RESEARCH LETTER

Nutritional status and body composition of patients hospitalized for exacerbated heart failure

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Introduction Despite progress in therapy for chronic heart failure (CHF) and increased recognition of its clinical risk factors, its prevalence continues to rise and has reached the proportions of a pandemic.[1] Therefore, it is very important to recognize all the factors that may potentially affect the course of CHF in order to prevent its exacerbation and reduce the need for hospitalization.[1,2] One of multiple such factors seems to be patients' nutritional status,[1-6] which is evidenced by the fact that the provision of nutritional support can improve the outcomes of patients with CHF.[7] In this population, assessing nutritional status on the basis of anthropometric parameters is not reliable due to water retention.[8-13] Therefore, we performed this observational study in order to assess nutritional risk, nutritional status, and body composition in patients with exacerbated CHF, as well as to determine the prognostic value of those parameters during 1-year follow-up.

Methods The study included 65 consecutive patients hospitalized in an urban university hospital for exacerbation of CHF, diagnosed on the basis of the European Society of Cardiology recommendations[1] as being in class III or IV of the New York Heart Association classification, and 32 patients hospitalized in the same clinic for life-limiting symptoms of peripheral artery disease without any clinical or laboratory features of CHF (ie, N-terminal pro–B-type natriuretic peptide [NT-proBNP] <400 pg/ml). Patients were recruited to the study between May 9, 2016 and February 21, 2018.

On the first day of hospitalization, medical history based on a dedicated study questionnaire was obtained from each patient enrolled in the study. Physical examination, biochemical assessment, and transthoracic echocardiography were also performed. Nutritional status and body composition analyses were performed twice: on admission and at discharge. The following parameters were measured: Nutritional Risk Screening 2002 (NRS-2002) and Mini Nutritional Assessment (MNA) surveys; as well as height (cm), body mass (kg), body mass index (BMI; kg/m^2) and waist circumference (WC; cm). Body composition was determined using whole-body bioelectrical impedance analysis (BIA) and a Tanita BC 420 MA device (Tanita Corporation, Japan). The following BIA parameters were analyzed: fat-free mass (kg); skeletal muscle mass (SMM; kg; percentage of fat-free mass); fat mass (FM; %; kg); visceral fat level (VFL); and total body water (TBW; kg).

The following parameters were calculated based on the abovementioned indices[3-5]:

- Waist-to-height ratio (WHtR), calculated as 100 × [quotient of waist circumference (cm) and height (cm)].
- Skeletal muscle index (SMI) according to the following formula: SMM (kg) / [height (m)]^2.

The following formulas of nutritional risk assessment were also calculated[3,8]:

- Nutritional Risk Index (NRI), calculated according to the following formula: NRI = 1.519 × blood albumin concentration [g/l] + (41.7 × actual body mass [kg] / ideal body mass [kg]);
- Controlling Nutritional status (CONUT), determined on the basis of blood albumin and total cholesterol concentrations and total lymphocyte count;
- Prognostic Nutritional Index (PNI), calculated according to the following formula: 10 × blood

albumin concentration [g/dl] + (0.005 × total lymphocyte count / mm^3).

Measured outcomes During the median (interquartile range [IQR]) follow-up period of 366 (365–403) days, the following end points were measured: all-cause mortality, cardiovascular mortality, all-cause readmission, and readmission for CHF exacerbation. The end points were obtained during routine checkups in an ambulatory clinic and in a telephone interview with the patient or his / her relatives.

Bioethics Committee The investigation was conducted in compliance with the Declaration of Helsinki for medical research, after receiving permission from the local Bioethical Committee (no. 325/2016; April 26, 2016). Each patient signed a written consent form regarding participation in the study.

Statistical analysis Statistical analysis was conducted using the licensed version of the statistical software STATISTICA, version 13.1 developed by TIBCO Software, Inc (2017) (Palo Alto, California, United States). Sample size was calculated with an assumption that changes in BIA parameters during hospitalization would amount to at least 12% with an SD of 20%, an alpha of 0.05 and a power of analysis of at least 90%. A total of 62 patients were required to complete the established group effect. Sample size was not calculated with regard to the occurrence of the outcomes measured.

The normal distribution of the study variables was checked using the Kolmogorov–Smirnov test. Data were presented as a mean (SD) or median (IQR). The statistical significance of differences between respective measurements and between groups was verified, depending on the variable distribution, using the paired and unpaired *t* test or Mann–Whitney and Wilcoxon tests for quantitative variables and the χ^2 test for qualitative variables. Spearman correlation analysis was also conducted.

Results With regard to parameters of nutritional status assessment, patients with CHF had greater WC and WHtR compared with the control group (TABLE 1). These differences were associated with greater nutritional risk for the CHF group expressed by scores in nutritional questionnaires: lower MNA and PNI, higher NRS-2002 and CONUT scores, and lower blood albumin levels. During hospitalization (median [IQR], 5 [4–7] days), a decrease in body mass, WHtR, TBW, SMM, and SMI, as well as an increase in the percentage of FM, were observed in patients with CHF.

Patients with CHF divided based on left ventricular ejection fraction (LVEF; <50% vs ≥50%) and class III vs class IV of the New York Heart Association classification did not differ in relation to values of nutritional scores, or the anthropometric, BIA, and biochemical parameters measured. However, patients with an LVEF of less than 50% lost more TBW and SMM during hospitalization (median [IQR], –6.25 [–9.7 to –2.3] vs –1.6 [–4.85 to –0.65]; P <0.01; and –3.55 [–5.6 to –1.5] vs –1.5 [–3.9 to –0.50]; P <0.48, respectively).

In patients with CHF, the length of in-hospital stay correlated significantly with parameter values obtained on admission, for example: A Body Shape Index (R = –0.38; P <0.001), CONUT score (R = 0.49; P <0.001), PNI score (R = –0.32; P = 0.001), TBW (R = 0.32; P = 0.036), percentage of FM (R = –0.39; P <0.001), and ΔBMI during hospitalization (R = –0.64; P <0.001).

Compared with the CHF patients who survived, those who died during follow-up had a significantly lower MNA score (P = 0.01), and a lower percentage of FM (P <0.001) on admission. Patients with CHF and SMM of 45.5% or greater had higher risk of all-cause mortality (odds ratio [OR], 9.0; 95% CI, 1.8–46.1; P <0.001) and CHF patients who had a VFL score of 15 or more on admission required rehospitalization more frequently during the follow-up period (OR, 9.9; 95% CI, 2–48; P = 0.004).

Discussion One of the most important observations in our study, and one that has not been previously reported, is that compared with the control group, those with exacerbated CHF were at greater nutritional risk, expressed, for example, by a lower score on the MNA questionnaire and lower blood albumin concentration (TABLE 1), which was in contrast to higher BMI, FM, VFL, and anthropometric parameters of abdominal fat distribution (WC, WHtR). Body composition of patients with CHF also changed significantly during hospitalization, mainly due to changes in body hydration (ΔBMI). This corroborates previously published data.[3-6,9-13]

We found that anthropometric (eg, BMI) and composed biochemical indices of nutritional status (eg, NRI) were not related to patients' survival. However, we confirmed that a lower percentage of FM was associated with longer in-hospital stay; a low MNA score and SMM of 45.5% or greater were linked with all-cause mortality; and a VFL score of 15 or greater was related to a higher risk of readmission in patients with CHF during 1-year follow-up. These data corroborate previously published results.[3,4,6] Yasuhara et al[5] concluded in their study that body fat percentage (in BIA) might be a good predictor of energy metabolism and prognosis in patients with CHF. Multifactorial analysis by Thomas et al[11] found that a higher body fat mass index (BFMI = FM / body surface area) determined using BIA was an independent prognostic factor of 5-year survival in CHF patients (an 11% decrease in mortality risk for every 1 kg/m^2 increase in BFMI), and the combination of low BFMI and lean body mass index increased the risk of all-cause mortality in CHF patients nearly 5-fold. Moreover, a few other studies have also shown the prognostic importance of BIA parameters[9-13] and

TABLE 1 Clinical and biochemical characteristics and parameters of bioelectrical impedance analysis (on admission and at discharge) of patients with chronic heart failure and in the control group

Parameter		CHF patients (n = 65)		Control group (n = 32)[a]	*P* value
Age, y		72.08 (9.1)		70.13 (7.6)	0.29
Male gender, n (%)		43 (66.2)		20 (62.5)	0.72
Length of in-hospital stay, d		5 (4–7)		3 (3–3.5)	<0.01
Death during 1-year follow-up, n (%)		11 (16.9)		1 (3.1)	0.5
Readmission, n (%)		47 (72.3)		15 (46.9)	0.01
Diabetes mellitus, n (%)		34 (52.3)		12 (37.5)	0.17
Chronic kidney disease, stage ≥3 (GFR <60 ml/min), n (%)		27 (41.5)		8 (25.0)	0.11
CCI, score		6 (4–7)		3 (3–4)	<0.01
NT-proBNP, pg/ml		2551 (1560–5872)		88.50 (37.5–122.5)	<0.01
Creatinine, mg/dl		1.3 (0.5)		0.9 (0.2)	<0.01
Albumin, g/dl		3.8 (0.4)		4.3 (0.4)	<0.01
NRS-2002, score		2 (1–2)		1 (0.0–1.0)	<0.01
NRI, score		113.6 (101.7–124.1)		115.6 (110.9–124.0)	0.29
CONUT, score		3.0 (2.0–4.0)		1 (0.0–2.0)	<0.01
PNI, score		45.5 (41.7–49.0)		53.6 (49.0–56.3)	<0.01
ACEI, n (%)		62 (95.4)		27 (84.4)	0.06
β-Blockers, n (%)		59 (90.8)		9 (28.1)	<0.01
Loop diuretics, n (%)		65 (100)		2 (6.3)	<0.01
Potassium-sparing diuretics, n (%)		53 (81.5)		0	<0.01
Statins, n (%)		60 (92.3)		31 (96.9)	0.37
Parameters determined on admission and at discharge for CHF patients		Δ during hospitalization in CHF patients	CHF patients at discharge (n = 65)	Control group (n = 32)	*P* value
MNA, score		0	24.5 (22.0–26.5)	26.0 (24.8–27.0)	0.01
Waist circumference, cm		1.5 (0.8)	107.34 (15.2)	100.97 (10.50)	0.04
Waist-to-height ratio		0.006 (0.0003)	0.62 (0.09)	0.60 (0.06)	0.04
ABSI		0.005 (0.004)	0.09 (0.09–0.1)	0.09 (0.08–0.09)	0.09
Body mass, kg		–4.5 (–7.8 to –3.0)	84.34 (22.97)	77.36 (14.67)	0.12
BMI, kg/m^2		–0.75 (–1.9 to –0.4)	29.84 (7.46)	27.50 (4.26)	0.1
BMI, n (%)	<18.5 kg/m^2	–	4 (6.2)	1 (3.1)	0.15
	18.5–24.9 kg/m^2		16 (24.6)	9 (28.1)	
	25–29.9 kg/m^2		14 (21.5)	13 (40.6)	
	≥30 kg/m^2		31 (47.7)	9 (28.1)	
Fat mass, %		2.5 (0.8–5.3)	27.42 (11.45)	31.02 (8.06)	0.11
Fat mass, kg		1.2 (0.1–3.0)	24.69 (13.95)	24.21 (7.56)	0.86
Visceral fat level, score		0 (0 to 1.0)	14.20 (5.31)	13.09 (3.98)	0.3
Total body water, kg		–4.2 (–7.6 to –1.1)	42.77 (11.02)	37.17 (8.73)	0.01
FFM, kg		–4.3 (–8.5 to –1.5)	60.14 (14.35)	53.44 (12.17)	0.03
Skeletal muscle mass, kg		–2.5 (–4.8 to –0.8)	34.04 (8.12)	30.24 (6.89)	0.03
Skeletal muscle mass, % of FFM		3.0 (–2.7 to 13.6)	41.11 (6.45)	39.03 (4.57)	0.11
Skeletal muscle index, kg/m^2		–0.8 (–1.8 to -0.3)	11.91 (2.12)	10.64 (1.70)	<0.01

Data are presented as mean (SD) or median (interquartile range) unless otherwise indicated.

a Bioelectrical impedance analysis was performed only at discharge.

Abbreviations: ABSI, A Body Shape Index; ACEI, angiotensin-converting enzyme inhibitor; BMI, body mass index; CCI, Charlson Comorbidity Index (age-adjusted); CHF, chronic heart failure; CONUT, Controlling Nutritional status; FFM, fat-free mass; GFR, glomerular filtration rate; MNA, Mini Nutritional Assessment; NRI, Nutritional Risk Index; NRS-2002, Nutritional Risk Screening-2002; NT-proBNP, N-terminal pro–B-type natriuretic peptide; PNI, Prognostic Nutritional Index

the existence of the "obesity paradox" among patients with CHF.[3,4,6]

The main limitation of our study is the small sample size; however, the number of patients was calculated as being sufficient to achieve statistical significance of assumed differences and is comparable with other published works. Additionally, we used a bioelectrical impedance device containing only 4 electrodes and that operates at only 2 frequencies, which may be a source of error in patients with fluid retention. Therefore, we performed 2 measurements: one on admission and one at discharge.

Conclusions In patients with exacerbated CHF, the clinical and biochemical parameters of nutritional risk coexist with higher indices of abdominal distribution of adipose tissue. The length of in-hospital stay for CHF patients increased with fluid retention level (initial TBW, ΔBMI), malnutrition risk determined by composed indices of nutritional status assessment, and a decrease in FM percentage. One-year mortality in CHF patients was associated with higher SMM. The association of lower FM and VFL with longer length of in-hospital stay and higher risk of readmission, respectively, may be a substitute for the "obesity paradox" in CHF patients.

ARTICLE INFORMATION

CONFLICT OF INTEREST None declared.

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