Interactive CardioVascular and Thoracic Surgery 16 (2013) 612–618
doi:10.1093/icvts/ivs549 Advance Access publication 29 January 2013

ORIGINAL ARTICLE - ADULT CARDIAC

Prognostic value of nutritional screening tools for patients scheduled for cardiac surgery[†]

Vladimir V. Lomivorotov, Sergey M. Efremov*, Vladimir A. Boboshko, Dmitry A. Nikolaev, Pavel E. Vedernikov, Mihail N. Deryagin, Vladimir N. Lomivorotov and Alexander M. Karaskov

Department of Anesthesiology and Intensive Care, Research Institute of Circulation Pathology, Novosibirsk, Russian Federation

* Corresponding author. Department of Anesthesiology and Intensive Care, Research Institute of Circulation Pathology, Novosibirsk, Russian Federation. Tel: +7-9833088415; e-mail: sergefremov@mail.ru (S.M. Efremov).

Received 26 June 2012; received in revised form 22 November 2012; accepted 7 December 2012

Abstract

OBJECTIVES: The aim of this study was to assess the prognostic value of different nutritional screening tools in patients undergoing cardiopulmonary bypass, with regard to adverse clinical outcome.

METHODS: This prospective cohort study analysed 1193 adult patients who underwent cardiopulmonary bypass. Patients were screened using five nutritional screening tools: Subjective Global Assessment (SGA), Nutritional Risk Screening 2002 (NRS-2002), Malnutrition Universal Screening Tool (MUST), Mini-Nutritional Assessment (MNA) and Short Nutritional Assessment Questionnaire (SNAQ). In-hospital mortality, postoperative complications, length of stay in intensive care unit and length of hospitalization were analysed. Multivariate backward logistic regression analysis was used to assess the independent predictive value of the studied screening tools.

RESULTS: In accordance with univariate analysis, malnutrition detected by SNAQ, MUST, NRS-2002 and MNA was associated with postoperative complications (odds ratio [OR] 1.8, 95% confidence interval [95% CI] 1.3–2.4; OR 1.9, 95% CI 1.4–2.6; OR 1.8, 95% CI 1.2–2.9 and OR 1.9, 95% CI 1.4–2.6). Malnutrition detected by MUST, NRS-2002, MNA and SGA was associated with intensive care unit stay >2 days (OR 1.5, 95% CI 1.1–2.1; OR 2.3, 95% CI 1.5–3.7; OR 1.7, 95% CI 1.2–2.2 and OR 2.7, 95% CI 1.6–4.6). Prolonged hospitalization (>20 days) was predicted by SNAQ, MUST and MNA (OR 1.4, 95% CI 1–1.9; OR 1.6, 95% CI 1.2–2.2 and OR 1.6, 95% CI 1.2–2.2). In accordance with multivariate analysis, only MUST and MNA independently predicted postoperative complications (OR 1.6, 95% CI 1.1–2.3 and OR 1.6, 95% CI 1.1–2.2). Other independent factors influencing postoperative complications were well-known logistic EuroSCORE (OR 1.06, 95% CI 1–1.1) and the duration of cardiopulmonary bypass in minutes (OR 1.01, 95% CI 1–1.01).

CONCLUSIONS: MUST and MNA both have independent predictive values with regard to postoperative complications. Taking into account simplicity, MUST is preferable for the cardiac surgical population.

Keywords: Malnutrition • Cardiac surgery • Postoperative complications

INTRODUCTION

Screening of nutritional status is a necessary aspect of good nutritional practice [1]. Because a variety of pathologies lead to malnutrition, several different tools have been developed for nutritional screening. One such tool designed more than 20 years ago, Subjective Global Assessment (SGA), yields results that are tightly correlated with other objective methods of assessment of nutritional status and has prognostic value with regard to infectious complications [2]. The European guidelines [3] recommend the Malnutrition Universal Screening Tool (MUST) [4] for the nutritional evaluation of adults in the community; Nutritional Risk Screening 2002 (NRS-2002) [5] for the detection of undernutrition and the risk of its development in hospital settings and Mini-Nutritional Assessment (MNA) [6] for elderly patients in home-care programmes, nursing homes and hospitals. The Short Nutrition Assessment Questionnaire (SNAQ) was developed specifically for the hospital outpatient population [7].

Malnutrition is widespread among patients with cardiovascular diseases and is related to adverse postoperative outcomes. Furthermore, malnutrition occurs in ∼10–25% of patients undergoing cardiac surgery [8]. However, despite the identification of the specific mechanisms of the development of malnutrition in patients with congestive heart failure leading to cardiac cachexia [9], a specific tool for nutritional screening in this population has not been designed. Furthermore, the lack of a comparative analysis of different screening tools among cardiac patients leaves clinicians without guidance in selecting the most effective approach. The aim of this study was to compare the five different nutritional screening tools (SGA, MUST, NRS-2002, SNAQ and

[†]Presented at the 26th Annual Meeting of the European Association for Cardio-Thoracic Surgery, Barcelona, Spain, 27–31 October 2012.

MNA) with regard to adverse outcome among cardiac patients undergoing cardiopulmonary bypass (CPB).

MATERIALS AND METHODS

This prospective cohort study was approved by the local ethics committee. Inclusion criteria were (i) age >18 years and (ii) scheduled cardiothoracic surgery with CPB. Exclusion criteria were (i) emergency surgery, (ii) pulmonary thromboembolism in need of thrombectomy and (iii) aortic dissection. We obtained informed consent from 1210 adult patients hospitalized between 1st January 2011 and 31st December 2011 and included them in the study. The patients were assessed in the preoperative period within 48 h of admission to the hospital. All patients were screened using five nutritional screening tools, namely, SGA, NRS-2002, MUST, MNA and SNAQ. The following groups of patients were excluded in the analytical phase of investigation: patients who underwent off-pump surgery ($n = 13$) and those who required deep hypothermic circulatory arrest ($n = 4$). Thus, 1193 patients were included in the final statistical analysis. Among baseline clinical characteristics, age, gender, presence of diabetes, left ventricle ejection fraction (LVEF), redo surgery, New York Heart Association class of heart failure, logistic EuroSCORE [10] and type of primary diagnosis were analysed.

Nutritional screening was performed by two trained specialists. The specifications of SNAQ, MUST, NRS-2002 and MNA tools are summarized in Table 1. SGA was performed as universally recognized and previously described [2]. The SGA questionnaire incorporated the patient's history (weight loss, changes in dietary intake, gastrointestinal symptoms and functional capacity), physical examination (muscle, subcutaneous fat, sacral and ankle oedema and ascites) and the clinician's overall judgment of the patient's status (A, well nourished; B, suspected to be malnourished or moderately malnourished and C, severely malnourished). An SGA score of B or C was classified as malnutrition.

A data-collection tool to collect data on the redundant items across the tools was developed. Patients' height and weight were measured on the first day of hospitalization using a measuring station for height and weight SECA 798 (Seca, Hamburg, Germany).

The postoperative follow-up characteristics were prospectively collected. Mortality was defined as in-hospital mortality. Complications were defined as complications observed during hospital stay, including acute heart failure, cardiac rhythm disturbances, sepsis, endocarditis, wound infection, mediastinitis, urinary tract infection and pneumonia. A prolonged intensive care unit (ICU) stay was defined as that of more than 2 days. Prolonged hospitalization was defined as hospitalization for more than 20 days.

Acute heart failure was defined as the need for infusion of an inotrope or vasopressor (dopamine, adrenaline, dobutamine, noradrenalin or phenylephrine), or a combination thereof, at a dosage equivalent to that of dopamine (>5 µg/kg/min), more than 6 h after surgery. Heart rhythm disturbances were defined as any clinically apparent heart rhythm disturbances (atrial fibrillation or the need for temporary pacing or further implantation of a pacemaker, ventricular tachycardia and ventricular fibrillation) that developed after surgery, but during the hospital stay. Mediastinitis was diagnosed when suppurative discharge appeared from the mediastinum, and a patient had one of the following symptoms: (i) an increase in body temperature over 38°C; (ii) chest pain and (iii) sternal instability. Postoperative sternal wound infections were diagnosed when (i) the growth of pathogenic flora in the deep soft-tissue culture was acquired in aseptic conditions (including fascia and muscular layer) except the discharge culture from the mediastinum, (ii) suppurative discharge from the deep postoperative wound, (iii) spontaneous sternal wound dehiscence or surgical wound opening because of infection, (iv) body temperature over 38°C or (v) chest pains were observed. Pneumonia was diagnosed based on a combination of physical signs (cough, fever, chest pain and tachypnea) and chest X-ray (lung consolidation). Urinary tract infection was diagnosed based on positive culture from urine combined with initiation of treatment.

Normality of distribution was verified using the D'Agostino-Pearson test. Non-parametric quantitative data are presented as medians with the 25–75 interquartile range in brackets. Quantitative characteristics are presented as numbers for each category with percentage in brackets. Odds ratio (OR) was used to measure the association between characteristics of adverse clinical course and nutritional screening results. To assess the predictive value of different perioperative factors with regard to postoperative complications, univariate and multivariate backward logistic regression analyses have been performed. Statistical data analysis employed standard methods [11] using MedCalc Statistical Software 12.1.0 (MedCalc Software, Belgium) [12]. A two-sided P-value <0.05 was considered statistically significant.

RESULTS

Coronary artery bypass grafting (CABG) was performed in 561 patients, heart valvular repair/replacement (HVR) was performed in 507 and 125 underwent combined (CABG and HVR) surgery. Baseline clinical characteristics are presented in Table 2. It should be noted that the overwhelming majority of patients exhibited an LVEF of >35%. It was not surprising to find patients with postoperative complications being older, with a higher proportion of females and redo surgery. All of these characteristics were included in EuroSCORE, which was also higher among patients with complications.

Nutritional screening with the five tools gave varying results. Among the general population, the greatest number of malnourished patients or patients at risk of malnutrition was detected by MNA (20%; Table 3). MUST and SNAG detected fewer malnourished patients: 16.9% had a medium or high risk of malnutrition according to MUST and 15.8% were moderately or severely malnourished according to SNAQ. Malnutrition was detected in only 7% of the cohort according to NRS-2002. SGA had the lowest level of detection of malnutrition. Using this tool, malnutrition was found in only 5% of all patients. Among patients with heart valve disease, malnutrition was found to occur on average three times more often than in those with coronary atherosclerosis.

There were 33 (2.8%) in-hospital deaths, and various complications were observed during hospitalization in 499 (41.8%) patients (Table 4). One patient died on ward suddenly due to life-threatening arrhythmia. Another 21 patients died in ICU because of the development of multiorgan failure due to haemorrhagic shock (5 patients), acute myocardial infarction (8 patients), cerebrovascular accidents (6 patients) and ventricular fibrillation (2 patients). Another 11 patients died in ICU due to the development of postoperative multiorgan failure. Malnutrition identified by SNAQ was significantly associated with the development of postoperative complications and prolonged hospitalization (Table 5). Malnourished patients detected by MUST had a high

Table 1: Composition of nutritional screening tools

Screening tool	Parameter		Score	Total score interpretation
SNAQ [6]	Did the patient lose weight unintentionally?	>6 kg in the last 6 months	3	(2) Moderate malnutrition
		>3 kg in the last 3 months	2	(3) Severe malnutrition
	Did the patient experience a decreased appetite over the last month?	Yes	1	
	Did the patient use supplemental drinks or tube feeding over the last month?	Yes	1	
MUST [3]	BMI	18.5–20 kg/m^2	1	(1) Medium risk of malnutrition
		≤18.5 kg/m^2	2	(≥2) High risk of malnutrition
	Weight loss in 3–6 months	5–10%	1	
		≥10%	2	
	Acute disease effect	Lack of nutritional intake >5 days	2	
NRS-2002 [4]	Nutrition	Weight loss >5% in 3 months or food intake 50–75% of normal requirements in the preceding week	1	(≥3) Malnutrition
		Weight loss >5% in 2 months, BMI 18.5–20.5 kg/m^2 and diminished general condition, or food intake 25–60% of normal in the preceding week	2	
		Weight loss >5% in 1 month or >15% in 3 months, BMI <18.5 kg/m^2 and diminished general condition, or food intake 0–25% of normal in the preceding week	3	
	Severity of disease	Chronic patients with acute complications, including cirrhosis, chronic obstructive pulmonary disease, chronic haemodialysis, diabetes and oncology	1	
		Stroke	2	
		Intensive care patients with APACHE >10	3	
	Age	>70 years	1	
MNA [5]	Has food intake declined over the past 3 months due to loss of appetite, digestive problems or chewing or swallowing difficulties?	Severe decrease in food intake	0	(8–10) At risk of malnutrition
		Moderate decrease in food intake	1	
		No decrease in food intake	2	(≤7) Malnutrition
	Weight loss during the last 3 months	>3 kg	0	
		Not known	1	
		Between 1 and 3 kg	2	
		No weight loss	3	
	Mobility	Bed- or chair-bound	0	
		Able to get out of bed/chair but does not go out	1	
		Goes out	2	
	Has the patient experienced psychological stress or acute disease in the past 3 months?	Yes	0	
		No	2	
	Neuropsychological problems	Severe dementia or depression	0	
		Mild dementia	1	
		No psychological problems	2	
	BMI (kg/m^2)	<19	0	
		19–21	1	
		21–23	2	
		≥23	3	

SNAQ: Short Nutritional Assessment Questionnaire; MUST: Malnutrition Universal Screening Tool; NRS-2002: Nutritional Risk Screening 2002; MNA: Mini-Nutritional Assessment; BMI: body mass index.

risk of developing postoperative complications, prolonged ICU stay and prolonged hospitalization. Malnutrition identified by NRS-2002 was associated with a risk of postoperative complications and prolonged ICU stay. Malnourished patients and patients at risk of malnutrition as identified by MNA had a high risk of complications, prolonged ICU stay and prolonged hospitalization. Malnutrition identified by SGA was significantly associated with the risk of prolonged ICU stay.

In accordance with univariate logistic regression analysis, logistic EuroSCORE and CPB time were predictive of postoperative complications (OR 1.08, 95% CI 1.05–1.11; $P < 0.0001$ and OR 1.01, 95% CI 1.01–1.02; $P < 0.0001$), prolonged ICU stay (OR 1.08, 95% CI 1.05.1.1; $P < 0.0001$ and OR 1.01, 95% CI 1–1.01; $P < 0.0001$) and prolonged hospitalization (OR 1.1, 95% CI 1.07–1.14; $P < 0.0001$ and OR 1, 95% CI 1–1.01; $P < 0.0001$). According to the results of multivariate analysis, EuroSCORE, CPB time and

Table 2: Baseline clinical characteristics

Characteristic	Patients with complications	Patients without complications	*P*-value
N	499	694	
Age in years	61 (55–66)	59 (53–64)	0.002
Age >65 years	130 (26%)	154 (22%)	0.14
Female	227 (45.5%)	219 (31.5%)	0.0001
Diabetes	70 (14%)	115 (16%)	0.26
LVEF <35%	21 (4.2%)	16 (2.3%)	0.09
Redo surgery	51 (10.2%)	38 (5.5%)	0.003
NYHA class			
1	6 (1.2%)	2 (0.3%)	0.04
2	88 (17.6%)	151 (21.7%)	
3	385 (77.2%)	524 (75.5%)	
4	20 (4%)	17 (2.5%)	
Logistic EuroSCORE	4.4 (2.4–8.7)	3 (1.7–5.5)	<0.0001
Primary diagnosis			
Coronary atherosclerosis	160 (32%)	424 (61.1%)	<0.0001
Mitral stenosis	111 (22.2%)	73 (10.5%)	<0.0001
Mitral insufficiency	81 (16.2%)	54 (7.8%)	<0.0001
Aortic stenosis	96 (19.2%)	98 (14.1%)	0.02
Aortic insufficiency	38 (7.6%)	35 (5%)	0.09
Tricuspid insufficiency	13 (2.6%)	10 (1.5%)	0.22

Age and EuroSCORE are median (25–75 percentile) and all other values are *N* (% of total).
LVEF: left ventricle ejection fraction; NYHA: New York Heart Association; CABG: coronary artery bypass grafting.

Table 3: Nutritional screening results

Screening tool	All patients, *N* (%)	CAD patients, *N* (%)	HVD patients, *N* (%)
N	1193	597	596
SNAQ			
Normal	1005 (84.2)	554 (92.8)	451 (75.7)
Moderately malnourished	82 (6.9)	23 (3.9)	59 (9.9)
Severely malnourished	106 (8.9)	20 (3.4)	86 (14.4)
MUST			
Low risk	991 (83.1)	543 (91)	448 (75.2)
Medium risk	103 (8.6)	36 (6)	67 (11.2)
High risk	99 (8.3)	18 (3)	81 (13.6)
NRS-2002			
Normal	1109 (93)	579 (97)	530 (88.9)
Malnourished	84 (7)	18 (3)	66 (11.1)
MNA			
Normal	954 (80)	522 (87.4)	432 (72.5)
At risk	228 (19.1)	74 (12.4)	154 (25.8)
Malnourished	11 (0.9)	1 (0.2)	10 (1.7)
SGA			
A	1133 (95)	588 (98.5)	545 (91.4)
B	55 (4.6)	9 (1.5)	46 (7.7)
C	5 (0.4)	0	5 (0.8)

Data presented as *N* (% of total).
CAD: coronary artery disease; HVD: heart valve disease; SNAQ: Short Nutritional Assessment Questionnaire; MUST: Malnutrition Universal Screening Tool; NRS-2002: Nutritional Risk Screening 2002; MNA: Mini-Nutritional Assessment.

Table 4: Postoperative complications in 1193 patients undergoing cardiothoracic surgery

Type of complication	*N* (%)
Death	33 (2.8%)
Acute heart failure	205 (17.2%)
Cardiac arrhythmia	352 (29.5%)
Bleeding	53 (4.4%)
All infectious complications	133 (11.1%)
Sepsis	8 (0.7%)
Mediastinitis	11 (0.9%)
Wound infection	35 (2.9%)
Pneumonia	25 (2.1%)
Endocarditis	31 (2.6%)
Urinary tract infection	55 (4.6%)
Patients with complications	499 (41.8%)

Data presented as *N* (% of total).
ICU: intensive care unit.

malnutrition detected by MUST and MNA are significantly associated with postoperative complications (Table 6). It should be emphasized that SNAQ and NRS-2002 were not independently associated with the development of postoperative complications. However, with regard to prolonged ICU stay, only NRS-2002 and SGA were independently predictive (Table 7). Prolonged hospitalization was not independently predicted by any nutritional screening tools.

DISCUSSION

Malnutrition has been reported to increase morbidity and mortality after cardiothoracic interventions. However, assessing nutritional status in patients before cardiac surgery can be quite challenging [13]. Nutritional screening is a simple tool that allows the quick and effective identification of the group of patients at high risk of malnutrition. The nutritional status of these patients should be assessed carefully, and perioperative nutritional intervention should be performed if needed.

Comparative analysis of screening tools has been performed in various patient populations [14–16]. Many such studies have focused on elderly patients [17]. In most published studies, nutritional status among cardiac patients is assessed by anthropometric and laboratory parameters [13]. To our knowledge, this study is the first to comparatively evaluate nutritional screening tools for cardiac surgery populations.

It is not surprising to find malnutrition to occur on average three times more often among patients with heart valve diseases than in patients with coronary atherosclerosis. Heart valve diseases are associated with profound haemodynamic alterations and inflammatory responses [18]. Moreover, overweight is a common finding in patients with coronary atherosclerosis.

Among all tested screening tools, MUST and MNA demonstrate a significant association with all of the analysed adverse clinical characteristics (the rate of postoperative complications, ICU stay >2 days and prolonged hospitalization) similarly. Furthermore, both of these tools are independently associated with postoperative

ORIGINAL ARTICLE

Table 5: Univariate analysis of the prognostic value of nutritional screening tools with regard to characteristics of adverse clinical course

	Complications		ICU stay >2 days		Hospitalization >20 days	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
SNAQ (malnourished)	1.8 (1.3–2.4)	0.0004	1.4 (1–3.9)	0.06	1.4 (1–1.9)	0.04
MUST (medium or high risk)	1.9 (1.4–2.6)	<0.0001	1.5 (1.1–2.1)	0.01	1.6 (1.2–2.2)	0.003
NRS-2002 (malnourished)	1.8 (1.2–2.9)	0.007	2.3 (1.5–3.7)	0.0002	1.4 (0.9–2.2)	0.15
MNA (risk/malnourished)	1.9 (1.4–2.6)	<0.0001	1.7 (1.2–2.2)	0.0005	1.6 (1.2–2.2)	0.001
SGA (B or C)	1.3 (0.7–2.1)	0.44	2.7 (1.6–4.6)	0.0002	1.6 (0.9–2.8)	0.07

SNAQ: Short Nutritional Assessment Questionnaire; MUST: Malnutrition Universal Screening Tool; NRS-2002: Nutritional Risk Screening 2002; MNA: Mini-Nutritional Assessment; ICU: intensive care unit, OR: odds ratio; CI: confidence interval.

Table 6: Perioperative factors influencing postoperative complications and multivariate logistic regression analysis

Risk factor	Model 1		Model 2		Model 3		Model 4	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Logistic EuroSCORE	1.06 (1–1.1)	<0.0001	1.06 (1–1.1)	<0.0001	1.06 (1–1.1)	<0.0001	1.06 (1–1.1)	<0.0001
CPB time (min)	1.01 (1–1.01)	<0.0001	1.01 (1–1.01)	<0.0001	1.01 (1–1.01)	<0.0001	1.01 (1–1.01)	<0.0001
Malnutrition (SNAQ)	1.3 (0.9–2)	0.11						
Malnutrition (MUST)			1.6 (1.1–2.3)	0.009				
Malnutrition (NRS-2002)					1.3 (0.7–2.3)	0.34		
Malnutrition (MNA)							1.6 (1.1–2.2)	0.006

Four models of multivariate logistic regression. Each model includes three variables: logistic EuroSCORE, CPB time and malnutrition depending on the screening tool (Model 1—SNAQ, Model 2—MUST, Model 3—NRS-2002 and Model 4—MNA).
CPB: cardiopulmonary bypass; MUST: Malnutrition Universal Screening Tool; SNAQ: Short Nutritional Assessment Questionnaire; NRS-2002: Nutritional Risk Screening 2002; OR: odds ratio; CI: confidence interval.

Table 7: Perioperative factors influencing prolonged intensive care unit stay and multivariate logistic regression analysis

Risk factor	Model 1		Model 2		Model 3		Model 4	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Logistic EuroSCORE	1.06 (1–1.1)	<0.0001	1.07 (1–1.1)	<0.0001	1.06 (1–1.1)	<0.0001	1.07 (1–1.1)	<0.0001
CPB time (min)	1.01 (1–1.01)	<0.0001	1.01 (1–1.01)	<0.0001	1.01 (1–1.01)	<0.0001	1.01 (1–1.01)	<0.0001
Malnutrition (MUST)	1.2 (0.9–2)	0.33						
Malnutrition (NRS-2002)			1.8 (1.1–3.2)	0.03				
Malnutrition (MNA)					1.4 (0.7–2.3)	0.07		
Malnutrition (SGA)							2 (1.1–3.7)	0.02

Four models of multivariate logistic regression. Each model includes three variables: logistic EuroSCORE, CPB time and malnutrition depending on the screening tool (Model 1—MUST, Model 2—NRS-2002, Model 3—MNA, Model 4—SGA).
CPB: cardiopulmonary bypass; MUST: Malnutrition Universal Screening Tool; SNAQ: Short Nutritional Assessment Questionnaire; NRS-2002: Nutritional Risk Screening 2002; OR: odds ratio; CI: confidence interval.

complications along with generally accepted preoperative factors, summarized in EuroSCORE and surgery-associated factor—duration of CPB. This finding leads to the assumption that preoperative nutritional support will reduce postoperative complications in the cardiac surgery population. However, this task needs to be supported in future trials. Taking into account the comparable prognostic value of the two nutritional screening tools (MNA and MUST) and rather complex nature of MNA, we recommend the MUST tool for nutritional screening in cardiac surgery.

Some of the screening tools included in our study have been studied previously in patients with cardiovascular pathology. Yamauti *et al*. [19] detected a rate of 51.9% malnutrition among hospitalized patients with congestive heart failure. However,

most of the patients (74%) in that study had decreased LVEF (<50%), whereas our study includes only 200 (17%) patients with an LVEF of <50%.

SGA depends considerably on the interviewer's training and the interpretation of the collected data. Thus, the subjectivity of SGA makes it less reproducible in daily clinical practice. It has repeatedly been indicated that SGA may fail to identify acute nutritional changes and can miss some cases of malnutrition [20]. Moreover, in light of the fluid retention observed among cardiac patients, it is difficult to interpret the history of weight loss and anthropometric data.

The prognostic impact of malnutrition assessed by MNA on long-term mortality in hospitalized patients with decompensated heart failure was studied by Bonilla-Palomas *et al.* [21]; in their study, 13% of patients were classified as malnourished, and 59.5% were at risk of malnutrition. The authors found a significant impact of malnutrition on survival. Notably, patients who underwent surgery to correct the cause of heart failure were excluded from that study. The accuracy of two quick and easy undernutrition screening tools—MUST and SNAQ in detecting undernutrition measured by a low-fat free mass index—was studied by van Venrooij *et al.* [22]. MUST demonstrated higher sensitivity in relation to the detection of patients with a low-fat free mass index. As far as we know, NRS-2002 has not been studied in patients with congestive heart failure.

Unfortunately, our study does not clarify the more clinically relevant question of how to deal with malnutrition—whether preoperative and postoperative nutritional intervention would improve the outcome and how it should be performed. Specific guidelines on preoperative nutritional support in cardiac surgery are lacking. It is known that preoperative nutritional support of cardiac patients by the use of continuous nasoenteric feeding for 2 weeks can be safely performed and improves nutritional parameters [23]. The European Society of Parenteral and Enteral Nutrition (ESPEN) recommends preoperative nutritional support for 10–14 days prior to major surgery for patients with severe nutritional risk [24]. Whenever feasible, the enteral route should be preferred and administered before admission to the hospital. Routine polymeric or high-protein formulae can be used with sodium and volume restriction according to the patient's clinical situation [25].

Our study has other limitations. Precise analysis of body composition using bioelectrical impedance methods could give more accurate data of nutritional status. One-year mortality and long-term outcome data (>5 years) were also not analysed.

In conclusion, MUST is the most reliable nutritional screening tool for patients undergoing cardiothoracic surgery. Nutritional screening results have independent prognostic value with regard to postoperative complications. The issue whether preoperative nutrition therapy would improve the outcome among malnourished cardiac patients needs to be studied.

Conflict of interest: none declared.

REFERENCES

[1] Mueller C, Compher C, Ellen DM. A.S.P.E.N. clinical guidelines: nutrition screening, assessment, and intervention in adults. JPEN J Parenter Enteral Nutr 2011;35:16–24.

[2] Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA *et al*. What is subjective global assessment of nutritional status? JPEN J Parenter Enteral Nutr 1987;11:8–13.

[3] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003;22:415–21.

[4] Malnutrition Advisory Group (MAG). MAG—Guidelines for detection and management of malnutrition. Redditch, UK: British Association for Parenteral and Enteral Nutrition, 2000.

[5] 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: 321–36.

[6] Vellas B, Guigoz Y, Garry PJ, Nourhashemi F, Bennahum D, Lauque S *et al*. The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients. Nutrition 1999;15:116–22.

[7] Neelemaat F, Kruizenga HM, de Vet HC, Seidell JC, Butterman M, van Bokhorst-de van der Schueren MA. Screening malnutrition in hospital outpatients. Can the SNAQ malnutrition screening tool also be applied to this population? Clin Nutr 2008;27:439–46.

[8] van Venrooij LM, van Leeuwen PA, de Vos R, Borgmeijer-Hoelen MM, de Mol BA. Preoperative protein and energy intake and postoperative complications in well-nourished, non-hospitalized elderly cardiac surgery patients. Clin Nutr 2009;28:117–21.

[9] Anker SD, Coats AJ. Cardiac cachexia: a syndrome with impaired survival and immune and neuroendocrine activation. Chest 1999;115:836–47.

[10] Roques F, Michel P, Goldstone AR, Nashef SA. The logistic EuroSCORE. Eur Heart J 2003;24:882–3.

[11] Zar JH. Biostatistical analysis. Upper Saddle River, NJ: Pearson Prentice-Hall, 2010;960.

[12] Schoonjans F, Zalata A, Depuydt CE, Comhaire FH. MedCalc: a new computer program for medical statistics. Comput Methods Programs Biomed 1995;48:257–62.

[13] Sanchez JA, Sanchez LL, Dudrick SJ. Nutritional considerations in adult cardiothoracic surgical patients. Surg Clin North Am 2011;91:857–75.

[14] Ozkalkanli MY, Ozkalkanli DT, Katircioglu K, Savaci S. Comparison of tools for nutrition assessment and screening for predicting the development of complications in orthopedic surgery. Nutr Clin Pract 2009;24: 274–80.

[15] Raslan M, Gonzalez MC, Dias MC, Nascimento M, Castro M, Marques P *et al*. Comparison of nutritional risk screening tools for predicting clinical outcomes in hospitalized patients. Nutrition 2010;26:721–6.

[16] Velasco C, García E, Rodríguez V, Frias L, Garriga R, Alvarez J *et al*. Comparison of four nutritional screening tools to detect nutritional risk in hospitalized patients: a multicentre study. Eur J Clin Nutr 2011;65: 269–74.

[17] Cereda E, Pedrolli C, Zagami A, Vanotti A, Piffer S, Opizzi A *et al*. Nutritional screening and mortality in newly institutionalised elderly: a comparison between the Geriatric Nutritional Risk Index and the Mini Nutritional Assessment. Clin Nutr 2011;30:793–8.

[18] Gölbasi Z, Uçar O, Keles T, Sahin A, Cagli K, Camsari A *et al*. Increased levels of high sensitive C-reactive protein in patients with chronic rheumatic valve disease: evidence of ongoing inflammation. Eur J Heart Fail 2002;4:593–5.

[19] Yamauti AK, Ochiai ME, Bifulco PS, Araújo MA, Alonso RR, Ribeiro RH *et al*. Subjective global assessment of nutritional status in cardiac patients. Arq Bras Cardiol 2006;87:772–7.

[20] Sungurtekin H, Sungurtekin U, Hanci V, Erdem E. Comparison of two nutrition assessment techniques in hospitalized patients. Nutrition 2004;20: 428–32.

[21] Bonilla-Palomas JL, Gámez-López AL, Anguita-Sánchez MP, Castillo-Domınguez JC, Garcıa-Fuertes D, Crespin-Crespinet M *et al*. Impact of malnutrition on long-term mortality in hospitalized patients with heart failure. Rev Esp Cardiol 2011;64:752–58.

[22] 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: 1924–30.

[23] Heymsfield SB, Casper K. Congestive heart failure: clinical management by use of continuous nasoenteric feeding. Am J Clin Nutr 1989;50: 539–44.

[24] Weimann A, Braga M, Harsanyi L, Laviano A, Ljungqvist O, Soeters P *et al*. ESPEN guidelines on enteral nutrition: surgery including organ transplantation. Clin Nutr. 2006;25:224–44.

[25] Jiménez Jiménez FJ, Cervera Montes M, Blesa Malpica AL, Metabolism and Nutrition Working Group of the Spanish Society of Intensive Care Medicine and Coronary units. Guidelines for specialized nutritional and

ORIGINAL ARTICLE

metabolic support in the critically-ill patient: update. Consensus SEMICYUC-SENPE: cardiac patient. Nutr Hosp 2011;26 (Suppl 2):76–80.

APPENDIX. CONFERENCE DISCUSSION

Dr F. Sbraga *(Barcelona, Spain)*: I think this is an interesting study, especially at this time when patients undergoing cardiac surgery are often older and with many associated pathologies. I have two questions. In daily practice, what is the utility of nutritional screening, only prognostic or with intention to treat?

Secondly, we have time to treat these patients before surgery: do you have experience in this field and did you think to treat these patients and how to treat them?

Dr Efremov: In response to your first question, we know that in general practice, especially in older and in terminal patients (for example, the elderly patients with hip fractures), there are many benefits to be derived from preoperative nutritional intervention.

According to the European Society for Parenteral and Enteral Nutrition Guidelines, preoperative nutritional support should be implemented from 7–14 days before surgery. However, in our settings, it is quite difficult to organize preoperative nutritional support because there are a lot of issues: where to perform this intervention, where should patients stay following preoperative nutritional support, and so on. The second question is?

Dr Sbraga: How to treat, and if it is necessary to treat, when we have time to treat.

Dr Efremov: How to treat?

Dr Sbraga: Yes.

Dr Efremov: There are different options for preoperative nutritional support. There are various supplemented drinks and supplements. Hypercaloric nutritional drinks may be more beneficial for cardiac patients. We should bear in mind that patients with heart failure suffer from fluid retention, and there is a risk of fluid overload. We do not have a large experience with preoperative nutritional support, and this is the aim of our future studies, I am sure.

Dr L. Hamilton *(Newcastle upon Tyne, UK)*: So has this changed your practice? Are you going to institute a programme of nutritional feeding beforehand?

Dr Efremov: This study was developed to detect the most effective nutritional screening tools because now that we are introducing good nutritional principles into our practice, nutritional screening is a necessary part of it. However, we did not know which was the best nutritional screening tool. Now that we know that this is the Malnutrition Universal Screening Tool, I believe that the next step would be some preoperative nutritional intervention.