * defined as the presence of a high-risk MNA grade, accompanied by 1 of the other 2 malnutrition indices (the CONUT score or the NRI)



Diagonal segments are produced by ties.

	AUC (95% CI)	P value
CONUT grade	0.666 (0.488-0.845)	0.134
NRI	0.438 (0.204-0.671)	0.573
MNA score	0.596 (0.371-0.822)	0.385

Figure 1: The image presents the ROC curves and AUC of nutritional indices for 1-month mortality or rehospitalization.

ROC, Receiver operating characteristic; AUC, Area under the curve; CONUT, Controlling Nutritional Status; JHH NS, Johns Hopkins Hospital Nutrition Score; MNA, Mini Nutritional Assessment questionnaire; NRI, Nutritional Risk Index

Table 3: Comparisons between patients with or without the need for nutritional support, defined as the presence of a high-risk MNA grade, accompanied by 1 of the other 2 malnutrition indices (the CONUT score or the NRI)

	Need for Nutritional Support N=31	No Need For Nutritional Support N=27	P value
Age, y	48.08 ± 18.387	51.21 ± 15.848	0.490
Male	12 (48.0%)	20 (60.6%)	0.427
Body mass index, kg/m ²	21.9 ± 4.2	24.4 ± 3.4	0.013
Diabetes mellitus	5 (20.0%)	8 (24.2%)	0.760
Hypertension	6 (24.0%)	5 (15.2%)	0.504
Current smoker	5 (20.0%)	5 (15.2%)	0.731
Creatinine, mg/dL	1.4 ± 0.8	1.4 ± 0.8	0.971
Albumin, mg/dL	30.2 ± 6.3	41.0 ± 3.3	<0.0001
Aspartate transaminase, IU/L	51.0 ± 29.8	37.6 ± 20.0	0.046
Alanine transaminase, IU/L	44.5 ± 25.8	37.2 ± 20.6	0.256
Total bilirubin, mg/dL	1.7 ± 0.8	0.9 ± 0.3	<0.0001
White blood cell count, 1000/mm ³	8152.0 ± 3569.4	7957.6 ± 2794.1	0.817
Lymphocyte count, count/1000/mm ³	1392.0 ± 758.2	1807.6 ± 922.6	0.072
Hemoglobin g/L	10.4 ± 2.4	12.2 ± 1.7	0.004
Platelets, count/1000/mm ³	319.1 ± 151.6	246.0 ± 124.9	0.049
Total cholesterol, mg/dL	112.7 ± 23.3	149.5 ± 31.3	<0.0001

Data are presented as the mean ± the standard deviation or frequencies (percentages).

CONUT, Controlling Nutritional Status; MNA, Mini Nutritional Assessment questionnaire; NRI, Nutritional Risk Index

Table 4: Predictors of the need for nutritional support

	Model 1 (Univariate)		Model 2 (Multivariate)	
	OR (95% CI)	P value	OR (95% CI)	P value
Body mass index	0.83 (0.71-0.97)	0.018	0.35 (0.13-0.97)	0.044
Total albumin	0.73 (0.63-0.84)	<0.0001	0.36 (0.15-0.88)	0.025
Aspartate transaminase	1.023 (0.99-1.05)	0.560	0.93 (0.83-1.05)	0.25
Total bilirubin	13.57 (3.16-58.27)	<0.0001	36.17 (0.03-42059.23)	0.32
Lymphocyte count	0.99 (0.99-1.00)	0.790	0.99 (0.991-1.001)	0.084
Hemoglobin	0.65 (0.49-0.88)	0.050	0.66 (0.32-1.37)	0.265
Total cholesterol	0.95 (0.92-0.98)	<0.0001	0.95 (0.85-1.06)	0.345

The need for nutritional support was defined as the presence of a high-risk MNA grade, accompanied by 1 of the other 2 malnutrition indices (the CONUT score or the NRI).

DISCUSSION

In the present study, over 40% of hospitalized patients with ADHF had moderate-to-severe nutritional disturbances determined by the NRI, the MNA, and the CONUT score. We sought to define the need for nutritional support in our study population using the aforementioned scoring systems, and our statistical analyses suggested that the patients needing nutritional support (43% of our patients with ADHF) had lower BMI, total albumin,

lymphocyte count, and hemoglobin, but higher AST and total bilirubin.

The use of nutritional status has been reported as a predictor of mortality in patients with HF. Low NRI values are associated with higher readmission rates and mortality in patients with ADHF¹¹ and outpatients with chronic HF.¹² Higher CONUT scores are associated with increased HF hospitalization and mortality rates in the elderly with cardiovascular disorders.¹³ Another nutritional screening

tool, the Mini Nutritional Assessment (MNA), was created with the primary goal of evaluating nutritional conditions in the elderly¹⁴ and is suggested to predict mortality in HF.¹⁵ However, the MNA needs the evaluation of many items, such as general conditions (residential status, psychological disorders, mobility, medication, and skin ulcers), anthropometric measures (BMI, arm and calf circumferences, and weight loss), dietary patterns (meals, food and fluid intakes, and the autonomy of feeding), and subjective data (self-perception of health and nutrition), making it is impossible to evaluate the MNA in all patients in general. The NRI and the CONUT score are both relatively simpler than the MNA and are easily calculable for patients with HF. The components of the scores (ie, albumin, total cholesterol, total lymphocyte count, and BMI) have been shown as risk predictors in patients with HF. Many investigations have tried to better define nutritional status and identify the risk of requiring nutritional support in specific groups of patients with cardiovascular diseases.¹⁵ For instance, the JHH NS score is an easily applicable risk score associated with an increased risk of needing nutritional support after cardiac surgery. Each 1-point increase in the JHH NS is associated with a 20% increase in the risk of requiring nutritional support. Better nutritional interventions in patients with heart failure require a similar nutritional risk scoring system. In this study, we tried to find whether there was any relationship between different nutritional risk indices in patients with heart failure and which one might be correlated with patient outcomes. Still, although we succeeded in finding some significant relationships between different nutritional scoring systems in these patients, the relationships were not only weak but also there was no correlation between nutrition indices and our outcome of interest

(early mortality and readmission). We think that a small sample size and a limited number of patients with the outcome may be the reason for the current result. Further investigations are needed to shed light on this issue; however, the results of the current study should be useful for new study designs.

Limitations

There are several limitations in the present study. First, we did not consider any changes in any parameters and used baseline data at admission for the analyses. Second, although we conducted multivariable analyses to evaluate associations between nutritional indices and prognosis in patients with HF, confounding factors could be entirely eliminated. Further studies with a larger population are needed.

CONCLUSIONS

Over 40% of our hospitalized patients with ADHF had moderate-to-severe nutritional disturbances. Patients needing nutritional support (43% of our patients with ADHF) had lower BMI, total albumin, lymphocyte count, and hemoglobin, but higher AST and total bilirubin.

Disclosure

The author declares no conflicts of interest in this work.

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