



Risk, prevalence, and impact of hospital malnutrition in a Tertiary Care Referral University Hospital: a cross-sectional study

Emanuele Rinninella¹ · Marco Cintoni^{1,2} · Antonino De Lorenzo² · Giovanni Addolorato³ · Gabriele Vassallo³ · Rossana Moroni⁴ · Giacinto Abele Donato Miggiano¹ · Antonio Gasbarrini³ · Maria Cristina Mele¹

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Abstract

Hospital malnutrition is still underestimated among physicians, even in internal medicine settings. This is a cross-sectional study, aiming to estimate the risk, the prevalence and the impact of malnutrition in an Internal Medicine and Gastroenterology Department of a large Italian hospital (Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome). Patients were evaluated within 72 h from admission according to Nutritional Risk Screening-2002 (NRS-2002) and European Society for Clinical Nutrition and Metabolism (ESPEN) Criteria. Anthropometric, laboratory tests and Bioelectrical Impedance Analysis (BIA) derived phase angle were also performed. Length of hospital stay (LOS) and in-hospital mortality were collected. Univariate and multivariate analyses were conducted to correlate nutritional status with LOS and hospital mortality. In 10 months, 300 patients were enrolled: male patients were 172 (57.3%); mean age was 63.7 (± 17.6). At admission, 157 (52.3%) patients were at risk of malnutrition; 116 (38.7%) were malnourished. Malnourished patients had a mean LOS of 11.5 (± 8.0) days, not-malnourished 9.4 (± 6.2) days ($p < 0.05$). In-hospital mortality did not significantly differ between the two groups. Multivariate analysis shows that both malnutrition ($p = 0.04$; 95% CI 0.03–3.41) and phase angle ($p = 0.004$; 95% CI -1.92 to -0.37) independently correlate with LOS. In an Internal Medicine and Gastroenterology Department, over half (52.3%) of the patients were found at risk of malnutrition, and over a third (38.7%) were malnourished at hospital admission. Malnutrition and BIA-derived phase angle are independently associated with LOS. ESPEN Criteria and phase angle could be performed at admission to identify patients deserving specific nutritional support.

Keywords Hospital malnutrition · NRS-2002 · ESPEN Criteria · Phase angle · Length of hospital stay · Hospital mortality · Personalized medicine

Introduction

Hospital malnutrition is defined as a condition of undernutrition during hospital stay, representing a detrimental variable for clinical outcomes such as length of stay (LOS), morbidity and hospital mortality, while also producing higher healthcare costs. It ranges from 11 to 69%, with considerable variability among geographical sites and clinical specialty wards [1, 2]. Notwithstanding its long-recognized role [3], it continues to be underestimated in clinical practice [1].

Several tools have been validated to investigate malnutrition at hospital admission. There is no “gold standard” tool to define malnutrition, even if Nutritional Risk Score-2002 (NRS-2002) [4] has been largely accepted to identify patients at risk of malnutrition in a hospital context. This score takes into account the patient’s weight loss, Body Mass Index (BMI), reduced dietary intake and the gravity

✉ Emanuele Rinninella
emanuele.rinninella@unicatt.it

¹ Clinical Nutrition Unit, Gastroenterology and Oncology Area, Fondazione Policlinico Universitario A. Gemelli IRCCS - Università Cattolica del Sacro Cuore, Largo Agostino Gemelli, 8, 00168 Roma, Italy

² Section of Clinical Nutrition and Nutrigenomic, Department of Biomedicine and Prevention, University of Rome Tor Vergata, Rome, Italy

³ Internal Medicine and Gastroenterology Unit, Gastroenterology and Oncology Area, Fondazione Policlinico Universitario A. Gemelli IRCCS - Università Cattolica del Sacro Cuore, Roma, Italy

⁴ Institute of Neurology, Neuroscience Area, Fondazione Policlinico Universitario A. Gemelli IRCCS - Università Cattolica del Sacro Cuore, Rome, Italy

of illness. Many studies use NRS-2002 to assess hospital malnutrition, even if it is more appropriate as a screening tool [5]. Recently, the European Society for Clinical Nutrition and Metabolism (ESPEN) released two optional criteria to define malnutrition, which were recently validated in at least two different hospitalized cohorts of patients [6, 7].

Other clinical tools, easy to perform at the bedside, are anthropometric measures, handgrip strength test (HGS) and bioelectrical impedance analysis (BIA) [8, 9]. A growing consideration has recently been given to BIA-derived Phase Angle (PhA). PhA is obtained by two electrical tissue properties at the passage of a low voltage current through the body, resistance (R) and reactance (Xc), according to the following formula:

$$\text{PhA} = \arctan(Xc/R) \times (180/\pi)$$

PhA is proportional to body cell mass, and a low PhA is associated with malnutrition and nutritional risk at hospital admission [10]. Furthermore, it has been correlated with poor prognosis in several diseases, and ESPEN recommends it as a prognostic nutritional measure [11].

A nutritional evaluation is of utmost importance in an Internal Medicine and Gastroenterology department-admitted patients. First of all, the majority of cancer diseases producing malnutrition—gastric, pancreas and liver cancer—are managed in an Internal Medicine and Gastroenterology Department. The impact of malnutrition in the prognosis of patients affected by such diseases has already been elucidated [12–14]. Liver diseases also often induce protein-energy malnutrition, micro, and macronutrient deficiencies and impair the metabolism of lipids and glucose [15]. Moreover, approximately 75% of hospital-admitted patients with Crohn disease (CD) are considered undernourished [16]. Other acute and chronic illnesses, such as pancreatitis, cholestatic liver diseases, alcohol-related diseases and heart failure, cause high metabolic expenditure, malabsorption and reduced oral intake aggravating undernutrition [17–20].

Aims of this work are:

- to estimate the risk and the prevalence of malnutrition among hospital-admitted patients in an Internal Medicine and Gastroenterology Department (primary endpoint);
- to evaluate the prognostic role of malnutrition in hospital outcomes (LOS and mortality) (secondary endpoint).

Methods

Study design

This is a prospective observational study, conducted according to guidelines for the classification and management of observational studies, published in the Determination of the

(Italian) Official Gazette March 20, 2008, General Series n. 76 of 31.03.2008. Patients have been recruited in the Department of Internal Medicine and Gastroenterology of the Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome. From March to December 2017, a nutritional evaluation of every adult (≥ 18 years old) admitted patient was performed, within 72 h from admission. Patients not suitable for evaluation, i.e., with the failure of at least one vital organ, were excluded. Patients hospitalized for a programmed procedure and discharged within four days were excluded. LOS was calculated from the admission day to discharge or death. Deaths during hospital stay were also assessed through clinical files and electrocardiographic reports.

Ethical statement

Patients who gave their informed consent for the collection and processing of their data were included in the study. The research was carried out according to the Declaration of Helsinki and obtained the approval of the Institutional Review Board and Ethics Committee of “Fondazione Policlinico Universitario A. Gemelli IRCCS”, Rome (Protocol Number 53572/17).

Data collection

Demographic characteristics, main admission diagnoses, comorbidities, date of hospital admission and discharge or death, clinical and anthropometric data, laboratory values and other nutritional measures were collected. The Charlson Comorbidity Index (CCI) [21] was calculated for each patient.

Body weight was measured using a professional balance beam scale with height rod (Seca 700 Physician's Balance, Seca®); subjects wore light pajamas and had no footwear. For bedridden patients, weight was obtained using bed-integrated weighing scale (Hill-Rom® 1000 Medical Surgical bed) and height estimated from ulna length, according to validated tables [22]. BMI was calculated as weight divided by height squared (kg/m^2). Body circumferences were obtained using a plastic fiber tape (Seca 201 Girth Measuring Tape, Seca®), according to accepted standards [23] and reported in centimeters. BIA was performed on patients lying down supine on the bed, with arms not touching the torso and legs not touching at the thigh, according to accepted standards [24]. A multifrequency device (MF-BIA) (BodyStat® 4000, BodyStat LTD) was used. R, Xc, and PhA (at 50 kHz) were measured, while fat mass (FM), fat-free mass (FFM) were derived, according to Company equations. FM index (FMI) and FFM index (FFMI) were then calculated by dividing FM and FFM by the square of the patient's height in meters (kg/m^2). We also calculated the PhA Z-score, according to the following formula:

$$\text{PhA } Z\text{-score} = \frac{(\text{patient's observed PhA}) - (\text{healthy population's median PhA})}{(\text{healthy population's standard deviation})}$$

The healthy population's values, according to gender and age, were adopted from Barbosa Silva et al. [25].

HGS was performed using a hand dynamometer (DynEx™ 12-0455 Digital Hand Grip, Akern SRL) according to accepted standards [8]. A total of three measures were obtained from each patient, and the mean HGS was calculated.

The Malnutrition Screening was performed with NRS-2002 [4]. It consists of a preliminary phase, questioning if patient's BMI is < 20.5, if the patient has lost weight in the last three months, had a reduced dietary intake in the last week, or if he/she is severely ill. If one of these questions is "yes," then a second phase follows, investigating nutritional status (giving 1–3 points) and severity of disease (1–3 points). One point is added to the final score if the patient is > 70 years old. A numerical score is obtained: < 3 stands for "no nutritional risk;" ≥ 3 identifies patients at nutritional risk, deserving a nutritional assessment and care plan.

Malnutrition was assessed according to ESPEN Criteria [27]. There are two optional ways to define malnutrition: the first is having a BMI < 18.5 kg/m². The second way is reached by the combination of two options: an unintentional weight loss (> 10% in an indefinite time or > 5% over 3 months) plus a reduced BMI (< 20 kg/m² in < 70 years old or < 22 kg/m² in ≥ 70 years old) or a low FFMI (< 15 kg/m² in females and < 17 kg/m² in males).

Data collection and data entry were performed by trained dietitians, and then critically reviewed by physicians (the Authors).

Statistical analysis

The sample size has been calculated considering the primary endpoint and assuming, according to the literature [3], an estimated proportion of malnutrition of 40%, setting the precision of estimate to 0.05 and the confidence level to 0.9. The required sample size was 260 and allowing a 15% of dropouts, the final sample size of 300 patients was reached.

Univariate and multivariate statistical analyses were performed to summarize the sample's main features. Descriptive statistics and frequency tables were provided for all baseline variables, and to give an overview of the demographic and clinical structure of the sample. Continuous variables were summarized with descriptive statistics (number, mean, standard deviation). Frequency counts and percentage of subjects within each category will be provided for categorical data. For all the performed tests a level of confidence $\alpha = 0.05$ has been considered.

Data were collected in an Excel® spreadsheet. Normal distribution of numerical data was assessed using Kolmogorov–Smirnov and Shapiro–Wilk tests. Patients were grouped according to malnutrition risk (NRS-2002 < 3, NRS-2002 ≥ 3) [4] and to ESPEN Criteria [26]. An unpaired *t* test was used to compare differences between means; categorical variables were compared by Pearson's Chi-square or Fisher's exact test.

LOS (expressed in days and calculated from admission to discharge day) and hospital mortality (death during hospital stay) were considered as clinical endpoints. Multiple linear regression was performed to estimate the impact on LOS (dependent variable) of the following independent variables: malnutrition (according to ESPEN Criteria), PhA, cancer, age (years) and CCI. Statistical analyses were performed with STATA® Software (Version 13, Stata Corporation; College Station, TX, USA).

Results

In 10 months of observation, data from 300 patients were collected. Male patients were 172 (57.3%), females were 128 (42.7%); mean age was 63.7 years (± 17.6). The majority of the patients (287, 95.6%) came from the Emergency Department (ED).

The most frequent admission diagnoses were cancer (112 patients, 37.4%), followed by cirrhosis (43, 14.3%) and biliary diseases (31, 10.3%). Demographic data and admission diagnoses were reported in Table 1.

Many patients had multiple diseases. Overall (beyond the admission diagnoses), 62 patients (20.6%) were affected by cirrhosis, of whom 11 were in Child A (17.7% of cirrhotic patients), 32 in Child B (51.6%), 19 in Child C (30.6%); 115 patients (38.3%) had a cancer: 24 pancreatic cancer, 19 Hepatocellular Carcinoma (HCC), 17 cholangio-cellular carcinoma (CCC), 15 gastric cancer, 14 colorectal cancer, 26 other malignancies, included hematological malignancies; 49 patients (16.3%) had a biliary disease; 25 (8.3%) were affected by pancreatitis; 24 (8%) were alcoholics; 11 (3.7%) were affected by IBD; 11 (3.7%) had an acute hepatitis; 10 (3.3%) had an upper gastroenterological disease; 95 patients (31.7%) were suffering from cardiovascular disease, 60 (20%) were affected by diabetes mellitus type 2, 58 (19.3%) had a chronic kidney disease, 30 (10%) had anemia, 15 (5%) had a chronic obstructive pulmonary disease, 14 (4.7%) had a neurological disease (data not shown). Ninety-eight patients (32.7%) had a CCI class 0; 88 patients (29.3%) a CCI class 1–2; 63 patients (21%) a CCI class

Table 1 Demographical data, main diagnoses and CCI of not-malnourished and malnourished patients, according to ESPEN Criteria

	Total (300 patients)	Not malnourished according to ESPEN Criteria 184 patients	Malnourished according to ESPEN Criteria 116 patients	<i>p</i>
Demographic data	<i>n</i> (%) or mean ($\pm$ SD)			
Male	172 (57.3)	101 (54.7)	71 (61.2)	0.28
Age (years)	63.7 $\pm$ 17.6	64.5 $\pm$ 15.8	62.5 $\pm$ 20.1	0.32
Type of hospital-admission	<i>n</i> (%)			
Emergency-admitted	287 (95.6)	175 (95.1)	112 (96.5)	0.53
Admission diagnoses	<i>n</i> (%)			
Cancer	112 (37.4)	64 (34.9)	48 (41.4)	0.19
Cirrhosis	43 (14.3)	33 (17.6)	10 (8.6)	0.025
Biliary pathology	31 (10.3)	17 (9.2)	14 (12.1)	0.58
Anemia (various etiology)	26 (8.7)	17 (9.3)	9 (7.8)	0.65
Cardiovascular diseases	18 (6.0)	15 (8.3)	3 (2.6)	0.06
Acute pancreatitis	16 (5.3)	10 (5.5)	6 (5.2)	0.91
Others (gastroenterological)	13 (4.3)	8 (4.3)	5 (4.3)	0.83
Infections	13 (4.3)	8 (4.4)	5 (4.3)	0.98
Inflammatory bowel diseases	9 (3.0)	4 (2.2)	5 (4.3)	0.45
Upper GI diseases	9 (3.0)	2 (1.1)	7 (6.0)	0.014
Alcoholic abuse disorder	5 (1.7)	3 (1.6)	2 (1.7)	0.95
Others (internal medicine)	5 (1.7)	3 (1.6)	2 (1.7)	0.95
Charlson comorbidity index	<i>n</i> (%)			
0	98 (32.7)	53 (28.8)	45 (38.8)	0.07
1–2	88 (29.3)	54 (29.3)	34 (29.3)	0.58
3–4	63 (21.0)	45 (24.5)	18 (15.5)	0.06
≥ 5	51 (17.0)	32 (17.4)	19 (16.4)	0.82

ESPEN European Society for Clinical Nutrition and Metabolism, SD standard deviation, GI gastrointestinal

3–4; 51 patients (17%) a CCI class ≥ 5 . No statistical differences were seen between malnourished or not malnourished patients (Table 1).

Nutritional and laboratory data are shown in Table 2.

Primary endpoint

Prevalence of malnutrition

According to NRS-2002, 157 patients (52.3%) were at risk of malnutrition at admission. Patients diagnosed as “malnourished” according to ESPEN Criteria were 116 (38.7% of the total cohort). Among patients considered “at risk of malnutrition,” ESPEN Criteria identified 91 patients as malnourished (57.9%).

Secondary endpoints

Length of hospital stay

Mean LOS was 10.3 ± 7.1 days. LOS was significantly higher in patients malnourished (according to ESPEN

Criteria) (11.5 ± 8.0 days) compared to not malnourished patients (9.4 ± 6.2 days) ($p < 0.05$).

Results from the multiple linear regression model highlights malnutrition and PhA as independent prognostic factors of LOS, even if corrected for other covariates such as cancer, age and CCI ($p = 0.04$; 95% CI 0.03–3.41 for malnutrition; $p = 0.004$; 95% CI -1.92 to -0.37 for PhA).

Hospital mortality

Overall, 12 patients (4%) died during hospitalization (Table 3). Patients who died during the hospital stay had been admitted for pancreatic cancer (2), gastric cancer (2), HCC (1), biliary neoplasia (1), ovarian cancer (1), cirrhosis (1), acute pancreatitis (1), protein-losing enteropathy (1), lymphoblastic leukemia (1), and sepsis (1) (Table 4).

Among patients who died during hospitalization, nine had not been considered malnourished (4.9% of not malnourished patients), whereas three had been considered malnourished (2.6% of malnourished patients), at admission. However, a significant difference in mortality rate between the two groups was not found ($p > 0.05$).

Table 2 Nutritional and laboratory data in not-malnourished and malnourished patients, according to ESPEN Criteria

	Total (300 patients)	Not malnourished according to ESPEN criteria 184 patients	Malnourished according to ESPEN criteria 116 patients	<i>p</i>
Nutritional data	mean ($\pm$ SD)			
Weight (kg)	68.2 $\pm$ 15.9	75.3 $\pm$ 14.6	57.0 $\pm$ 10.4	<0.00001
Height (m)	1.67 $\pm$ 0.22	1.66 $\pm$ 0.26	1.67 $\pm$ 0.09	0.57
BMI (kg/m ²)	24.32 $\pm$ 5.02	26.97 $\pm$ 4.33	20.21 $\pm$ 2.67	<0.00001
Wrist circumference (cm)	16.8 $\pm$ 1.6	17.2 $\pm$ 1.5	16.1 $\pm$ 1.5	<0.00001
MUAC (cm)	26.4 $\pm$ 3.9	27.9 $\pm$ 3.7	24.1 $\pm$ 2.9	<0.00001
Hip circumference (cm)	91.5 $\pm$ 15.1	97.5 $\pm$ 13.7	80.9 $\pm$ 11.1	<0.00001
Waist circumference (cm)	94.6 $\pm$ 18.9	98.1 $\pm$ 11.2	88.4 $\pm$ 6.7	<0.00001
Phase angle (°)	4.38 $\pm$ 1.23	4.50 $\pm$ 1.25	4.18 $\pm$ 1.18	0.031
Standardized phase angle (Z-score)	-1.70 $\pm$ 1.36	-1.62 $\pm$ 1.35	-1.82 $\pm$ 1.37	0.23
Fat-free mass (kg)	47.2 $\pm$ 11.0	51.5 $\pm$ 10.5	40.5 $\pm$ 8.2	<0.00001
Fat-free mass index (kg/m ²)	16.8 $\pm$ 3.2	18.4 $\pm$ 2.8	14.3 $\pm$ 1.9	<0.00001
Fat mass (kg)	21.5 $\pm$ 7.9	23.9 $\pm$ 8.1	17.4 $\pm$ 5.7	<0.00001
Fat mass index (kg/m ²)	7.7 $\pm$ 2.9	8.6 $\pm$ 2.9	6.2 $\pm$ 1.9	<0.00001
Handgrip strength test (kg)	19.3 $\pm$ 9.4	20.2 $\pm$ 9.5	17.9 $\pm$ 9.1	0.05
Laboratory data	mean ($\pm$ SD)			
Hemoglobin (g/dl)	11.3 $\pm$ 2.5	11.1 $\pm$ 2.5	11.3 $\pm$ 2.5	0.46
White blood cells ($\times 10^9$ /mm ³)	9.1 $\pm$ 5.8	8.8 $\pm$ 5.5	9.5 $\pm$ 6.3	0.31
Lymphocytes ($\times 10^9$ /mm ³)	1.6 $\pm$ 1.7	1.5 $\pm$ 1.9	1.6 $\pm$ 1.4	0.86
Glycemia (mg/dl)	114 $\pm$ 48	118 $\pm$ 54	107 $\pm$ 35	0.05
Creatinine (mg/dl)	0.97 $\pm$ 0.66	1.01 $\pm$ 0.72	0.91 $\pm$ 0.54	0.18
Albumin (g/l)	30.5 $\pm$ 6.2	30.4 $\pm$ 6.0	30.6 $\pm$ 6.6	0.87
Iron (gamma/dl)	59.9 $\pm$ 49.6	60.1 $\pm$ 50.7	59.6 $\pm$ 47.9	0.96
Ferritin (ng/ml)	419.8 $\pm$ 581.6	398.3 $\pm$ 515.2	451.4 $\pm$ 671.4	0.61
Transferrin (mg/dl)	211.3 $\pm$ 71.9	209.9 $\pm$ 74.1	213.6 $\pm$ 69.3	0.81
CRP (mg/l)	66.5 $\pm$ 100.5	59.4 $\pm$ 79.6	77.1 $\pm$ 125.5	0.22
Vitamin D (ng/ml)	20.2 $\pm$ 11.4	18.4 $\pm$ 9.9	23.7 $\pm$ 13.2	0.019
Vitamin B12 (ng/ml)	796.5 $\pm$ 824.7	828.9 $\pm$ 836.7	747.4 $\pm$ 810.5	0.54
Folic Acid (ng/ml)	12.2 $\pm$ 15.8	12.8 $\pm$ 15.6	11.3 $\pm$ 16.1	0.54
Zinc (gamma/dl)	43.9 $\pm$ 17.2	42.1 $\pm$ 14.7	47.7 $\pm$ 20.9	0.12

ESPEN European Society for Clinical Nutrition and Metabolism, SD standard deviation, BMI body mass index, MUAC mid-upper arm circumference, CRP C-reactive protein

Table 3 Hospital outcomes in not malnourished and malnourished patients, according to ESPEN Criteria

	Total (300 patients)	Not malnourished according to ESPEN Criteria 184 patients	Malnourished according to ESPEN Criteria 116 patients	<i>P</i>
Outcomes	<i>n</i> (%) or mean ($\pm$ SD)			
LOS (days)	10.3 $\pm$ 7.1	9.4 $\pm$ 6.2	11.5 $\pm$ 8.0	0.011
Exitus	12 (4.0)	9 (4.9)	3 (2.6)	0.38

ESPEN European Society for Clinical Nutrition and Metabolism, LOS length of hospital stay

Discussion

Even if a gold standard has not been defined, NRS-2002 is largely considered a reliable tool to identify malnutrition risk among hospitalized patients. It was developed to

identify patients who were likely to benefit from a nutritional intervention [27]. Despite its original purpose, it is usually applied to assess patients' nutritional status [5].

Other malnutrition screening and assessment tools are used now. The Subjective Global Assessment (SGA) is considered a reliable malnutrition assessment tool, even if it is

Table 4 Multivariate analysis: impact of malnutrition (according to ESPEN Criteria) on length of stay

	Coefficient	95% Confidence interval	p
Malnutrition according to ESPEN	1.72	0.03–3.41	0.04
Cancer	0.08	–1.94 to 2.09	0.94
Phase Angle	–1.15	–1.92 to 0.37	0.004
Age	–0.04	–0.09 to 0.01	0.11
Charlson comorbidity index	0.07	–0.41 to 0.54	0.78
Constant	17.25	11.02 to 23.48	

ESPEN European Society for Clinical Nutrition and Metabolism

based on subjective evaluation and is quite dated [28]. The Mini Nutritional Assessment (MNA) [4] is a sensible tool, specific for the elderly, and it also evaluates mental aspects [5]. Even though it is a reliable tool in hospital contexts, the Malnutrition Universal Screening Tool (MUST) [29] is specifically developed for community studies. ESPEN Criteria for a diagnosis of malnutrition have been recently released by ESPEN Society, based on a Consensus Statement [26], and then validated in hospital studies [6, 7]. In this study, NRS-2002 was used as a nutritional screening tool, malnutrition was assessed according to ESPEN Criteria.

Our study, conducted for 10 months in an Internal Medicine and Gastroenterology Department of a large Italian hospital, shows, at admission, 52.3% of patients (157/300) “at risk of malnutrition” according to NRS-2002. According to ESPEN Criteria, 38.7% (116/300) were considered “malnourished.” The rate of malnourished patients is significantly higher among patients reporting an NRS-2002 score ≥ 3 than in those with an NRS-2002 < 3 (57.9% vs. 17.5%; $p < 0.001$). This confirms the reliability of NRS-2002 score in identifying the risk of malnutrition in hospitalized gastroenterological patients.

Such evidence is in line with other European hospital cross-sectional studies. A Danish study, conducted on 126 patients in a Gastroenterology Department, identified a prevalence of nutritional risk of 58%, according to NRS-2002 [30]. A German study, enrolling 815 patients admitted in a Department of Medicine, showed a malnutrition risk rate (NRS-2002 ≥ 3) of 44.6%, whereas the prevalence of malnutrition, according to SGA was 53.6% [31]. In a university hospital in Portugal, Guerra et al. [6] recently conducted a prospective observational study on 632 patients (in several wards), showing a nutritional risk (NRS-2002 ≥ 3) in 72% of patients. Among these, 57.1% were undernourished according to Patient-Generated (PG)-SGA and 12.1% undernourished according to ESPEN Criteria.

In a geriatric hospital setting, in Italy, Orlandoni et al. [7] show a high malnutrition risk (according to MUST) in 28.2% of patients: of these, 88.3% were malnourished according to ESPEN Criteria (24.6% of the total population). In both the last two studies, malnutrition (assessed with ESPEN Criteria) is independently associated with a longer LOS [6, 7].

Our study confirms the independent association of malnutrition assessed by ESPEN Criteria with LOS, and the validity of these criteria to investigate malnutrition at hospital admission. On the contrary, no association between malnutrition and hospital mortality is found. There is evidence of a certain impact of nutritional status in hospital mortality [32]. In our context, our results may probably be due to the overall short mean LOS (10.3 ± 7.1 days).

We also investigated the prognostic role of PhA in some hospital outcomes (LOS and mortality). PhA is nowadays considered a body composition marker and a nutritional prognostic score. Its predictive value was largely demonstrated in cancer diseases. Many retrospective and prospective studies show that a low PhA is associated with a worse survival rate in patients affected by HCC, pancreatic and colon cancer [14, 33, 34] with cut-off values slightly variable (respectively, $\leq 4.8^\circ$, $< 5.0^\circ$ and $\leq 5.57^\circ$). Recently, a low PhA is related to poor nutritional status and independently associated with mortality in a cohort of male patients affected by cirrhosis [35]. A prognostic role of PhA in prolonging LOS was already assessed in several hospital settings, both in a miscellaneous cohort [36] and in specialist wards, such as in Intensive Care Unit (ICU) [37, 38] and cardiac surgery [39]. A low PhA was already correlated with hospital mortality both in geriatric and ICU admitted patients [40, 41]. The prognostic role of PhA as nutritional marker was recently assessed in gynecologic oncology where it correlates with the extent of cytoreduction and postoperative complications in ovarian cancer [42].

In our study, PhA shows a strong inverse association with LOS ($p = 0.004$; 95% CI -1.92 to -0.37); for this reason, we encourage clinicians to assess PhA at a patient's admission in their clinical practice.

Our cohort shows a high rate of cancer patients. This category needs a special nutritional evaluation as recently ESPEN guidelines recommend. [43]. However, in our survey, cancer patients are not statistically more represented in the malnourished category. This could partially be due to the heterogeneity of the stages and etiologies of cancer diseases.

Surprisingly, patients admitted for cirrhosis were more likely not recognized as malnourished by ESPEN Criteria. However, these Criteria consider weight loss and BMI

as crucial points in the assessment of malnutrition; at the same time, many cirrhotic patients may undergo weight gain, especially in the advanced stages of the disease, when the weight gain may be more attributable to fluid overload rather than to body mass. Indeed, 82.2% of the cirrhotic patients of this cohort were in CHILD B or C stage (decompensated disease). Therefore, ESPEN Criteria seem to be unreliable in the detection of malnutrition in cirrhotic patients.

On the contrary, the rate of malnourished patients seems to be higher in upper GI diseases (esophageal or gastric inflammation, ulcer or stenosis): this could be explained by reduced food intake in this category.

Most of the nutritional parameters (including PhA) are worse in malnourished patients. On the contrary, laboratory values do not significantly differ among the two classes, with the only exception of Vitamin D, which is significantly higher in the malnourished group (23.7 ± 13.2 vs. 18.4 ± 9.9 ; $p = 0.019$) (Table 2). However, its value is below the normal range in both groups, and we did not collect data about (hexogen) vitamin D supplementation.

A possible limitation of this study may be the heterogeneity of the cohort. Our patients had different admission diagnoses and several comorbidities, as happens in every Internal Medicine and Gastroenterology department. Nevertheless, malnutrition is independently associated with LOS even when corrected for cancer, age, and CCI.

We avoided using data from patients having a programmed hospitalization of ≤ 4 days, who had been admitted only for a single technical procedure. Most of the patients were admitted from the ED. In our opinion, adding data from patients undergoing programmed procedures could have further strengthened the difference in LOS between malnourished and not-malnourished patients; in fact, patients admitted for the programmed procedure were generally well nourished.

A critical question is whether nutritional support starting from admission could ameliorate hospital outcomes. Given the cross-sectional type of study, we did not collect data about a possible impact of nutritional intervention. An older Cochrane review on the use of protein and energy supports in elderly people at risk of malnutrition finds a small but consistent weight gain in older people, with a reduction in mortality in undernourished older people. Conversely, no evidence of improvement in reduction in LOS is found [44]. However, it has been demonstrated that the application of a validated nutritional screening tool may ameliorate hospital nutritional management, through several actions such as referral to a dietitian, provision of energy-enriched snacks, adjustment of consistency of food and drinks and monitoring the nutritional intake [45]. Moreover, our group recently demonstrated the efficacy of nutritional support on postoperative complications, LOS, and hospital costs, in a surgical cohort of colon cancer patients [46].

Further studies are needed to confirm the clinical value of nutritional support at admission in malnourished patients, in hospital settings.

The clinical value of this study may reside in emphasizing the need for a nutritional screening of gastroenterological patients at admission, given the high prevalence of malnutrition and its impact on LOS and, therefore, on hospital costs.

In conclusion, our study shows, in a high-volume Italian Internal Medicine and Gastroenterology Department, a high rate (52.3%) of patients at risk of malnutrition at hospital admission, according to NRS-2002, with over a third (38.7%) of patients malnourished, according to ESPEN Criteria. This evidence should be taken into account in clinical practice at the time of hospital admission, given its impact on LOS. The application of nutritional risk scores and simple tools such as BIA-derived PhA should be mandatory to identify patients who need a prompt nutritional intervention.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Statement of human and animal rights The study was carried out according to Declaration of Helsinki and obtained the approval of the local Ethics Committee (Fondazione Policlinico A. Gemelli). Protocol number 53572/17.

Informed consent Patients gave their informed consent to participate to the survey.

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