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The relationship between prognostic and organ failure scoring systems and nutritional scores in geriatric patients in intensive care unit

Yoğun bakım ünitesindeki geriatrik hastalarda prognostik ve organ yetmezliği skorlama sistemleri ile nütrisyon skorları arasındaki ilişki

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ABSTRACT

***Aim*:** The relationship between prognostic and organ failure scoring systems and nutritional scores was investigated in geriatric patients in the intensive care unit (ICU).

Methods: This cross-sectional study included 45 geriatric patients who were admitted to the ICU. Physical examinations were performed, and blood tests were analysed. Nutritional status was assessed by Mini Nutritional Assessment (MNA) and Nutritional Risk Screening 2002 (NRS2002). Acute Physiology and Chronic Health Evaluation II (APACHEII), Simplified Acute Physiology Score (SAPSII), Multiple Organ Dysfunction Score (MODS), Sequential Organ Failure Assessment (SOFA) and Glasgow Coma Scale (GCS) of patients were calculated. The patients were divided into groups as normal nutrition status, at risk of malnutrition and malnourished according to nutritional status, and high-risk and low-risk according to prognostic scores. Significance was accepted as $p<0.05$.

Results*:* According to the MNA score, 18 of 45 patients had malnutrition and 22 had malnutrition risk, while only 5 patients had normal nutrition status. According to NRS2002, all patients were at risk of malnutrition. There was a difference in SAPSII and GCS scores between the malnourished group and those at risk of malnutrition according to MNA ($p=0.033$;$p=0.040$). NRS2002 score was significantly higher in the high-risk group according to the APACHEII and SAPSII score ($p=0.012$;$p=0.021$). There was negative correlation between MNA and SAPSII and MODS, and positive correlation between MNA and GCS. There was positive correlation between NRS2002 and APACHEII, SAPSII, MODS, SOFA.

Conclusion: We found that malnutrition can have a significant impact on organ failure and prognosis in patients hospitalized in ICU.

Keywords*:* aged; APACHE; ıntensive care units; malnutrition; nutrition assessment; organ dysfunction scores

ÖZET

Amaç: Bu çalışmada yoğun bakım ünitesindeki (YBÜ) geriatrik hastalarda gibi prognostik skorlama sistemleri ile nütrisyon skorları arasındaki ilişki araştırıldı.

Yöntem: Kesitsel-prospektif olan bu çalışmaya YBÜ'ye interne edilen 45 geriatrik hasta dahil edildi. Hastaların fiziki muayeneleri yapılıp kan tetkikleri analiz edildi. Nutrisyon durumu Mini Beslenme Değerlendirmesi (MNA) ve Beslenme Riski Taraması 2002 (NRS2002) ile değerlendirildi. Hastaların Akut Fizyoloji ve Kronik Sağlık Değerlendirmesi II (APACHEII), Basitleştirilmiş Akut Fizyoloji Skoru II (SAPSII), Çoklu Organ Disfonksiyon Skoru (MODS), Ardışık Organ Yetmezliği Değerlendirmesi (SOFA) ve Glasgow Koma Skorları (GKS) hesaplandı. Hastalar nutrisyon durumlarına göre normal, malnütrisyon riski altında ve malnütre olacak şekilde, prognostik skorlarına göre ise yüksek-riskli ve düşük-riskli diye gruplara ayrıldı. $p<0.05$ olarak kabul edildi..

Bulgular: MNA skoruna göre 45 hastanın 18'inde malnütrisyon ve 22'sinde malnütrisyon riski varken iken yalnızca 5 hasta normal nütrisyon durumundaydı. NRS2002'ye göre ise tüm hastalar malnütrisyon riski altındaydı. MNA göre malnütrisyon riski altında olan ve malnütrisyonlu grup arasında SAPSII ve GKS skoru açısından farklılık saptandı ($p=0.033$; $p=0.040$). APACHEII ve SAPSII skoruna göre yüksek riskli olan grupta NRS2002 skoru anlamlı olarak daha yüksekti ($p=0.012$; $p=0.021$). MNA ile SAPSII ve MODS arasında negatif, MNA ile GKS arasında ise pozitif korelasyon tespit edildi. NRS2002 ile APACHEII, SAPSII, MODS, SOFA arasında pozitif ve NRS2002 ile GKS ile arasında negatif korelasyon saptandı.

Sonuçlar: Çalışmamız malnütrisyonun yoğun bakımda yatan hastalarda organ yetmezliği ve prognoz üzerine önemli bir etkiye sahip olabileceğini göstermiştir.

Anahtar kelimeler*:* APACHE; beslenme değerlendirmesi; malnütrisyon; organ bozukluğu skorları; yaşlanma; yoğun bakım ünitesi

Introduction

Unlike other services, intensive care units (ICU) are units where effective and continuous treatment of patients in need of advanced life support is provided (Gardaz, Doll & Ricou, 2011). With the increasing number of intensive care patients and advances in medicine, support in fluid and electrolyte, nutrition, mechanical ventilation, and other vital areas in patients hospitalized in ICU has become more important (Ferner, Nauck & Laufenberg-Feldmann, 2020). The frequency of hospitalization of geriatric patients in these units is gradually increasing (Flaatten, Beil & Guidet, 2021). It is known that 30-40% of the patients hospitalized in the ICU are over 65 years old (Flaatten et al., 2021). We know that the nutritional status of these patients affects many parameters such as length of

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stay on ventilator, length of hospital stays, susceptibility to infections (Lew et al., 2017). Since the clinical course of the patients is unstable, their vital functions are mostly supported by external devices and drugs and continue with high-level treatment and care services, mortality and morbidity scores that show the prognosis in these patients gain importance. These scoring systems are widely used in ICUs to determine disease severity and degree of organ dysfunction and to predict response to treatment (Keegan, Gajic & Afessa, 2011). The Acute Physiology and Chronic Health Evaluation II (APACHE II), Simplified Acute Physiology Score (SAPS II), Multiple Organ Dysfunction Score (MODS), Sequential Organ Failure Assessment (SOFA) and Glasgow Coma Scale (GCS) are scoring systems that show mortality and organ dysfunction in ICU patients (Vincent & Moreno, 2010). Malnutrition, which is accepted as a disease associated with aging, is a major public health problem all over the world (Corish & Bardon, 2019). Malnutrition has been shown to be associated with high mortality (Badosa et al., 2017). It was also predicted that malnutrition may have a significant effect on organ failure and prognosis in patients hospitalized in ICU (Lew et al., 2017).

As far as we know, there is no data in the literature evaluating 5 different prognostic scoring systems and 2 different nutritional assessment systems together. For this reason, we aimed to contribute to the literature by investigating the relationship between prognostic scoring systems such as APACHE II, SAPS II, MODS, SOFA and GCS and nutritional scores such as Mini Nutritional Assessment (MNA) and Nutritional Risk Screening 2002 (NRS 2002) in geriatric patients in ICU.

Methods

Study design

This study was designed as a cross-sectional, prospective, and single-center study. The study protocol was approved by University of Health Sciences Umraniye Education and Research Hospital (Date: 16.05.2017; Number: B.10.1.TKH.4.34.H.GP.0.01 / 46). The study was carried out in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients/patient relatives. For the power analysis, the study of Sheean et al was taken as reference (Sheean et al., 2013). Considering the correlation coefficient between MNA and APACHE II score being 0.99, the sample size per group was calculated as minimum 12, with a Type 1 error of 0.05 and the strength of the study being 80%. With a 20% loss, a total of 45 patients were incorporated in the study.

Geriatric patients over the age of 65 who were admitted to University of Health Sciences Umraniye Education and Research Hospital general intensive care unit for any reason were included. Patients under 65 years of age, preoperative/postoperative and with a history of malignancy that may cause malnutrition were not included in the study. Detailed medical history was taken from all patients and their relatives, and physical examinations of the patients were performed. Weight, height, body mass index (BMI), waist circumference and blood pressure were recorded. Biochemical blood tests, hemogram and arterial blood gas analyzes were analyzed. SOFA, MODS, SAPS II, APACHE II and GCS of the patients were calculated. MNA and NRS 2002 were used for nutritional assessment.

Metabolic parameters

Plasma glucose by the enzymatic test method, albumin, aspartate transaminase, and alanine transaminase by enzymatic colorimetric test (Hitachi 747 autoanalyzer, German), c reactive protein by immunoassay, iron binding capacity, iron, total protein, blood urea nitrogen, and uric acid by spectrophotometer, creatinine by Jaffe` method, bilirubins by diazo method, sedimentation by the Westergren standard method, ferritin by immunechemiluminescence, sodium, and potassium level with ion-selective electrode analysis was measured with Architect plus device. Hemogram parameters were measured by electrical impedance method with Mindray BC 6800 device. Blood gas measurements were measured with the ABL800 FLEX device.

Evaluation of nutrition

MNA and NRS 2002 questionnaires were used in the nutritional assessment of the patients. According to the MNA score, patients were divided into 3 groups: <17 points: Malnourished, 17-23.5 points: At risk of malnutrition, and 24-30 points: Normal nutritional status (Kondrup et al., 2003). In the NRS 2002 assessment patients were divided into 2 groups, ≥3 points: Risk of malnutrition, <3: Normal nutritional status (Kondrup et al., 2003).

Calculation of risk scores

The patients' APACHE II, MODS, SOFA, and SAPS II scores were calculated using a calculator using some parameters such as mean arterial pressure, heart rate, respiratory rate, rectal temperature level, PaO2/Fio2, arterial pH, bicarbonate level, sodium level, potassium level, serum creatinine level, hematocrit, leukocyte count, hypotension status, bilirubin level, platelet count, type of hospital admission, presence of chronic disease, age, serum creatinine/BUN ratio, systolic blood pressure, hourly urine output and GCS score (APACHE II, 2019; SOFA, 2019; MODS, 2019; SAPS II, 2019). The Glasgow Coma Score was calculated using eye-opening response, motor response, and verbal response (Rowley & Fielding, 1991). Patients were grouped according to the APACHE II risk score as <25 points: low risk and ≥25 points: high risk; according to the SAPS 2 score as <41 points: low risk and ≥4: high risk; according to the MODS score as <13 points: low risk and ≥13 points: high risk; according to the SOFA score as <13 points: low risk and ≥13 points: high risk; and finally according to the GCS score as <8 points: high risk, 8-13 points: medium risk, and >13 low risk.

Statistical analysis

Descriptive statistics such as mean, standard deviation, maximum, minimum and median were used to define continuous variables. Comparison of two normally distributed and independent continuous variables was done with Student's t test, and comparison of two independent and non-normally distributed variables was done with Mann Whitney u test. Pearson correlation coefficient was calculated to determine the relationship between two normally distributed continuous variables, and Spearman's rho correlation coefficient was calculated to determine the relationship between two non-normally distributed continuous variables. Chi-Square (or Fisher Exact test, where appropriate) was used to examine the relationship between categorical variables. Statistical significance level was determined as 0.05. Analyzes were performed using MedCalc Statistical Software version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013).

Result

This prospective study included 21 female and 24 male geriatric patients over 65 years of age.

Table 1. The general characteristics of the patients, anthropometric measurements, vital signs, clinical and biochemical parameters of the patients (n=45)

Parameter	Mean	Median	SD	Min	Max
Age (years)	75.7	75	8.6	65	92
Weight (kg)	68.3	65	15.7	45	130
Height (m)	1.69	1.69	0.08	1.5	1.9
BMI (kg / m2)	23.7	23.5	4.8	16.8	46.1
SBP (mm/hg)	111.7	115	24.1	52	166
DBP (mm/hg)	61.2	61	15.2	31	91
MAP (mm/hg)	78	80.3	17.2	38	116
Pulse (/min)	101.8	100	21.5	30	150
Respiration Rate (/min)	20.2	18	6.9	12	45
Upper Arm Circumference (cm)	21.7	21	4.9	14	41
Calf Circumference (cm)	30.4	30	4.3	21	39
Alanine Aminotransferase (U/L)	83.078	18	237.763	6	1520
Albumin (g/dl)	2.958	2.8	0.8572	1.9	6
Aspartate transaminase (U/L)	177.951	38	647.5703	8	4195
Total bilirubin (mg/dL)	1.9538	0.93	2.56707	0.18	12.6
C-reactive protein (mg/l)	11.0356	9.4	7.74917	0.1	29.5
Iron (ug/dL)	52.2	42	38.7701	6	180
Total Iron Binding Capacity (ug/dL)	174.356	144	120.3945	40	407
Ferritin (ml/ng)	2302.633	360	6136.8046	10.8	40000
Glucose (mg / dl)	172.533	133	105.7126	47	606
Bicarbonate (mEq/L)	21.504	19.2	9.1474	7.6	47
Blood urea nitrogen (mg / dL)	117.1973	83	98.51168	12.8	571
Creatinine (mg /dl)	2.2407	1.47	2.0027	0.4	8.2
Potassium (mEq/L)	4.767	4.5	1.3017	2.8	8.9
Total Protein (g/dl)	5.368	5.2	1.05814	2.7	7.8
Sedimentation (mm/h)	60.422	49	41.2175	6	140
Sodium (mEq / L)	138.489	138	9.7085	106	164
Leukocyte (ul)	14.6722	12.5	10.58517	0.49	41.6
Hemoglobin (g/l)	10.3251	9.6	2.55646	4.54	16.3
Platelet (mm3)	168.75	154	116.02	9.07	504

SD: Standard deviation. BMI: Body mass index. SBP: Systolic Blood Pressure. DBP: Diastolic Blood Pressure. MAP: Mean Arterial Pressure

The mean age of the patients was 75.7±8.6 years and the mean hospitalization was 7.2±5.1 days. While 46.7% of the patients were discharged from the intensive care unit, 53.3% died. The general characteristics of the patients, anthropometric measurements, vital signs, clinical and biochemical parameters of the patients are summarized in Table 1. In the nutritional assessment made according to the MNA score. 18 of 45 patients had malnutrition and 22 had malnutrition risk. while only 5 patients were in normal nutritional status. According to NRS 2002. all patients were at risk of malnutrition. Therefore. patients could not be grouped according to the NRS 2002 score. In the analysis of the between MNA score and mortality and morbidity scores. SAPS II and GCS scores showed statistically significant differences between the malnutrition risk group and the malnourished group (p=0.033; p=0.04. respectively). In the analysis between the APACHE II score and the nutrition scores. when the patients were divided into two groups as high-risk and low-risk according to the APACHE II score. there was no difference in MNA scores. while the NRS 2002 score was significantly worse in the high-risk patient group (p=0.012). In the analysis between the SAPS II score and the nutrition scores. when the patients were divided into two groups as high-risk and low-risk according to the SAPS II score. there was no difference in MNA scores. while the NRS 2002 score was significantly worse in the high-risk patient group (p=0.021). In the evaluation between GCS score and nutrition scores. NRS 2002 score and MNA score showed statistically significant differences between the three groups when they were divided into 3 groups with high risk. medium risk. and low risk according to GCS score (p=0.006; p=0.004, respectively).

When the patients were divided into two groups as exitus and discharge from the ICU. a significant difference was found between the two groups in terms of MNA score (p= 0.01) and NRS 2002 score (p<0.001).

In the correlation analysis between the length of stay in the ICU and the prognostic scores. a moderately negative correlation was found between the length of stay and APACHE II, SAPS II, MODS, SOFA and a positive moderately significant correlation with GCS. There was no correlation between the length of stay in the ICU and malnutrition risk scores of the patients. (Table 2). In the correlation analysis between MNA and morbidity and mortality scores; we found a moderately negative correlation between MNA and SAPS II and a negative and weak correlation between MNA and MODS a positive moderate correlation between MNA and GCS (***Table 3***).

In the correlation analysis between NRS 2002 and morbidity and mortality risk scores; we found a moderately positive correlation between NRS 2002 and APACHE II, SAPS 2, MODS and SOFA and a moderately significant negative correlation between NRS 2002 and GCS (Table 4).

Discussion

In this study, we showed that as the nutritional status of patients worsened the scoring systems used to determine the patient's response to treatment and the severity of the disease worsened. The study is valuable because it is the most comprehensive study on this subject. The present study showed that malnutrition may have a significant impact on organ failure and prognosis in ICU patients.ICU's are areas where critically ill and high-risk patients are followed with invasive or non-invasive methods, their life functions are supported and aggressively treated (Weil, & Tang, 2011).

Table 2. The correlation analysis between the length of stay in the ICU and all scores

		APACHE II	SAPS II	MODS	SOFA	GCS	MNA	NRS 2002
The length of stay in the ICU	**r**	**-0.653****	**-0.662****	**-0.554****	**-0.585****	**0.509****	0.234	-0.008
	p	**0**	**0**	**0**	**0**	**0**	0.122	0.961
	N	45	45	45	45	45	45	45

***Pearson Spearman's rho* p<0.05 (For the correlation between two continuous variables that are not normally distributed)
ICU: Intensive Care Unit, APACHE II: The Acute Physiology and Chronic Health Evaluation II, SAPS II: Simplified Acute Physiology Score, MODS: Multiple Organ Dysfunction Score, SOFA: Sequential Organ Failure Assessment, GCS: Glasgow Coma Scale, MNA: Mini Nutritional Assessment, NRS 2002: Nutritional Risk Screening 2002

Table 3. The correlation analysis between MNA and risk scores

		APACHE II	SAPS II	MODS	SOFA	GCS	NRS 2002
MNA	**r**	-0.279	**-0.449****	-0.302	-0.294	**0.509****	**-0.727****
	p	0.063	**0.002**	0.044	0.05	**0**	**0**
	N	45	45	45	45	45	45

***Pearson. Spearman's rho* p<0.05 (For the correlation between two continuous variables that are not normally distributed)
APACHE II: The Acute Physiology and Chronic Health Evaluation II, SAPS II: Simplified Acute Physiology Score, MODS: Multiple Organ Dysfunction Score, SOFA: Sequential Organ Failure Assessment, GCS: Glasgow Coma Scale, MNA: Mini Nutritional Assessment, NRS 2002: Nutritional Risk Screening 2002

Since the clinical status of the patients in the ICU can change instantaneously, their vital activities are mostly supported by external devices and drugs, and they are treated at a high level, mortality and morbidity risk calculations are extremely important in this patient group (Vincent & Moreno, 2010). The prognosis of patients in the ICU is determined by the patient's physiological reserve, the type of disease, and the response to treatment. Scoring systems developed based on these factors have an important role in determining the prognosis (Fleig, Brenck, Wolff & Weigand, 2011).

Malnutrition is a clinical condition that occurs with an imbalance of macronutrients or micronutrients that adversely affects body composition and functions (Cederholm et al., 2017). Malnutrition is a very common condition in patients in ICU (Kang, KJ & Moon, 2018). Nutritional support is a basic treatment method in intensive care patients for organ function and continuity, healing of wounds, protection of cardiopulmonary functions, and integrity of the immunological system (Singer et al., 2019). While the main goals in nutritional support were to preserve energy stores in the body and avoid complications of malnutrition, today nutritional support has some goals such as reducing disease severity, regulating immunological response, reducing complications and increasing survival (Allingstrup et al., 2017).

In the study conducted by Findlay, Plenderleith and Schroeder (2000) on 774 intensive care patients, they found that the length of stay of the patients in the intensive care unit varied between 1-68 days. In the present study, the hospitalization period of the patients hospitalized in the intensive care unit was 7.2±5.1 days. We found a moderately negative correlation between length of hospital stay and APACHE II, SAPS II, MODS, and SOFA, and a moderately positive correlation between length of hospital stay and GCS. Although a negative correlation was found between length of stay and malnutrition in many studies, we could not find a relationship between nutritional risk scores and length of stay in the ICU in our study. We can explain this with the high mortality rate in malnourished patients.

Many studies have been conducted between nutritional status and prognosis in the literature and malnutrition has been shown to be an independent risk factor for mortality, but the present study is valuable because it is the most comprehensive study on this subject (Badosa et al., 2017; Gomes, Emery & Weekes 2016; Lim et al., 2012). In a review including five studies, the relationship between NRS 2002 and Nutrition Risk in the Critically Ill scores and APACHE II scores in patients in the intensive care unit was investigated and no clear relationship was found between them (Kondrup,2014). However, in our study, the NRS 2002 score was significantly higher in the high-risk group compared to the APACHE II score. We also found a moderate positive correlation between NRS 2002 and APACHE II. In another study by Atalay et al., no correlation was found between the nutritional status measured by Subjective Global Assessment (SGA) and the mortality rate of critically ill geriatric patients. It was stated that SGA could not be a good predictor of survival in this patient group (Atalay, Yağmur, Nursal, Atalay & Noyan, 2008). In another cohort study of patients hospitalized in the intensive care unit, a close relationship was shown between MNA and APACHE II score (Sheean et al., 2013). The present study revealed that both NRS 2002 and MNA can be used to predict mortality in this patient group.

The present study had some limitations. First, the study was a single center cross-sectional analysis. We could not establish a causal relationship between prognostic scoring systems and nutritional scores. Second, patients' risk scores were evaluated at a single time point. Despite all these limitations, to the best of our knowledge, there is no such extensive study on this subject in the literature so that the present study is valuable.

Conclusion

In this study, we showed a significant relationship between MNA and NRS 2002 and APACHE II, SAPS2, MODS and SOFA in general ICU patients. Therefore, we believe that healthcare professionals working in these units should be more careful in terms of malnutrition, which has a significant impact not only on the primary pathology of the patients, but also on both prognosis and organ failure.

Table 4. The correlation analysis between NRS 2002 and risk scores

		APACHE II	SAPS II	MODS	SOFA	GCS	MNA
NRS 2002	**r**	**0.493****	**0.554****	**0.417****	**0.496****	**-0.492****	**-0.727****
	p	**0.001**	**0**	**0.004**	**0.001**	**0.001**	**0**
	N	45	45	45	45	45	45

***Pearson. Spearman's rho* p<0.05 (For the correlation between two continuous variables that are not normally distributed)
APACHE II: The Acute Physiology and Chronic Health Evaluation II, SAPS II: Simplified Acute Physiology Score, MODS: Multiple Organ Dysfunction Score, SOFA: Sequential Organ Failure Assessment, GCS: Glasgow Coma Scale, MNA: Mini Nutritional Assessment, NRS 2002: Nutritional Risk Screening 2002

Conflict of interest

There is no conflict of interest.

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Ethics Committee Approval

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Informed Consent

Informed consent was obtained from participant in this study.

Peer-review

Externally peer-reviewed.

Author Contributions

R.S.: Concept, Design, Data Collection or Processing, Literature Search, Writing

S.U.B.: Concept, Design, Data Collection or Processing, Literature Search, Writing

O.B.: Data Collection or Processing, Writing

O.K.: Data Collection or Processing

D.O.: Data Collection or Processing

E.S.: Data Collection or Processing

A.B.: Analysis or Interpretation

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