



Original / Valoración nutricional

Use of Subjective Global Assessment, Patient-Generated Subjective Global Assessment and Nutritional Risk Screening 2002 to evaluate the nutritional status of non-critically ill patients on parenteral nutrition

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Abstract

Objective: To evaluate the nutritional status of non-critically ill digestive surgery patients at the moment of parenteral nutrition initiation using three different nutritional test tools and to study their correlation. To study the association between the tests and the clinical and laboratory parameters used in the follow-up of PN treatment.

Methods: Prospective study over 4 months. Anthropometric and clinical variables were recorded. Results of Subjective Global Assessment; Patient-Generated Subjective Global Assessment; and Nutritional Risk Screening 2002 were compared applying kappa test. Relationship between the clinical and laboratory parameters with Subjective Global Assessment was studied by multinomial regression and with the other two tests by multiple linear regression models. Age and sex were included as adjustment variables.

Results: Malnutrition in 45 studied patients varied from 51% to 57%. Subjective Global Assessment correlated well with Patient-Generated Subjective Global Assessment and Nutritional Risk Screening 2002 ($\kappa = 0.531$ $p = 0.000$). The test with the greatest correlation with the clinical and analytical variables was the Nutritional Risk Screening 2002. Worse nutritional state in this test was associated with worse results in albumin ($B = -0.087$; $CI = -0.169/-0.005$), prealbumin ($B = -0.005$; $CI = [-0.011/-0.001]$), C-reactive protein ($B = 0.006$; $CI = [0.001/0.011]$) and leukocytes ($B = 0.134$; $CI = [0.031/0.237]$) at the end of parenteral nutrition treatment.

Conclusions: Half of the digestive surgery patients were at malnutritional risk at the moment of initiating parenteral nutrition. Nutritional Risk Screening 2002 was the test with best association with the parameters used in the clinical follow-up of parenteral nutrition treated patients.

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UTILIZACIÓN DE SUBJECTIVE GLOBAL ASSESSMENT, PATIENT-GENERATED SUBJECTIVE GLOBAL ASSESSMENT Y NUTRITIONAL RISK SCREENING 2002 PARA EVALUAR EL ESTADO NUTRICIONAL DE PACIENTES NO CRÍTICOS CON NUTRICIÓN PARENTERAL

Resumen

Objetivo: Evaluar el estado nutricional de pacientes no críticos de cirugía digestiva, en el momento de iniciar la nutrición parenteral, utilizando tres tests de evaluación nutricional. Estudiar la correlación entre los tests y su asociación con los parámetros clínicos y de laboratorio utilizados para el seguimiento de estos pacientes.

Métodos: Estudio prospectivo de 4 meses. Se recogen variables antropométricas y clínicas. Los resultados de Subjective Global Assessment, Patient-Generated Subjective Global Assessment y Nutritional Risk Screening 2002 se comparan mediante test kappa. La relación entre las variables clínicas y de laboratorio con Subjective Global Assessment se estudian con regresión multinomial; y con Patient-Generated Subjective Global Assessment y Nutritional Risk Screening mediante regresión lineal múltiple. Edad y sexo se introdujeron como variables de ajuste.

Resultados: La desnutrición en 45 pacientes estudiados variaba entre el 51% y el 57%. Subjective Global Assessment correlacionaba bien con Patient-Generated Subjective Global Assessment y el Nutritional Risk Screening ($\kappa = 0,531$ $p = 0,000$). Nutritional Risk Screening 2002 mostró mejor asociación con variables clínicas y analíticas: peor estado nutricional en este test se asoció con peor comportamiento de albúmina ($B = -0,087$; $CI = -0,169/-0,005$); prealbumina ($B = -0,005$; $CI = [-0,011/0,001]$), proteína C reactiva ($B = 0,006$; $CI = [0,001/0,011]$) y leucocitos ($B = 0,134$; $CI = [0,031/0,237]$) al final de la nutrición parenteral.

Discusión: La mitad de los pacientes de cirugía digestiva presentan algún grado de desnutrición en el momento de iniciar la nutrición parenteral. El Nutritional Risk Screening 2002 se mostró como el test con mayor relación con las variables utilizadas en el seguimiento clínico de los pacientes con nutrición parenteral.

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Palabras clave: *Valoración nutricional. Nutrición parenteral. Estado nutricional. Terapia nutricional. Cirugía digestiva.*

Abbreviations

NRS 2002: Nutritional Risk Screening 2002.

PG-SGA: Patient-Generated Subjective Global Assessment.

PN: Parenteral nutrition.

SGA: Subjective Global Assessment.

Introduction

Malnutrition is an independent risk factor with a significant effect on the clinical parameters of mortality, complication rates, nosocomial infections, length of hospital stay, tolerance of treatment, quality of life and prognosis¹⁻⁵. Its early treatment is a highly effective way to save money in health care^{5,6}.

In the Digestive Surgery Department of our hospital (Hospital Universitari Bellvitge), parenteral nutrition (PN) is used in patients coming from different surgical processes that, for different reasons, make the normal use of the gut as the route of nutrition impossible. Prior to surgery, these patients can suffer a restricted nutrition for a variable period of time, and between the surgery and the beginning of PN they may stay in a variable fasting time with the oral or enteral nutrition being essayed without reaching completely successful results. Together, these situations can result in some degree of malnutrition at the starting time of PN.

Timely identification and treatment of nutrition problems may improve a patient's prognosis^{7,8}. However, the evaluation of nutritional status traditionally assessed by a combination of anthropometric and laboratory measures, is costly, time consuming, and difficult to perform⁸. Even when the use of clinical scores may help, the lack of a widely accepted system, which detects those patients who might benefit clinically from nutritional support, is commonly seen as a major limiting factor because there is not a consensus on the best method for evaluation of the nutritional status of hospitalised patients¹.

Several nutritional screening and assessment tools coexist in the recommendations^{9,10}, among them: the Subjective Global Assessment (SGA)^{9,11}, the scored patient-generated subjective global assessment (PG-SGA) –a modification of the SGA^{8,12,13}–, or the Nutritional Risk Screening 2002 (NRS 2002)^{7,14}. The SGA has been used worldwide and has been considered by some authors as the gold-standard for nutritional assessment in hospital settings⁶. It was the method proposed by the American Society of Parenteral and Enteral nutrition in the 2002 guidelines¹⁵. The NRS 2002 is a screening tool proposed by the European Society for Clinical Nutrition and Metabolism^{7,9}. Both are easy-to-use, inexpensive and non-invasive clinical tools and, although nutritional screening and assessment tools do not have the same goal, their comparison is of interest^{10,16-18}.

Objective

The primary objective of this study is to evaluate the nutritional status of digestive surgery non-critically ill patients on PN using the SGA, the PG-SGA, and the NRS 2002 tests and to study the agreement between these three tests. The secondary objective is to study the usefulness of the tests as a monitoring tool, studying if there is any association between the results of the tests and clinical and laboratory parameters used in the clinical follow-up of PN treatment.

Methods

Patients

This is a prospective study carried out over a 4-month period in a large third level teaching hospital of 600 beds. Patients aged at least 18 years old who had begun PN while admitted in the Digestive Surgery Department were eligible for inclusion in the study. Initially, all the patients who met these criteria were considered for the study. Non parametric Kolmogorov-Smirnov tests and t-test, when applicable, were carried out to corroborate the normal distribution of the evaluated sample of patients all together, and categorised by sex and age distribution.

At the time of PN initiation, sex, age and diagnostic data were obtained; and within the first 72 hours of PN treatment, nutritional status was evaluated by two PN Unit members from the Pharmacy Department. Each single patient was evaluated by both of them at the same time.

Oral informed consent from research participants was obtained at the beginning of the study. The confidential information of the patients was protected according to national normative. This manuscript has been approved for its publication by the Clinical Research Ethics Committee (IRB00005523).

Anthropometric measurements

Body height, current body weight and body weight in the 1, 3 or 6 months before hospital admittance were obtained from the information system of the hospital before the interview with the patient and these data were corroborated by the patient. Nowadays, the hospital database contains information about anthropometric measurements obtained by nurses at the hospitalization time. In addition, this system connects with clinical data obtained in the primary care and among these data weight and height are actualized very often, almost every time that the patient goes to this health assistance. The obtained data were corroborated directly with the patient in the interview and with his/her family if they were present. The body mass index (BMI) was then calculated (weight/height squared).

Nutritional risk indicators

Blood samples to determine albumin, prealbumin (transtiretin), C-Reactive Protein (CRP), leukocytes and lymphocytes were obtained (together with the sample necessary for the patient's follow-up) at the beginning of PN treatment and at the end of the PN treatment (a margin of 2 days was permitted).

Subjective Global Assessment (SGA) questionnaire

The SGA was obtained as the overall judgment of the patient's status and the patients were classified into three categories: A: well nourished; B: suspected malnourished or moderately malnourished and C: severely malnourished.

SGA is a clinical technique for nutritional assessment that combines data from subjective and objective aspects of medical history (weight change, dietary intake change, gastrointestinal symptoms and changes in functional capacity) and physical examination (loss of subcutaneous fat, muscle wasting, ankle or sacral edema and ascites)^{11,9}. There is no explicit numerical scoring to achieve a final SGA rank, rather it is subjective. SGA has only been validated in gastrointestinal surgery in adult patients⁹.

Score Patient-Generated Subjective Global Assessment (PG-SGA) questionnaire

The PG-SGA was performed using a questionnaire, much of which can be completed by the patient, but in our study was obtained from an interview with the patient. The higher the PG-SGA score, the greater the risk of malnutrition. The total score provides a guideline for the level of nutrition intervention required, as well as facilitating quantitative outcome data collection¹².

PG-SGA has been specifically developed for patients with cancer¹² due to the fact that the SGA has limited predictive power in cancer patients¹³. Unlike the SGA, which is categorical in nature, the PG-SGA can also measure the nutritional status on a continuous scale, thus allowing for the detection of subtle changes in nutritional status over a short period of time⁸.

Nutritional Risk Screening (NRS) 2002 questionnaire

The NRS 2002 was obtained from a nutritional score plus a severity of disease score and an age adjustment for patients aged >70 years⁷.

NRS 2002 is a screening tool based on knowledge about the association between impaired nutritional status, impaired function and a grading of severity of diseases as a reflection of increased nutritional requirements⁹. It is designed to cover all possible patient categories in a hospital^{7,14}.

Clinical variables

Other variables associated with the clinical situation and the evolution of the patient were also recorded. Regarding PN treatment, the number of days in treatment, the amount of kcal/kg/day of actual body weight provided and the amount of protein/kg/day of ideal body weight provided were recorded. Regarding clinical evolution; the length of hospital stay (LOS) and the number of patients involved in the study that died in the hospital were recorded.

Statistical analysis

All data were analysed using SPSS 19.0 (SPSS INC, Chicago IL, USA). In order to compare the results of the different tests, a categorization was performed at three different levels for the PG-SGA and the NRS 2002 taking into account the score obtained. For the categorization we followed the publications of other authors. For the PG-SGA, patients were classified as well-nourished with a score of ≤ 8 , moderately malnourished with a score between 9 and 14 and as severely malnourished with ≥ 15 ^{6,13,19}. For the NRS 2002 test, well-nourished patients had a score ≤ 2 points, moderately malnourished between 3 and 4 and severely malnourished from 5 to 7^{16,20}. Agreement between the methods was analysed by the kappa (κ) statistic. The value varies from 0 to 1 and expresses the concordance between the tests. A value < 0.2 implies poor concordance; 0.2-0.4 is fair agreement; 0.4-0.6 moderate agreement; 0.6-0.8 substantial agreement; and finally > 0.8 almost perfect concordance^{9,16}.

The association between tests and the analytical and clinical variables was also studied. In the case of PG-SGA and NRS 2002, as continuous variables, a multiple regression model was employed. Then, 26 multiple regression models for the dependent variables PG-SGA and NRS 2002 (13 each) were performed. Variables included as independent variables were analytical and clinical data (one in each model) adjusted by sex and age (sex and age were considered as adjustment variables and were included in every single model). Multinomial regression was used for SGA as a categorical variable. In this case, 13 multinomial regressions of 3 categories, one for each independent variable, were developed to study the factors associated with the SGA. Category of well nourished patients (A) was used as the reference. A global significance test was carried out with the inclusion of interactions. Sex and age were also included as adjustment variables.

Statistical significance was reported at the conventional $p < 0.05$ level (two-tailed).

Results

During the study period (November 2011 to February 2012), 205 patients received treatment with

PN; 56 initiated the treatment directly in the Digestive Surgery Department. Three patients refused to participate. In 5 patients the evaluation could not be performed in the first 72 hours of treatment and another 3 patients could not be evaluated because they were unable to answer the questions. The remaining 45 patients were included in the study. Among them, 73.3% were male with a median age of 65 years old. Demographic, clinical and PN characteristics are presented in table I. To ensure the inference of data obtained in the study we have applied the Kolmogorov-Smirnov test and we have found that the studied population follows a normal distribution ($p = 0.193$). Also, another Kolmogorov-Smirnov test was carried out demonstrating that age follows a normal distribution ($p = 0.948$). On the other hand, 12 women (56.8 ± 19.9 years old) and 33 men (63.7 ± 13.2 years old) were included in the study. Again, a Kolmogorov-Smirnov test of the age depending on the sex was performed and no statistically significance differences were found ($p = 0.2$; $p = 0.2$). In addition, a t-test was carried out to compare both

sexes and their age distribution and we have found that there wasn't statistically significant differences ($p = 0.184$). Finally, even when any difference was found, age and sex were introduced as adjustment factors in all the multivariate studies developed for every variable.

Regarding diagnoses and surgical interventions, an explanation, classification and justification of PN utilisation is done in the following paragraph.

Five patients (11.1%) weren't operated on since there were diagnosed of esophageal perforation (1), fistula (2) and pancreatitis (1). In all cases the decision was a conservative treatment and it was considered impossible to insert an enteral nutrition tube. The last patient was transferred from other hospital with a diagnosis of biliary adenocarcinoma with liver metastasis in order to place a biliary drainage (not considered as a surgical intervention). As the patient showed alimentary intolerance, PN was administered.

Regarding the remaining patients, in 22.5% the surgery was urgent and in 77.5% the surgery was programmed. Two patients received pre-surgical PN

Table I
Demographic, clinical and parenteral nutrition characteristics

<i>Data</i>	<i>Number or median (range)</i>	
Male sex (n = 45)		73.3%
Age (n = 45)		65 years (18-85)
Height (n = 45)		1.65 m (1.45-1.82)
Weight	Initial (n = 45)	70 kg (37-100)
Body Max Index	(initial) (n = 45)	24.9 kg/m ² (13.9-31.6)
Albumin	Initial (n = 44) Final (n = 42)	28 g/L (20-42) 31 g/L (19-45)
Prealbumin (transtiretin)	Initial (n = 37) Final (n = 30)	114 mg/L (52-300) 189 mg/L (63-461)
C Protein Reactive	Initial (n = 36) Final (n = 32)	114 mg/L (4-301) 81 mg/L (0.5-347)
Leukocytes	Initial (n = 45) Final (n = 45)	9.7×10^9 cel/L (3.1-23.2) 8.7×10^9 cel/L (3.1-19.5)
Lymphocytes	Initial (n = 45) Final (n = 45)	1×10^9 cel/L (0.20-6) 1.2×10^9 cel/L (0.5-20)
Length of hospital stay (n = 45)		18 days (8-55)
PN duration (n = 45)		9 days (5-50)
Kcal/kg/day (actual body weight) (n = 45)		24.5 kcal (13.6-34.5)
Protein/kg/day (ideal body weight) (n = 45)		1.3 g (0.7-1.6)
Deaths (n = 45)		1 patient

(5%) and for the rest (95%) PN was initiated after the surgery.

Six patients developed paralytic ileus and they started PN in a media of 6.8 days after the surgical intervention; 2 of these patients had colon neoplasm, 2 of them femoral hernia (one with gangrene and the other with intestinal occlusion) and 1 Crohn disease; the interventions in these patients were intestinal resections, either colon or small intestine. The last patient was operated on for an ileostomy closure.

Seventeen patients had a major digestive surgery intervention: 8 of them had a duodenopancreatectomy because of different cancer diagnoses; 6 patients had a gastrectomy because of gastric cancer; 2 patients had a total colectomy –one because of polyposis and the other because of pseudo-membranous colitis– and one patient a coloplasty after esophagectomy.

Three patients with a hemicolectomy received PN because of some complications. One was a Crohn with two fistulas (enteroenteric and enterovesical), one had an intestinal occlusion and the last one was a complicated surgery with vesical involvement. Six patients were operated on because of rectum neoplasm; in one of them, peritonitis was present and the other 5 were considered as elder people (mean 76.6 ± 5.4 years old) in bad nutritional status.

Two patients had a fistula that needed intervention. One of them was a gastric fistula in a patient with terminal ileostomy; the other had radice enteritis with vesical fistula. Three patients were admitted into the hospital because of intestinal occlusion, two of them with intestinal perforation and the other with entero-vesical fistula; intestinal resection was performed in all of them.

In the last three patients the diagnoses were diverse: one of them was a gynaecological patient with ovary abscesses and during the surgical intervention hepatic abscesses were found and extirpated. A second patient had a perforated duodenal ulcer with peritonitis and the

last one was a patient with a lobectomy because of liver cancer who developed alimentary intolerance.

One year after surgery two more patients had died, in addition to the one that died during the study. In this same period of time 18 patients were readmitted into the hospital with a median of 1.8 (1-4) admissions.

Patients classified as well nourished were 22 in the SGA; 21 in the PG-SGA and 19 in the NRS 2002 (Table II). The rest of the patients were detected to have some degree of malnutrition (moderate + severe): 51.2% in SGA; 52.3% in PG-SGA; and 57.7% in NRS 2002. Agreement between PG-SGA and SGA results was found to be moderate (κ 0.53 $p = 0.000$) as it was between NRS 2002 and SGA (κ 0.53 $p = 0.000$). Nevertheless, agreement between PG-SGA and NRS 2002 was fair (κ 0.31 $p = 0.004$).

A slight majority of patients (53.3%) had no change in the amount of food eaten in the month before starting PN, but 42.2% of them reported to have had a lower ingestion than they normally did for different reasons (Fig. 1). Regarding the type of food, 51.1% of patients reported eating normal food, 35.6% reported eating normal food but in smaller quantities or a lower amount of solid food; the rest ingested only liquids or supplements or almost nothing. Regarding their activities, the majority of patients (71.1%) did not report any change in their normal daily behaviour and 8.9% said they were able to do almost all normal activities. On the other hand, 8.9% spent all day in bed, 4.4% more than half the day and the remaining 6.7% were unable to do any activity at all, spending the day between bed and chair.

The relationship between the nutritional tests and the anthropometric, clinical and biochemical variables are shown in tables III, IV and V.

- A) For the SGA test a statistically significant relationship was found for patients classified as moderately malnourished (B category) with BMI ($p = 0.034$; $CI = 0.569-0.979$) and final leuko-

Tabla II
Categorization of the tests and number (percentage) of patients in each group

Test	Category	Well nourished		
		Moderate malnutrition	Severe malnutrition	
SGA	Classification	A	B	C
	Patients (%)	22 (48.9%)	16 (35.6%)	7 (15.6%)
PG-SGA	Punctuation	0-8 points	9-14 points	≥ 15 points
	Patients (%)*	21 (47.7%)	14 (31.8%)	9 (20.5%)
NRS 2002	Punctuation	0-2 points	3-4 points	≥ 5 points
	Patients (%)	19 (42.2%)	20 (44.4%)	6 (13.3%)

*1 patient unable to be evaluated.

SGA: Subjective Global Assessment; PG-SGA: Patient-Generated Subjective Global Assessment; NRS 2002: Nutritional Risk Screening 2002

test results: PG-SGA vs SGA: κ 0.53 $p = 0.000$

PG-SGA vs NRS 2002: κ 0.31 $p = 0.004$

NRS 2002 vs SGA: κ 0.53 $p = 0.000$.

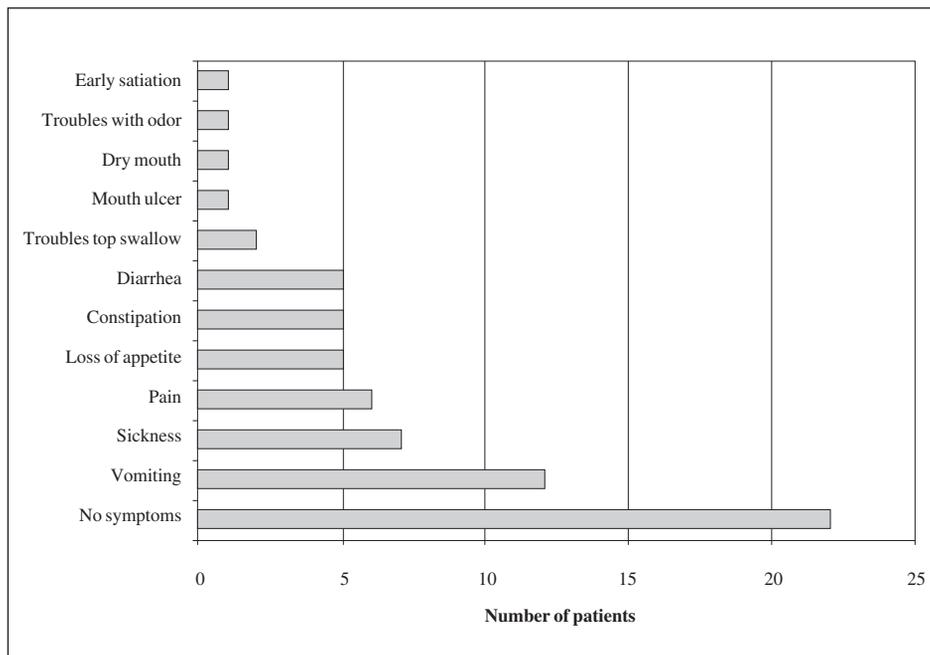


Fig. 1.—Symptoms that resulted in decreased food intake in the month prior to starting parenteral nutrition.

Table III
Clinical and analytical parameters significantly associated with SGA categories B and C adjusted by sex and age (multinomial regression). Category A (well nourished patients) was taken as reference

SGA category	Parameter	n	Mean ± standard	Odds Ratio [Confidence interval]	p
B	BMI (kg/m ²)	16	24.2 ± 3.07	0.764 [0.596 0.979]	0.034
	Final leukocytes	16	11.2 ± 4.6	1.223 [1.021 1.465]	0.029
C	BMI (kg/m ²)	7	21.2 ± 6.1	0.588 [0.413 0.836]	0.003
	Initial CRP (mg/L)	6	44.4 ± 39	0.979 [0.960 0.998]	0.034
	Final CRP (mg/L)	4	250 ± 101.14	1.018 [1.001 1.035]	0.042

Multinomial models for: initial albumin, final albumin, initial prealbumin, final prealbumin, initial leukocytes, initial lymphocytes, final lymphocytes, length of stay, and parenteral nutrition duration, were non statistically significant in both categories.
SGA: Subjective Global Assessment; BMI: body mass index; CPR: reactive-C protein.

Table IV
Results of the multiple linear regressions performed to study the association between clinical and analytical variables and the PG-SGA test, adjusted by sex and age

Parameter	B coefficient	[Confidence interval]	p
BMI	-0.740	[-1.240 -0.241]	0.005
Age	0.161	[0.026 0.296]	0.021
Initial prealbumin	-0.049	[-0.094 -0.04]	0.034
Final leukocytes	0.486	[0.019 0.954]	0.042

Multiple linear regression models for: initial albumin, final albumin, final prealbumin, initial CPR, final CPR, initial leukocytes, initial lymphocytes, final lymphocyte, length of stay and parenteral nutrition duration were non statistically significant.
PG-SGA: Patient-Generated Subjective Global Assessment; BMI: body mass index; CPR: reactive-C protein.

cytes (p = 0.029; CI = 1.021-1.465). Meanwhile, for patients classified as severely malnourished (C category), association was found with BMI

(p=0.003; CI=0.413-0.836); initial CRP (p=0.034; CI = 0.960-0.998]; and final CRP (p = 0.042; CI = 1.001-1.035). Meaning that low values of

Table V
Results of the multiple linear regressions performed to study the association between clinical and analytical variables and the NRS 2002 test adjusted by sex and age

Parameter	B coefficient	[Confidence interval]	p
BMI	-0.227	[-0.326 -0.127]	0.000
Age	0.032	[0.005 0.059]	0.022
Initial prealbumin	-0.010	[-0.021 -0.001]	0.050
Final albumin	-0.087	[-0.169 -0.005]	0.039
Final prealbumin	-0.005	[-0.011 -0.001]	0.050
Final PCR	0.006	[0.001 0.011]	0.023
Final leukocytes	0.134	[0.031 0.237]	0.012

Multiple linear regression models for: initial albumin, initial CPR, initial leukocytes, initial lymphocytes, final lymphocyte, length of stay and parenteral nutrition duration were non statistically significant. NRS 2002: Nutritional Risk Index 2002; BMI: body mass index; CPR: reactive-C protein.

initial BMI were seen in patients with a worse nutritional state in the SGA classification (both B and C classification); and that higher value of CRP at the beginning and also at the end of PN treatment was found in the more malnourished patients according to SGA criteria (C category). Final leukocytes were worse in the category B patient but not in the C, and this may be explained because of the categorical character of this test.

- B) For the PG-SGA test a statistically significant relationship was found with BMI ($p = 0.005$; $B = -0.740$); the initial prealbumin ($p = 0.034$; $B = -0.049$); and final leukocyte value ($p = 0.042$; $B = 0.486$). Those associations can be interpreted in the following way: patients with a lower nutritional status in PG-SGA had lower values of BMI and prealbumin at the beginning of PN and ended the PN treatment with higher values of leukocytes.
- C) The NRS 2002 was related with BMI ($p = 0.000$; $B = -0.227$), initial prealbumin ($p = 0.050$; $B = -0.010$), final albumin ($p = 0.039$; $B = -0.087$), final prealbumin ($p = 0.050$; $B = -0.005$), final CRP ($p = 0.023$; $B = 0.006$) and final leukocytes ($p = 0.012$; $B = 0.134$). Those associations suggest that patients with a worse classification in NRS 2002 had also significantly worse values of BMI, prealbumin and albumin at the beginning of their PN treatment and exhibited worse recovery of the levels of prealbumin at the end of PN treatment, maintaining higher levels of CRP and leukocytes at the end of PN administration.

Any influence of sex and age was seen in the majority of these significant models, except for age and BMI in two of them. Worse BMI together with older age conditioned a lower nutritional status in PG-SGA and NRS 2002.

Discussion

The aim of this study was to assess the nutritional status of non-critically ill patients on PN using the PG-SGA, the SGA and the NRS 2002 tests and to study the agreement between these tests. To our knowledge, this is the first study that explores the nutritional status of non-critically ill patients on PN and we found that between 51.2 and 57.7% of patients had a certain degree of malnutrition at the time of starting the treatment with PN. The severity of malnutrition is quite similar between the tests, with the SGA scoring more cases as not malnourished (48.9%) despite being not so different from the other tests (42.2% and 47.7%). We examined the results of three easy-to-use and inexpensive clinical techniques in patients with a diagnosis that impaired a normal oral nutrition. In these patients, some objective measures (anthropometric, biochemical and immunological tests) have been questioned in view that they are likely to be influenced by many non-nutritional factors¹⁹.

Our overall results showed malnutrition levels comparable to other authors taking into account that the range of patients malnourished is very wide among the literature and that the majority of these studies evaluated the patients at the moment of hospital admittance^{1,6,16,21,22}. Gupta et al.⁸, using SGA, found 52% of malnutrition (SGA B+C) in colorectal cancer patients. Kyle et al.¹⁶ found that NRS 2002 classified 28% of adult patients admitted to the hospital as in a medium-high nutritional risk meanwhile SGA classified them as 39%. Bauer et al.¹⁹ classified malnutrition in 59% of general cancer patients using SGA B and 17% with SGA C; and when applying PG-SGA to the same patients classified malnutrition as 53% (punctuation ≥ 9). Raslan et al.⁶, at the time of admission in a public hospital, identified 28% at nutritional risk with the NRS 2002 test and 39% with the SGA test. Among newly

diagnosed lung cancer patients, Li et al.²³ identified 40.6% to be severely malnourished. In geriatric hospitalized patients, Drescher et al.²⁴ found that 33% were at moderate to severe risk of malnutrition using NRS 2002. In patients with gastric carcinoma, Guo et al.²⁰ determined that 39% of patients had a NRS 2002 ≥ 3 .

In our results, in agreement with other authors⁶, the concordance between SGA and the other two tests was moderate but NRS 2002 and PG-SGA had only a fair agreement. In most part of the studies, SGA is used as the reference test to compare the results obtained from other tools in either screening or assessment^{9,13}. Even though some authors have proposed the SGA as a gold-standard tool for nutritional assessment^{16,25}, other authors defend that NRS 2002 has higher sensitivity, specificity and positive and negative predictive values when compared with SGA¹⁶. In addition, NRS 2002 also allows for the gradation of disease effect and classifies the risk in a continuous scoring system.

Regarding the relationship between the tests and the clinical and analytical variables at the beginning of the PN therapy, we have only found association of BMI and the initial values of prealbumin and CRP. All the tests were related to the BMI, as could be expected, since loss of weight is one of the main points considered. Some authors argue that malnourished cancer patients may have a BMI within the healthy or overweight range, with body fat masking loss of lean body mass^{23,26}. Even though our patients presented good BMI values, we found a clear association between this parameter and the tests applied and this relation appears conditioned by the age.

We also have tried to study if there was any relation between the values of the nutritional tests at the beginning of the PN with the final results of the analytical variables commonly used for the follow-up of PN patient's evolution. Even when it is recognized that the relationship between some of these analytical variables and the patient's nutritional or inflammatory state has not been validated¹⁰, we thought that the study of these relationships could be of interest.

Some associations were found, showing the NRS 2002 association with 4 clinical and analytical variables in concordance with the results of other authors⁶ that found that NRS 2002 was the strongest predictor for the death outcome. In our study we found that patients with more degree of malnutrition in the NRS 2002 presented lower values of albumin and prealbumin at the end of PN therapy together with higher values of leukocytes and CPR than those patients that had better nutrition status in the NRS 2002.

According to some authors, SGA lacks sensitivity to detect improvements in nutritional status observed over a short hospital admission¹⁹ and it is not as sensitive in detecting short-term nutrition status improvements¹³. These could be some reasons to explain why the association between SGA and analytical variables are less than the associations found for NRS 2002. Nevertheless, even when it is postulated that the PG-

SGA score can be used as an objective measure to demonstrate the outcome of nutrition intervention¹⁹, in our group of patients the PG-SGA test showed less correlation with the clinical and analytical variables studied than the NRS 2002 test.

No relationship was found between the tests and length of stay or PN duration, but some authors have published an agreement between a worse classification in the assessment tests and longer LOS with the three tests^{16,19}. As it was expected, no association was found with PN duration maybe because it is mainly dependent of others factors more related with the digestive tube availability, than with the nutritional status of the patient.

The strength of this study lays in the application of different nutritional screening/assessment tests in a population that has not been evaluated before (digestive surgery patients treated with PN). We have found that the results are coherent with published literature and there is a logical correlation between the tests. In these patients, the NRS 2002 seems to be more related with the patient evolution taking into account the normal parameters used to follow-up the nutritional evolution of these patients. SGA and NRS 2002 have the advantage of being easier and quicker to apply than PG-SGA^{13,9}. Nevertheless, between SGA and NRS 2002, it seems that the latter is more accurate possibly due to the less subjective parameters used to determine the nutritional status.

The limitation of this study are the small sample size, but we have applied some statistics that state that the studied population could be representative of the normal population. In addition, all the statistics have been performed adjusting by sex and age. A possible bias can be attributed due to the exclusion of some patients because of cognitive and emotional problems that prevented them from answering the PG-SGA. In this study we compared the information obtained from the nutritional tests with the clinical and analytical parameters that we usually apply in the clinical monitoring of PN patients. This approach can be criticized due to the fact that these parameters are often masked by other non-nutritional factors.

Conclusions

Even if the number of subjects in our study precludes definitive conclusions, our results indicate that a large percentage of digestive surgery patients were at nutritional risk in the moment of initiating PN.

The NRS 2002 appears to be a superior test compared with SGA and PG-SGA in predicting outcome in these PN treated patients.

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Statement of authorship

MBT designed the experiment, collected data and wrote the manuscript; SCS collected and analysed data; ELB analysed data and wrote the manuscript; MMZ designed the experiment and collected data, NMC collected data; RJM analysed data and corrected the manuscript; JLT analysed data and corrected the manuscript.

Conflict of interest statement

Nothing to declare.

References

1. Pablo AMR, Izaga MA, Alday LA. Assessment of nutritional status on hospital admission: nutritional scores. *Eur J Clin Nutr* 2003; 57 (7): 824-31.
2. Sorensen J, Kondrup J, Prokopowicz J, Schiesser M, Krähenbühl L, Meier R, et al. EuroOOPS: an international, multicentre study to implement nutritional risk screening and evaluate clinical outcome. *Clin Nutr* 2008; 27 (3): 340-9.
3. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. *Clin Nutr* 2008; 27 (1): 5-15.
4. Amaral TF, Matos LC, Tavares MM, Subtil A, Martins R, Nazaré M, et al. The economic impact of disease-related malnutrition at hospital admission. *Clin Nutr* 2007; 26 (6): 778-84.
5. Löser C. Malnutrition in hospital: the clinical and economic implications. *Dtsch Arztebl Int* 2010; 107 (51-52): 911-7.
6. Raslan M, Gonzalez MC, Torrinhas RSMM, Ravacci GR, Pereira JCR, Waitzberg DL. Complementarity of Subjective Global Assessment (SGA) and Nutritional Risk Screening 2002 (NRS 2002) for predicting poor clinical outcomes in hospitalized patients. *Clin Nutr* 2011; 30 (1): 49-53.
7. Kondrup J. ESPEN Guidelines for Nutrition Screening 2002. *Clin Nutr* 2003; 22 (4): 415-21.
8. Gupta D, Lammersfeld CA, Vashi PG, Burrows J, Lis CG, Grutsch JF. Prognostic significance of Subjective Global Assessment (SGA) in advanced colorectal cancer. *Eur J Clin Nutr* 2005; 59 (1): 35-40.
9. Anthony PS. Nutrition screening tools for hospitalized patients. *Nutr Clin Pract* 2008; 23 (4): 373-82.
10. Charney P. Nutrition screening vs nutrition assessment: how do they differ? *Nutr Clin Pract* 2008; 23 (4): 366-72.
11. 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 Enter Nutr* 1987; 11 (1): 8-13.
12. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition* 1996; 12 (1 Suppl.): S15-19.
13. Makhija S, Baker J. The Subjective Global Assessment: a review of its use in clinical practice. *Nutr Clin Pract* 2008; 23 (4): 405-9.
14. Kondrup J. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr* 2003; 22 (3): 321-36.
15. American Society for Parenteral and Enteral Nutrition. Guidelines for the Use of Parenteral and Enteral Nutrition in Adult and Pediatric Patients. *JPEN J Parenter Enter Nutr* 2002; 26 (1 Suppl.): 1SA-138SA.
16. Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: A population study. *Clin Nutr* 2006; 25 (3): 409-17.
17. 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 (2): 274-80.
18. Huhmann MB, August DA. Review of American Society for Parenteral and Enteral Nutrition (ASPEN) Clinical Guidelines for Nutrition Support in Cancer Patients: nutrition screening and assessment. *Nutr Clin Pract* 2008; 23 (2): 182-8.
19. Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. *Eur J Clin Nutr* 2002; 56 (8): 779-85.
20. Guo W, Ou G, Li X, Huang J, Liu J, Wei H. Screening of the nutritional risk of patients with gastric carcinoma before operation by NRS 2002 and its relationship with postoperative results. *J Gastroenterol Hepatol* 2010; 25 (4): 800-3.
21. Waitzberg DL, Correia MITD. Nutritional assessment in the hospitalized patient. *Curr Opin Clin Nutr Metab Care* 2003; 6 (5): 531-8.
22. Shike M. Nutrition therapy for the cancer patient. *Hematol Oncol Clin North Am* 1996; 10 (1): 221-34.
23. Li R, Wu J, Ma M, Pei J, Song Y, Zhang X et al. Comparison of PG-SGA, SGA and body-composition measurement in detecting malnutrition among newly diagnosed lung cancer patients in stage IIIB/IV and benign conditions. *Med Oncol* 2011; 28 (3): 689-96.
24. Drescher T, Singler K, Ulrich A, Koller M, Keller U, Christ-Crain M et al. Comparison of two malnutrition risk screening methods (MNA and NRS 2002) and their association with markers of protein malnutrition in geriatric hospitalized patients. *Eur J Clin Nutr* 2010; 64 (8): 887-93.
25. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. *Nutrition* 1999; 15 (6): 458-64.
26. Aydin N, Karaöz S. Nutritional assessment of patients before gastrointestinal surgery and nurses' approach to this issue. *J Clin Nurs* 2008; 17 (5): 608-17.