

## Nutritional Status and Malnutrition Assessment of Patients Followed in Pediatric Intensive Care Unit

### Çocuk Yoğun Bakım Ünitesinde İzlenen Hastaların Beslenme Durumu ve Malnütrisyon Değerlendirmesi

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#### Abstract

**Background:** Malnutrition, which occurs at the time of hospitalization or develops during follow-up, has a negative effect on patients in pediatric intensive care unit (PICU). In our study, we aimed to determine the malnutrition status at the time of hospitalization, the relationship of malnutrition status at hospitalization with mortality scores, as well as the changes in malnutrition status during hospitalization in PICU.

**Materials and Methods:** Patients aged between 1 month and 18 years, who were hospitalized and followed up in PICU of our hospital for at least 7 days between January and June 2016, were included in our study. Pediatric Nutritional Risk Score (PNRS) scores were compared with Gomez and Waterlow scores both at the admission to the PICU and discharge from the PICU.

**Results:** Our study has included total 102 patients, weight loss was detected in 33 (32.3%) of the patients compared to hospitalization, while weight gain was detected in 44 (43.1%) patients. We detected newly developed malnutrition both at the time of admission and during the PICU follow-up. Patients with malnutrition at the time of discharge had a high PNRS score at admission.

**Conclusions:** In conclusion, the malnutrition status and risk situations of patients should be determined and patient-specific nutritional strategies applied from the beginning of treatment in PICU.

**Keywords:** Malnutrition, Nutrition, Pediatric intensive care unit, Pediatric nutritional risk scores

#### Öz.

**Amaç:** Hastanede yatış sırasında ortaya çıkan veya izlem sırasında gelişen malnütrisyon, çocuk yoğun bakım ünitesindeki (ÇYBÜ) hastaları olumsuz etkilemektedir. Çalışmamızda, ÇYBÜ'nde yatış anındaki malnütrisyon durumunu, yatıştaki malnütrisyon durumunun mortalite skorları ile ilişkisini ve ÇYBÜ'nde yatışı sırasında malnütrisyon durumundaki değişiklikleri belirlemeyi amaçladık.

**Materyal ve metod:** Çalışmamıza Ocak-Haziran 2016 tarihleri arasında hastanemiz ÇYBÜ'nde yatarak en az 7 gün takip edilen 1 ay-18 yaş arası hastalar dahil edildi. Pediatrik Nutrisyonel Risk Skoru (PNRS), ÇYBÜ yatışında ve taburcu olduklarında ölçülen antropometrik ölçümler yanısıra hesaplanan Gomez ve Waterlow skorları ile karşılaştırıldı.

**Bulgular:** Çalışmamıza toplam 102 hasta dahil edilmiş olup, hastaların 33'ünde (%32.3) hastaneye yatışa göre kilo kaybı, 44'ünde (%43.1) kilo artışı saptanmıştır. Hem başvuru anında hem de ÇYBÜ takibinde yeni gelişen malnütrisyon saptandı. Taburculuk sırasında malnütrisyonlu olan hastaların başvuru sırasında yüksek PNRS skoru vardı.

**Sonuç:** Çocuk yoğun bakım ünitesinde tedavinin başlangıcından itibaren hastaların malnütrisyon durumu ile risk durumları belirlenmeli ve hastaya özel beslenme stratejileri uygulanmalıdır.

**Anahtar Kelimeler:** Malnütrisyon, Beslenme, Çocuk yoğun bakım ünitesi, Pediatrik nutrisyonel risk skoru

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Geliş tarihi / Received: 05.02.2022

Kabul tarihi / Accepted: 11.03.2022

DOI: 10.35440/hutfd.1068515

The study was presented;

1. 28<sup>th</sup> Annual Meeting of The European Society of Paediatric and Neonatal Intensive Care (6-9 Haziran 2017, Lizbon, Portekiz).
2. Uluslararası Katılımlı 14. Çocuk Acil Tıp ve Yoğun Bakım Kongresi (18-21 Ekim 2017, Adana, Türkiye)

## Introduction

The relationship between nutritional status and critical illness has a great importance in the intensive care unit follow-up of patients. For this reason, the impact of nutritional strategies on patient prognosis is an ongoing area of research. Studies have shown that nutritional deficiency in critically ill children is between 20-47% (1). It is known fact that malnutrition, which occurs at the time of hospitalization or develops during follow-up, has a negative effect on patients in pediatric intensive care unit (PICU). The causes of malnutrition in PICU can be counted as: the main disease, mechanical ventilation, dialysis, and parenteral nutrition (2).

The metabolic response of the organism to stress, injury, surgery or inflammation cannot be changed by nutrition. However, deficiency of nutrition causes the development of malnutrition (3-6). This situation has an increasing effect on morbidity and mortality (3). During hospitalization, determination of nutritional status and risk assessment of patients are important for foreseeing possible clinical outcomes. Traditionally, anthropometric measurements such as body weight, height, and upper middle arm circumference (UMAC) are used to detect malnutrition (7,8).

In our study, we aimed to determine the malnutrition status at the time of hospitalization, the relationship of malnutrition status at hospitalization with mortality scores, as well as the changes in malnutrition status during hospitalization in PICU.

## Materials and Methods

### Patient Selection and Method

Patients aged between 1 month and 18 years, who were hospitalized and followed up in PICU of our hospital for at least 7 days between January and June 2016, were included in our study. Patients who had abdominal surgery on admission or during follow-up were excluded from the study. In addition, the follow-up of patients whose hospitalization period exceeded 60 days was terminated.

Pediatric Nutritional Risk Score (PNRS), anthropometric measurements, oral intake, eating ability, increased food, medical condition, symptoms affecting nutrition (pain, dyspnea, depression) were evaluated in the first 48 hours of hospitalization (Appendix.1). PNRS scores were compared with Gomez and Waterlow scores when patients were discharged from the PICU. Weight, height, UMAC, and triceps skinfold thickness (TST) (Holtain caliper, Crymych, England) were measured at five different periods, at the time of admission and 1st, 2nd, 4th, 8th weeks of hospitalization. In these specified timepoints, in addition to anthropometric values, patients' Gomez and Waterlow scores were calculated and at the end of the study they were compared with their base scores. We used this approach in order to be able to detect when the patient developed malnutrition either at the time of admission or

during PICU stay. The collected data were recorded in detail by the same person.

### Appendix 1. Pediatric Nutritional Risk Score Risk Factors (Score Values)

Pain [1]			
Pathology*	Daily Food Intake <50% [1]	Score	Nutritional Risks
Mild (grade 1) [0]	None	0	Low
Mild (grade 1) [0]	One	1	Moderate
Mild (grade 1) [0]	Both	2	Moderate
Moderate (grade 2) [1]	None	1	Moderate
Moderate (grade 2) [1]	One	2	Moderate
Moderate (grade 2) [1]	Both	3	High
Severe (grade 3) [3]	None	3	High
Severe (grade 3) [3]	One	4	High
Severe (grade 3) [3]	Both	5	High

\* Pathology grading criterias

1. Grade: Mild stress factors	2. Grade: Moderate stress factors	3. Grade: Severe stress factors
Detection of health problem	Current surgery	Cardiac surgery
Bronchiolitis	Chronic cardiopathy	Worsening of chronic disease
Gastroenteritis	Chronic enteropathy	Major internal organ surgery
Minor surgery	Severe infections	Hemopati
Other mild infections	Cystic fibrosis	Heamatologic disease
	Sickle cell disease	Severe depression
	Others	Severe sepsis
		Others

**PNRS calculation:** Depending on the degree of the stress factor, 0,1 or 3 points were added, 1 point was added if the patient had pain, and 1 point was added if the patient took less than 50% of the daily calories. The current scores were summed and the risk level was calculated.

### Ethics

The study was conducted in accordance with the principles of the Declaration of Helsinki and the International Conference on Harmonization Good Clinical Practice guidelines. The ethics committee approval for the study was obtained from Doctor Behcet Uz Pediatrics Education and Research Hospital (2016/73). Written informed consent was obtained from all patients before the study procedures.

### Statistical Analyses

In our study, the data were recorded to clinical research forms and statistically evaluated using the SPSS 22.0 Microsoft. As statistical methods; mean, standard deviation, minimum-maximum, median and percentile distribution data were used for descriptive findings. Paired t-test was used for the data with normal distribution in the anthropometric measurements of the patients at the time of admission and discharge from the PICU and Wilcoxon analysis was used for those who did not. Chi-square test was used to compare patients' status at the time of admission and discharge from the PICU, malnutrition scores and PNRS according to the Gomez and Waterlow classification. A p-value below 0.05 was considered significant for all analyses.

## Results

Our study has included total 102 patients, consisted of 45 (44.1%) girls and 57 (55.9%) boys. The age of the patients was between 1-138 months and the median age was found as 8 months (IQR:22). The most common hospitalization diagnosis was pneumonia (40 patients 39.2%), and followed by metabolic diseases (27 patients 26.5%), congenital heart diseases (13 patients 12.7%), central nervous system infection (5 patients 4.9%), sepsis/septicemia (5 patients 4.9%), other diseases (12 patients 11.7%) (acute/chronic renal failure, hemolytic uremic syndrome, epilepsy/status epilepticus, Guillain-Barre syndrome, cancer, ion imbalance). Examining the duration time in PICU revealed that, the average time of duration was between 7-60 days and the median was 18 days (IQR:12). The time to start feeding after hospitalization was 0-32 days, and the median number of days was calculated as three (IQR:3). Weight loss was detected in 33 (32.3%) of the patients compared to hospitalization, while weight gain was detected in 44 (43.1%) patients. The duration of time from the admission to the PICU until the initiation of either oral or parenteral nutrition ranged from 0 to 32 days, and the median was calculated as 3 days (IQR:3). Twenty-two (22.5%) of the patients started nutrition within the first 24 hours, and 42 (41.1%) of them within the first 48 hours. For all the patients we aimed to start early nutrition (enteral and/or parenteral) and to give 1-2 gr/kg/day protein and 100-150 kcal/day energy at the time of full nutrition till a week.

In our study, when the Gomez scores of the patients at the time of admission and discharge were examined, an increase in the malnutrition score was observed in five patients and a decrease in the malnutrition score in two patients. Although 39 of the patients were hospitalized with moderate or severe malnutrition, no improvement was achieved in their scores at the time of discharge from the PICU. As a result, 44 (43.1%) patients were admitted to the general ward as moderate or severe malnourished while leaving the PICU (Table.1 and Table.2). In addition, the development of moderate or severe malnutrition ratio was 43,1% in duration of PICU, and the proportion of patients with weight loss was 32,3%.

**Table 1.** Anthropometric measurements of the patients at the time of admission and discharge from the PICU

	Admission of PICU	Discharge of PICU	p value
Body weight (kg)*	6,95 (IQR:6,48)	7 (IQR:6,14)	0,06
Height (cm)*	65,5(IQR:32,5)	66(IQR:30,13)	0,17
UMAC (cm)**	13,83(±2,89)	13,78(±2,87)	0,59
TST (mm)**	10,07((±3,86)	10,38((±4,02)	0,15

\*Median \*\*Average

**Table 2.** The status of the patients at the time of admission and discharge from the PICU according to the Gomez classification

	Discharge of PICU		Total	p value	
	Gomez classification	Normal or mild malnutrition			Moderate or severe malnutrition
Admission of PICU	Normal or mild malnutrition	56(%54.9)	5(%4.9)	61(%59.8)	<0,001
	Moderate or severe malnutrition	2(%1.9)	39(38.2)	41(%40.1)	
Total		58(%56,8)	44(%43.1)		

At the time of hospital stay, patients have a strong risk of malnutrition. Therefore, we compared PNRS with Gomez and Waterlow malnutrition score at the time of discharge from the PICU. Patients with malnutrition at the time of discharge had a high PNRS score at admission as seen in Table.3 and Table.4.

**Table 3.** Comparison of Gomez Malnutrition score and PNRS score at the time of discharge from the PICU

PNRS	Gomez Malnutrition Score				p value
	>90	75-89	60-74	<60	
Mild	4(%3,9)	0(%0)	0(%0)	0(%0)	0,01
Moderate	5(%4,9)	14(%13,7)	6(%5,8)	1(%0,9)	
Severe	11(%10,7)	24(%23,5)	22(%21,5)	15(%14,7)	
Total	20(%19,6)	38(%37,2)	28(%27,4)	16(%15,6)	

**Table 4.** Comparison of Waterlow Malnutrition score and PNRS score at the time of discharge from the PICU

PNRS	Waterlow Malnutrition score			p value
	Normal	Acute	Chronic	
Mild	3(%2,9)	0(%0)	1(%0,9)	0,02
Moderate	8(%7,8)	11(%10,7)	7(%6,8)	
Severe	14(%13,7)	18(%17,6)	39(%38,2)	
Total	25(%24,5)	29(%28,4)	47(%46)	

## Discussion

Malnutrition is observed both at the time of admission to PICU and during the hospitalization in PICU. In our study, we detected newly developed malnutrition both at the time of admission and during the PICU follow-up. When the Gomez scores of the patients at the time of admission and discharge were examined, an increase in the malnutrition score was observed in five patients and a decrease in the malnutrition score in two patients. Although 39 of the patients were hospitalized with moderate or severe malnutrition, no improvement was achieved in their scores at the time of discharge from the PICU. As a result, 44 (43.1%) patients were admitted to the general ward as moderate or severe malnourished while leaving the PICU (Table.1 and

Table.2). This is a very dramatic finding on how often malnutrition can be seen in PICU.

The beginning time of nutrition enteral, parenteral or both form of admission to the PICU ranged from 0 to 32 days in our study, and the median was calculated as 3 days. Twenty-two (22.5%) of the patients started nutrition within the first 24 hours, and 42 (41.1%) of them within the first 48 hours. In the study conducted by Taylor et al. examined the nutritional status of 95 children in the PICU for at least 3 days, it was found that 59% of them started to nutrition (both enteral and parenteral) in the first 24 hours. However, the rate of patient who started enteral nutrition within the first 24 hours is 48.2%. At the same time it has been observed that patients can receive only 58% of their energy needs and nutritional status cannot be corrected until about the 10th day (9). A study by Mikhailov et al consisted of 5105 critically ill children concluded that the initiation of enteral nutrition in the first 48 hours was associated with decreased mortality rates (10)

Patients followed in PICU are at risk for nutritional problems and anthropometric changes that may affect morbidity and mortality. In the study conducted by Frédéric V. Valla et al. in 2019, they observed that 24% of the patients in the PICU had a weight loss of 5% or more (11). Ventura et al., determined that 18% of the patients had deficiency of nutrition at the time of admission to the PICU (12). In addition, Hulst et al. detected a relationship between anthropometric measurements and nutritional status. In another study by Hulst et al. found the anthropometric deterioration, that developed during the PICU follow-up, returned to normal after 6 months (13, 14). In our study, the development of moderate or severe malnutrition ratio was 43,1% in duration of PICU, and the proportion of patients with weight loss was 32,3%. This situation explained the high frequency of both nutrition deficiency at the time of hospitalization and weight loss during hospitalization in PICUs.

In addition, nutritional deficiency/malnutrition is associated with poor clinical outcomes, including increased length of stay in PICU, prolonged mechanical ventilation therapy, and higher mortality (15). In the PNRS validation study conducted in Turkey in 2020 by Taşçı et al., examining the patients hospitalized in the pediatric services, weight loss was found in 62.2% of high-risk patients (16). In our study, we compared PNRS with Gomez and Waterlow malnutrition score at the time of discharge from the PICU. Patients with malnutrition at the time of discharge had a high PNRS score at admission (Table.3 and Table.4). While this situation reveals a significant relationship between malnutrition and PNRS, it also explains that the importance of nutritional risk calculation at the time of hospitalization.

The fact that our study was performed in a single center, only covers a 6-month period in a year, and finally not being able to measure basal metabolic rate in the study population can be counted as our limitations. Moreover, our patients were closely monitored for daily volume overload but

we did not calculate their protein/lipid ratios. Therefore we couldn't argue about the effect of dietary combination.

## Conclusion

In conclusion, malnutrition is an important problem in PICUs. Malnutrition can be observed in patients both at the time of admission and duration of hospitalization. For this reason, the malnutrition status and risk situations of patients should be determined and patient-specific nutritional strategies applied from the beginning of treatment in PICU. We thought that the nutritional status of PICU should be observed detailed in future studies.

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**Ethical Approval:** The ethics committee approval for the study was obtained from Doctor Behcet Uz Pediatrics Education and Research Hospital (2016/73).

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## Author Contributions:

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

**Financial Disclosure:** The author(s) received no financial support for the research, authorship, and/or publication of this article.

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