

# The Impact of Preoperative Nutritional Status of Elderly Patients on the Postoperative Outcome: Comparison of Two Nutritional Assessment Tests and Biochemical Tools

Özlem Sezen , Banu Çevik 

Department of Anesthesiology and Reanimation, University of Health Sciences, Kartal Dr. Lütfi Kırdar Training and Research Hospital, İstanbul, Turkey

ORCID iDs of the authors: Ö.S. 0000-0002-2144-9224; B.Ç. 0000-0002-7872-1794.

Cite this article as: Sezen Ö, Çevik B. The Impact of Preoperative Nutritional Status of Elderly Patients on the Postoperative Outcome: Comparison of Two Nutritional Assessment Tests and Biochemical Tools. *Cyprus J Med Sci* 2020; 5(4): 333-8.

## BACKGROUND/AIMS

Our main goal was to compare the two validated nutritional screening tools and serum proteins that are used as routine biochemical markers for the prediction of the postoperative outcome.

## MATERIAL and METHODS

The current study was design to evaluate the prevalence of malnutrition among elderly patients undergoing elective curative gastrointestinal cancer and trochanteric hip fracture surgery. On admission to the preoperative holding area, all patients underwent the two nutritional screening tests: Mini Nutritional Assessment (MNA) and Nutritional Risk Screening 2002 (NRS - 2002). After assessment, all participants were followed-up throughout their hospital stay. We calculated the lymphocyte-monocyte ratio (LMR) and albumin-globulin ratio (AGR) according to the laboratory results. The surgical outcome (discharge to ward/intensive care) and postoperative infection (systemic or surgical site) were recorded.

## RESULTS

The group of patients with MNA < 17 (malnutrition) had a significantly high ICU admission rate and incidence of systemic or surgical infection, which led to the prolonged length of hospital stay. According to the NRS-2002 screening tool, the ICU admission rate was higher in patients with a score  $\geq 3$ . The surgical site infection rate in this group was also significantly higher than that of the patients with an NRS-2002 score < 3. When comparing the two screening tools, the incidence of ICU admission was significantly higher in patients with MNA > 17. The mean serum albumin and globulin levels and the AGR was comparable between before and after the surgery. However, the mean LMR was significantly lower than the preoperative value.

## CONCLUSION

Measurements with easy-to-perform tests will provide guidance in terms of identifying potential perioperative risks.

**Keywords:** Malnutrition, older adults, nutritional biomarkers, MNA, NRS-2002

## INTRODUCTION

People are living longer worldwide, and the proportion of the population that is over 60 years is expected to increase from 12% to 22% between 2015 and 2050 (1). With increasing age, people have various age-related co-morbidities, and many of them require hospitalization. A larger proportion of the elderly population undergoes surgical procedures due to advances in surgical, anesthetic, and intensive care interventions.

Malnutrition leads to a progressive decline in the health condition, reduced physical and cognitive functional status, increased utilization of health care services, premature institutionalization, and increased mortality in the elderly population (2).

Determining the malnutrition risk is an important area of concern, and precautions need to be taken in order to initiate appropriate nutritional support. However, physicians do not always have enough time to treat malnutrition. Due to functional alterations caused by malnutrition, falls are frequent in the geriatric population, and hip fracture is

one of the main reasons of hospitalization. Early hip surgery within 48 hours was recommended because of the decrease in mortality risk and perioperative complications (3). A recent meta-analysis indicated that the prevalence of malnutrition in patients with hip fracture was approximately 18.7% using the Mini-Nutritional Assessment (MNA) test. Using the Body Mass Index (BMI) as a diagnostic tool, the prevalence increased up to 45.7% (4). Malignancies are the other main cause of malnutrition, and weight loss can sometimes be the first symptom of cancer. A systematic review revealed that malnutrition was significantly positively associated with increased risk of all-cause mortality (5). In a retrospective study that included 709 adult patients in 25 Brazilian hospitals, the incidence of complications among patients with malnutrition was 27% (relative risk [RR] = 1.60) compared with 17% among the well-nourished counterparts. The mortality of patients with malnutrition and well nutrition was 12.4% vs 4.7%, respectively (RR = 2.63) (6).

Nutritional assessment is a systemic process and can be done by using the ABCD methods, that is, the anthropometry, biochemical/biophysical, clinical, and dietary methods (7). Although many screening and diagnostic tools have been introduced in clinical practice, no single test is sufficient for the assessment of the nutritional status (8). The Nutritional Risk Screening 2002 (NRS 2002) test and Mini Nutritional Assessment (MNA) are the most common screening tools for hospitalized patients (9, 10). The MNA is a more useful tool for the identification of frail patients (11).

Many nutritional assessments and screening tools use biochemical markers such as albumin, prealbumin, transferrin, C-reactive proteins, and total lymphocyte count. Albumin is mostly used as a laboratory marker to assess the nutritional status in daily clinical practice. However, its sensitivity and specificity is a controversial issue. A recent meta-analysis indicated that serum albumin level was strictly affected by the nutritional status and that hypovolemia is a negative prognostic index in the elderly population (12). Globulin is another major component of serum proteins that plays a role in the immune and chronic inflammatory process. Both serum levels of albumin and globulin alone could be easily affected by many factors; therefore, albumin-to-globulin ratio (AGR) was recommended as a valuable prognostic factor, especially in the cancer patients (13).

The current study was design to evaluate the prevalence of malnutrition among elderly patients undergoing elective curative gastrointestinal cancer and trochanteric hip fracture surgery. The main goal was to compare the two validated nutritional screening tools and serum proteins that are used as routine biochemical markers for the prediction of the postoperative outcome.

## MATERIAL and METHODS

This prospective, observational, cross-sectional study was conducted after receiving approval from the Institutional Ethics Committee (decision no:2018/514/144/3) according to the ethical principles outlined in the Helsinki Declaration and Good Clinical Practice guideline. Written informed consents were obtained from all the participants.

## Study Population

We consecutively enrolled patients aged  $\geq 65$  years who were scheduled for elective curative gastrointestinal cancer and trochanteric hip fracture surgery between January and April 2019.

## Exclusion Criteria

Patients undergoing palliative or emergency surgery, aged  $< 65$  years, those who refused to participate in the study, having cognitive impairment, communication problems, multiple trauma patients, and right-sided hip fractures were excluded.

## Assessment of the Nutritional Risk

On admission to the preoperative holding area, all patients underwent the two nutritional screening tests; MNA and NRS-2002. After assessment, all participants were followed-up throughout their hospital stay.

MNA has two forms, including the short (MNA-SF) and long form (MNA-LF). MNA-SF consists of six sections including appetite, recent weight loss, mobility impairment, acute illness, dementia or depression, and body mass index. We used the MNA-LF, which consisted of twelve more sections: Living arrangements, medications, presence of pressure ulcers, quality and number of meals, fluid intake, autonomy of feeding, self-perception about health and nutrition, and mid-upper arm and calf circumferences. Scores below 17 indicated malnourished, 17-23.5 at risk of malnutrition, and 24-30 normal nutritional status (14).

NRS-2002 consists of body mass index, weight loss, recent decrease in food intake and severity of illness. This tool has three components: a severity of disease score, a nutritional score, and an age score. The score ranges between 0 and 6 according to the assessment. We categorized the patients as well-medium risk ( $<3$ ) and nutritionally at risk ( $\geq 3$ ) (15).

## Anthropometric Measurements

Personal characteristics such as age, gender, weight, height, and body mass index were recorded. Right middle arm circumference was measured at the mid-point between the acromial process of the scapula and the olecranon process of the ulna with the arm hanging loosely by the side. Calf circumference was measured from the widest part of the right leg while the patient was in the supine position and the knee was in a right angle between the thigh and calf.

## Laboratory Tests

All laboratory data were acquired from patients within seven days prior to any surgery in our institution. In hip fractures, the laboratory tests depend on the admission date of the patients, and they are scheduled for surgery within three days. Total lymphocyte count, monocyte count, and serum albumin and globulin levels are part of the standard preoperative assessment laboratory tests for surgical patients.

## Data Collection

For this study, clinical data were collected from the patient's electronic health records, including age, date of admission, clinical diagnosis, and American Society of Anesthesiologist' (ASA) physical status. All anthropometric measurements were performed by the same investigator. If the patient was unaware of his/her height, the investigator estimated the approximate

height of the patient. In case of unknown body weight, we used the Buckley's bed side method for estimation of the body weight. This method uses the abdominal circumference (AC) and thigh circumference (TC) to estimate the actual body weight (ABW) of the patient. In male and female patients, ABW is formulated as  $-47.8 + 0.78 \times AC + 1.06 \times TC$  and  $-40.2 + 0.47 \times AC + 1.30 \times TC$ , respectively (16). The scores of MNA-LF and NRS-2002 were recorded. We retrieved the laboratory findings from the hospital electronic database and calculated the lymphocyte-monocyte ratio (LMR) and albumin-globulin ratio (AGR) according to the laboratory results. Surgical outcome (discharge to ward/intensive care) and the postoperative infection (systemic or surgical site) were recorded.

### Statistical Analysis

Statistical analyses were performed using GraphPad Prism 8. While analyzing the study data, Student's t-test was used for comparisons between descriptive statistical parameters (mean, standard deviation, minimum and maximum value) and one-way ANOVA followed by the Tukey posttest for multiple comparisons.

The differences were considered statistically significant when p values were  $< 0.05$  (\*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.001$ ). The data has been reported as mean  $\pm$  standard deviation (SD).

### RESULTS

Totally, 100 patients were recruited into the study. We excluded 18 patients due to reoperation and missing data; therefore, statistical analysis was conducted using data from 82 patients (Figure 1). Patients' characteristics and anthropometric measurements are shown in Table 1. The mean serum albumin and globulin levels and the AGR were comparable between before and after operation. However, the mean LMR after surgery was significantly lower than the preoperative value (Table 2). The group of patients with MNA  $< 17$  (malnutrition) had a significantly higher ICU admission rate and incidence of systemic or surgical infection, which led to the prolonged length of hospital stay (Table 3).

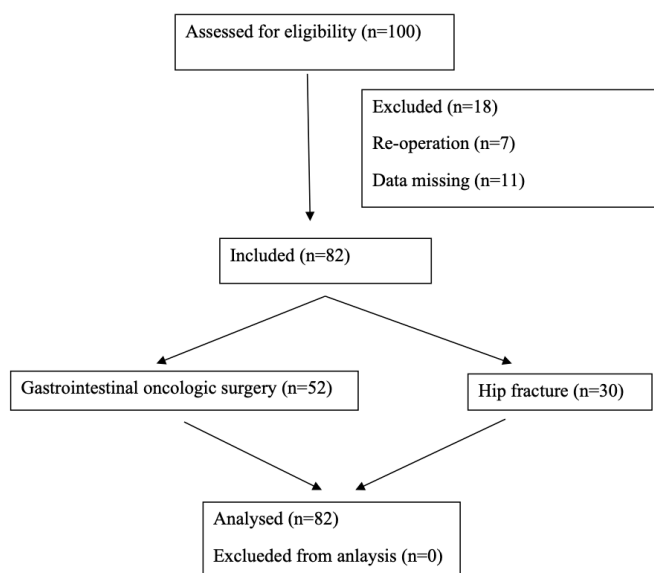


FIGURE 1. The consort flowchart of the study

According to the NRS-2002 screening tool, the ICU admission rate was higher in patients with a score  $\geq 3$ . The incidence of surgical site infection in this group was also significantly higher than that of the patients with an NRS-2002 score  $< 3$  (Table 4).

TABLE 1. Patients' characteristics and anthropometric measurements

Variables	Results
Age (years)*	73.57 $\pm$ 8.25
Gender **	
Female	41 (50)
Male	41 (50)
Weight (kg)*	67.70 $\pm$ 11.24
Height (cm)*	163.7 $\pm$ 8.97
BMI*	22.99 $\pm$ 3.46
ASA physical status**	
II/III/IV	50(60.98)/29 (35.37)/3(3.65)
Middle arm circumference (cm)*	25.40 $\pm$ 4.32
Calf circumference (cm)*	41.12 $\pm$ 6.05

Data was expressed as \*Mean  $\pm$  Standard Deviation (SD); \*\*the number of patients (n) and the percentage (%). ASA: American Society of Anesthesiologist; BMI: Body Mass Index; kg: kilograms; cm: centimeters

TABLE 2. Patients' clinical data

Variables	Results
Reason of admission <sup>1</sup>	
GIS oncologic surgery	52 (63.41)
Hip fracture	30 (36.59)
Outcome <sup>1</sup>	
Ward	48(58.54)
Intensive care unit	34(41.46)
Length of hospital stay (days) <sup>2</sup>	9.73 $\pm$ 6.78
Serum albumin level (g/dL) <sup>2</sup>	
Preoperative	3.22 $\pm$ 0.56
Postoperative	2.76 $\pm$ 0.52
Serum globulin level (g/dL) <sup>2</sup>	
Preoperative	2.66 $\pm$ 0.54
Postoperative	2.17 $\pm$ 0.49
AGR <sup>2</sup>	
Preoperative	1.22 $\pm$ 0.21
Postoperative	1.31 $\pm$ 0.03
Total lymphocyte count (%) <sup>2</sup>	
Preoperative	15.44 $\pm$ 8.57
Postoperative	8.85 $\pm$ 5.16
Monocyte count (%) <sup>2</sup>	
Preoperative	6.76 $\pm$ 3.25
Postoperative	6.24 $\pm$ 3.04
LMR <sup>2</sup>	
Preoperative	2.52 $\pm$ 1.53
Postoperative	1.56 $\pm$ 1.01*

GIS: Gastrointestinal system; AGR: Albumin-globulin ratio; LMR: Lymphocyte-monocyte ratio  
Data was expressed as <sup>1</sup>the number of patients (n) and the percentage (%) and <sup>2</sup>Mean  $\pm$  Standard Deviation (SD); \* highly significant.

**TABLE 3.** The correlation of MNA groups with the study parameters<sup>1</sup> (Mean  $\pm$  SEM)

Variables	17<MNA (n=36)	17≤MNA<24 (n=32)	24≤MNA (n=14)	p
ICU admission (%)	77.78 $\pm$ 7.03	15.63 $\pm$ 6.52	7.14 $\pm$ 7.14	*<0.0001
The presence of systemic infection (%)	52.78 $\pm$ 8.44	6.25 $\pm$ 4.35	0	*<0.0001
The presence of surgical site infection (%)	63.89 $\pm$ 8.12	25.00 $\pm$ 7.78	7.14 $\pm$ 7.14	*<0.0001
Length of hospital stay (days)	12.89 $\pm$ 1.48	7.47 $\pm$ 0.54	6.79 $\pm$ 0.37	*<0.0001
Postoperative AGR	1.26 $\pm$ 0.05	1.33 $\pm$ 0.05	1.42 $\pm$ 0.09	0.225
Postoperative LMR	1.75 $\pm$ 0.19	1.35 $\pm$ 0.16	1.55 $\pm$ 0.22	0.259

<sup>1</sup>Mann Whitney-U test; SEM: Standard Error of Mean; MNA: Mini Nutritional Assessment; ICU: Intensive care unit; AGR: Albumin-globulin ratio; LMR: Lymphocyte-monocyte ratio; \* highly significant

**TABLE 4.** The correlation of NRS-2002 groups with the study parameters<sup>1</sup>

Variables	NRS-2002<3 (n=15)	NRS-2002 ≥3 (n=67)	p
ICU admission (%)	6.67 $\pm$ 6.67	49.25 $\pm$ 6.15	*0.002
The presence of systemic infection (%)	13.33 $\pm$ 9.09	28.36 $\pm$ 5.55	0.233
The presence of surgical site infection (%)	13.33 $\pm$ 9.09	44.78 $\pm$ 6.12	**0.024
Length of hospital stay (days)	8.33 $\pm$ 1.44	10.04 $\pm$ 0.86	0.380
Postoperative AGR	1.36 $\pm$ 0.09	1.31 $\pm$ 0.04	0.554
Postoperative LMR	1.56 $\pm$ 0.19	1.56 $\pm$ 0.13	0.999

<sup>1</sup>Student t test; SEM: Standard Error of Mean; NRS: Nutritional Risk Score; AGR: Albumin-globulin ratio; LMR: Lymphocyte-monocyte ratio; \* very significant

**TABLE 5.** Data related to the comparison of two assessment tests in patients with malnutrition risk

Variables	17<MNA (n=36)	NRS-2002 ≥3 (n=67)	p
ICU admission (%) <sup>1</sup>	77.78 $\pm$ 7.03	49.25 $\pm$ 6.15	0.005*
The presence of systemic infection (%) <sup>1</sup>	52.78 $\pm$ 8.44	28.36 $\pm$ 5.55	0.014
The presence of surgical site infection (%) <sup>1</sup>	63.89 $\pm$ 8.12	44.78 $\pm$ 6.12	0.065
Length of hospital stay (days) <sup>2</sup>	12.89 $\pm$ 1.48	10.04 $\pm$ 0.86	0.078
Postoperative AGR <sup>2</sup>	1.26 $\pm$ 0.05	1.31 $\pm$ 0.04	0.715
Postoperative LMR <sup>2</sup>	1.75 $\pm$ 0.19	1.56 $\pm$ 0.13	0.398

<sup>1</sup>Student t test; <sup>2</sup>Mann-Whitney U test; SEM: Standard Error of Mean; NRS: Nutritional Risk Score; AGR: Albumin-globulin ratio; LMR: Lymphocyte-monocyte ratio; \* very significant

Comparing the two screening tools, the incidence of ICU admission was significantly higher in patients with MNA>17 (Table 5), and MNA was a good predictor for ICU admission and the development of systemic infection (Table 6).

## DISCUSSION

Elderly patients often suffer from malnutrition, which is a condition that is usually underestimated in surgical patients. However, the nutritional status is a main factor for the postoperative process. Our study indicated that patients with MNA < 17 and NRS-2002 ≥ 3 have significantly higher ICU admission rates and incidence of infection. When comparing the two screening tools, MNA has a better predictive value than NRS-2002. Regarding

biochemical markers, LMR showed a significant decline after surgery, but this parameter has no correlation with the screening tools and postoperative outcome.

It is essential to assess the uniqueness of an elderly patient in order to achieve a successful perioperative management. The nutritional status has a paramount importance in the surgical risk stratification and the risk-modifying interventions that help to predict the surgical outcome. Malignancy is often associated with poor food intake. A prospective cohort study concerning elderly patients suffering from perianal neoplasm indicated that 87% of patients were classified into the at-risk-of malnutrition or malnourished group by using the MNA screening tool. These patients showed a higher overall surgical morbidity (17).

The prevalence of malnutrition in older patients with hip fracture is higher than in older adults. This is due to the fact that there is an increased need for calories secondary to the systemic inflammatory response, poor nutrition due to pain and decrease in mobility. In a review evaluating the effect of malnutrition and nutritional treatment on outcomes and mortality in elderly patients with a hip fracture, it was stated that malnutrition increases mortality (30% within 1 year and up to 40% within 3 years.), affects functional recovery after the fracture, and increases health expenditures (18, 19).

Helminen et al. (20) stated in their study that they evaluated the prognosis of 594 elderly patients with hip fracture according to MNA-SF, MNA-LF, and serum albumin levels, and found that all of these tests were a strong indicator in determining short- and long-term mortality.

In our study, MNA-LF and NRS-2002 tests were used. MNA-LF was a good predictor for ICU admission and the development of systemic infection. In our study, no difference was found between preoperative and postoperative AGR. However, the LMR decreased in the postoperative period.

Norman et al. (21) found that pressure sores and infections were associated with malnutrition. Our results are consistent with the work by Norman et al. Surgical site infection rate was higher in patients with NRS-2002 ≥ 3 than in the group with NRS-2002 < 3. In patients with MNA < 17, both systemic and surgical site infection rates were high. Gurneiro et al. (22) established that MNA-LF is suitable for predicting mortality. In our study, the incidence of ICU admission was significantly higher in patients with malnutrition according to the two nutritional assessment tests used (MNA-LF and NRS-2002).

**TABLE 6.** Correlation of two screening tests to the study parameters

	AUC	95% CI	Sensitivity (%)	Specivity	Cut-off	p
MNA-LF						
ICU admission	0.652	0.539-0.754	70.5	62.5	19.5	0.01*
The presence of systemic infection	0.722	0.612-0.815	90.4	49.1	20.5	0.0004*
The presence of surgical site infection	0.600	0.486-0.707	37.5	84.0	13.5	0.139
NRS-2002						
ICU admission	0.561	0.447-0.670	47.0	64.5	3	0.329
The presence of systemic infection	0.602	0.488-0.709	33.3	83.6	4	0.157
The presence of surgical site infection	0.532	0.418-0.643	25.0	82.0	4	0.622

AUC: Area Under Curve from ROC; CI: Confidence Interval, \*statistically significant, MNA-LF: Mini Nutritional Assessment test-Long Form, NRS-2002: Nutritional Risk

JunDe et al. (23) compared MNA-SF, NRS-2002, biochemical markers among elderly patients and reported that MNA-SF may be a favorable test for nutritional analysis. Myoung-Ha et al. (24) compared five nutrition tests (MNA-LF, MNA-SF, GNRI, MUST, and NRS-2002) and reported that MUST is the best test for nutritional analysis. Koren-Hakim et al. (25) in their studies comparing the MNA-SF, NRS-2002, and MUST tests, found that all tests were performed well, although they reported that MNA-SF predicted readmissions and mortality better. In our study, when the two screening tests (MNA-LF and NRS-2002) were compared, the incidence of ICU admission was significantly higher in MNA-LF.

In a study where the nutritional status of 246 patients undergoing pancreatoduodenectomy was evaluated with the MNA test and biochemical markers (albumin, prealbumin, and transferrin), it was reported that malnutrition was related to poor postoperative outcomes (26).

In a retrospective, single-center study performed by Inoue et al. (27) in elderly patients with a hip fracture, who underwent MNA-SF, NRS-2002, MUST, and the Geriatric nutritional risk index (GNRI) tests prior to surgery, MNA-SF was found to be an optimal test for nutritional screening.

### Limitations

We acknowledge various limitations in our study. If a patient did not know his/ her height, the investigator estimated the height value.

Our study was conducted in a single center. A multicenter study will be needed to disseminate our results to a larger patient population.

In conclusion, consequently, the nutritional status is a topic that is often overlooked in preoperative evaluations. However, measurements with easy-to-perform tests will provide guidance in terms of identifying potential perioperative risks.

Nutritional risk screening tools can indicate the negative consequences of hospitalized patients.

MNA is a good predictor for ICU admission and the development of systemic infection.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of Kartal Dr. Lütfi Kırdar Training and Research Hospital Clinical Research ethics committee (2018/514/144/3).

**Informed Consent:** Written informed consent was obtained from patients who participated in this study

**Peer-review:** Externally peer-reviewed.

**Author contributions:** Concept - Ö.S.; Design - Ö.S.; Supervision - B.Ç.; Resource - Ö.S., B.Ç.; Materials - Ö.S., B.Ç.; Data Collection and/or Processing - Ö.S.; Analysis and/or Interpretation - Ö.S., B.Ç.; Literature Search - Ö.S., B.Ç.; Writing - Ö.S.; Critical Reviews - B.Ç.

**Conflict of Interest:** Authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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