



# Evaluation of Enteral Nutrition Applications in Pediatric Intensive Care Units in Türkiye

## Türkiye'deki Çocuk Yoğun Bakım Ünitelerinde Enteral Beslenme Uygulamalarının Değerlendirilmesi

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### ABSTRACT

**Objective:** Enteral nutrition practices in pediatric intensive care units (PICUs) in Türkiye and all around the world are mostly performed in accordance with an expert opinion due to the inadequacy of evidence-based practices. Therefore, different approaches are observed in enteral nutrition applications. This research aimed to evaluate the enteral nutrition practices in PICUs in Türkiye.

**Materials and Methods:** The research was carried out through the online survey database between February 2021 and June 2021 by reaching 73 out of 93 PICUs according to the 2019 data of the Ministry of Health of the Republic of Türkiye. The "clinical identification form" and "the clinic's evaluation form for enteral nutrition practices" were prepared by the researcher and expert opinion was taken. The data were analyzed with the SPSS 21.0 program.

**Results:** As a standard, the first preferred method was the gastrointestinal tract (98.6%) followed by the intermittent feeding method (93.2%). The commonly used criteria to evaluate enteral feeding tolerance included gastric residual volume (GRV), vomiting, increased abdominal pressure, and diarrhea. 61.6% of PICUs routinely measured GRV in patients who were on enteral feeding, whereas 31.5% did not routinely measure it but measured GRV only in patients with signs of intolerance. The frequency of GRV measurement was 50.7% in patients who were on intermittent feeding, and it was performed before each feeding.

**Conclusion:** It was determined that the routine GRV control was frequently performed in enterally fed patients in PICUs, and the first preferred enteral feeding method was the intermittent gastric route. However, it is noteworthy that the use of written enteral nutrition protocols in PICU was insufficient. In accordance with these findings, we recommend implementing practices to encourage the use of the enteral nutrition protocol in the PICU.

**Keywords:** Enteral nutrition, pediatric intensive care, gastric residual volume, intensive care nurse

### ÖZ

**Amaç:** Türkiye'de ve dünyadaki çocuk yoğun bakım ünitelerinde (ÇYBÜ) enteral beslenme uygulamaları kanıta dayalı uygulamaların yetersizliği sebebiyle büyük ölçüde uzman görüşü doğrultusunda yürütülmektedir. Bu duruma bağlı olarak enteral beslenme uygulamalarında farklı yaklaşımlar görülmektedir. Araştırma, Türkiye'de bulunan çocuk yoğun bakım ünitelerindeki enteral beslenme uygulamalarını değerlendirmek amacıyla planlanmıştır.

**Gereç ve Yöntem:** Araştırma, Şubat 2021- Haziran 2021 tarihleri arasında online survey veri tabanı üzerinden Türkiye Cumhuriyeti Sağlık Bakanlığı 2019 verilerine göre toplam 93 ÇYBÜ'nin 73'üne ulaşılarak yapılmıştır. Veriler araştırmacı tarafından hazırlanan ve uzman görüşü alınan "klinik tanımlama formu" ve "klinik'in enteral beslenme uygulamalarını değerlendirme formu" kullanılarak elde edilmiştir.

**Bulgular:** Standart olarak ilk tercih edilen yol ve yöntem, %98,6 oranında gastrointestinal yol ile %93,2 oranıyla aralıklı beslenme yöntemidir. Enteral beslenme tolerasyonunu değerlendirmede en sık kullanılan kriterler sırasıyla; gastrik rezidüel volüm (GRV) miktarı, kusma, abdominal basınç artışı ve ishaldir. ÇYBÜ'lerinin %61,6'sı rutin olarak enteral beslenmeye başlanan her hastada GRV ölçmekte ve % 31,5'i ise rutin olarak bakmayıp sadece intolerasyon belirti/bulgusu olan hastalarda GRV ölçmektedir. GRV ölçüm sıklığı aralıklı beslenme yönteminin kullanıldığı hastalarda en fazla % 50,7 oranıyla her beslenme öğünü öncesinde yapılmaktadır.

**Sonuç:** ÇYBÜ'lerinde enteral beslenen hastalarda rutin GRV kontrolünün sıklıkla yapıldığı ve ilk tercih edilen enteral beslenme yönteminin aralıklı gastrik yol olduğu belirlendi. Bununla birlikte ÇYBÜ'nde yazılı enteral beslenme protokolü kullanımının yetersiz olduğu dikkati çekmektedir. Bu sonuçlar doğrultusunda ÇYBÜ'nde enteral beslenme protokolü kullanımının teşvik edilmesi konusunda uygulamalar yapılması önerilebilir.

**Anahtar Kelimeler:** Enteral beslenme, çocuk yoğun bakım, gastrik rezidüel volüm, yoğun bakım hemşiresi

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## Introduction

The needs of patients in intensive care units (PICUs) are quite different from those in wards due to factors such as trauma, stress, and metabolic response to critical illness. In case of a strong metabolic response, in critically ill patients, malnutrition is inevitable if adequate nutritional support cannot be provided. As a result of malnutrition, there is an increase in morbidity and mortality due to impaired immune functions, delayed wound healing, and increased duration of infection (1-4).

Malnutrition is mostly observed in cases of prolonged starvation in intensive care patients since these patients are severely ill, and early enteral feeding cannot be initiated (2). In addition to undernutrition, overnutrition causes energy imbalance in patients under treatment in the PICU. In particular, children with fluid restriction, whose nutrition is interrupted due to multiple interventions, and who experience nutritional intolerance are at great risk of malnutrition (2,5).

The American Society for Parenteral and Enteral Nutrition (ASPEN) recommended the use of the enteral route for feeding support in the clinical guideline for nutritional support in critically ill pediatric patients, which was published in 2017 (4). It has been reported that enteral nutrition supports intestinal physiology, prevents intestinal villus atrophy, preserves the intestinal barrier, reduces intestinal permeability, protects against ischemic-reperfusion injury by stimulating intestinal blood supply, improves regional and systemic immune response, and increases epithelial development (3,6). Even a small amount of enteral nutrition improves intestinal perfusion and intestinal barrier function and supports enteral hormone release owing to its trophic effect (6).

In a multicenter study investigating the relationship between the protein intake and 60-day mortality in critically ill children, the mortality rate was found to be lower in children who took 60% or more of the desired protein amount (3). Mehta et al. (7) reported in a study, conducted with patients in the PICU who were on enteral and parenteral feeding, that the prevalence of mortality and infection was lower in enterally fed children compared to those who were on parenteral feeding. In a study performed by Mikhailov et al. (8), hospital costs were significantly lower in the early fed group, although there was no significant difference in the length of hospital stay. This was observed in critically ill children who stayed in the PICU for at least 96 hours and were on enteral feeding (25% of the target calories in the first 48 hours).

Consequently, even though enteral nutrition is frequently applied in the PICU, it is mostly performed based on the

opinion of clinical experts due to the lack of evidence both nationally and internationally. However, this situation has led to the emergence of different approaches in enteral nutrition practices. In the light of this information, this descriptive study was carried out to determine the necessity of enteral nutrition in PICUs in Türkiye and to evaluate the methods and practices used in the initiation of feeding and during feeding.

## Materials and Methods

This research was carried out through an online survey between February and June 2021. The form prepared by the researcher was transferred to the online platform and sent to the responsible nurses working in the PICU.

### a) Participants and sampling

There are a total of 93 PICUs in Türkiye according to the 2019 data of the Republic of Türkiye Ministry of Health, General Directorate of Public Health. The population of the research consisted of 93 nurses (one responsible nurse from each unit was included in the research) working in the PICUs of public, private, and university hospitals. This study aimed to reach the entire population, and therefore no sample selection was made. The sample of the study consisted of 73 PICU that replied and sent back the entire form (response rate: 78.5%). The inclusion criterion was the presence of a 3<sup>rd</sup> level ICU in hospitals. To carry out the research, the nurses in charge of the PICUs were reached through the Nursing Commission formed by the Pediatric Emergency Medicine and Intensive Care Association to represent the nurses working in this field. One head nurse from each unit was asked to answer the questionnaire through the common communication network of the nursing commission.

### b) Data collection tools

In the study, data were collected using the "clinical identification form" and "the clinic's evaluation form for enteral nutrition practices". The forms prepared by scanning the literature 9-11 were sent to nurses, physicians and academicians who are experts in the field, and the suitability of the content of the questions was evaluated. The pre-application of the online forms was carried out with five pediatric intensive care nurses with different levels of education and experience (specialist, doctor, associate professor, and professor). In accordance with the feedback, necessary corrections were made and the form was finalized.

Clinical identification form: consisted of a total of 7 questions describing the educational levels of the nurses who

agreed to participate in the study, and the characteristics of the nurse/doctor/patient attendant working in the unit.

The clinic's evaluation form for enteral nutrition practices consists of 20 questions about nutritional practices such as the presence of an enteral nutrition protocol in the institutions of the nurses participating in the study, the presence of a pediatric nutrition assessment scale, the time to start feeding, the time to reach full energy level, and the status of gastric residual volume (GRV) measurement.

Data were collected through a total of 27 questions in both forms. It took 5-10 minutes to fill out the questionnaire.

### Statistical Analysis

The data obtained in the research were analyzed using the SPSS (Statistical Package for Social Sciences) 21.0 program. Number, percentage, mean, and standard deviation values were used as descriptive statistical methods to evaluate the data.

### Ethical Issues

Permission for the research was obtained from the Ethics Committee of Okan University (no:133, date: 17.02.2021). To conduct the study, permission was obtained from the Pediatric Emergency Medicine and Intensive Care Association Board of Directors (on 07.04.2021). Before starting the study, a reminder text containing information about the purpose, target population, data collection, and storage of the research was provided. The online form became available after the approval of the consent form.

### Results

Characteristics of the responsible nurses and institutions participated in the study

When the characteristics of the responsible nurses and institutions that participated in the study were investigated, 71.2% of the nurses who answered the questionnaire had a bachelor's degree. Considering the number of patients per nurse in the day/night shift, 47.9% of them were in charge of following two patients at night and two patients during the day, whereas 24.7% of them were following three patients at night and two patients during the day. The titles of the physicians working in the unit were examined as well. The findings revealed that the percentage of units consisting of a physician holding a rank of associate professor or professor was 54.8%, while the percentage of units with a pediatrician was 13.7%. It is determined that 27.4% of them work with one assistant during night shifts and two personnel during day shifts. The

average number of nurses working in the PICUs was found to be  $25.55 \pm 15.75$ . Considering the number of nurses with certificates in the units, it was observed that an average of  $6.14 \pm 8.91$  nurses had an intensive care nursing certificate, and  $4.49 \pm 10.17$  nurses had a pediatric intensive care nursing certificate (Table 1).

### Characteristics of the enteral nutrition applications in the pediatric intensive care units (PICU)

Considering the characteristics of the enteral nutrition practices in the PICUs, 24.7% of them used a written "pediatric

**Table 1. Characteristics of health workers and institutions participating in the study**

Features	Frequency (n)	Percent (%)
<b>Education status</b>		
High school	2	2.7
Associate degree	3	4.1
Bachelor's degree	52	71.2
Postgraduate	16	21.9
<b>Day/night working time</b>		
8 h during daytime, 16 h during nighttime	57	78.1
10 h during daytime, 14 h during nighttime	4	5.5
12 h during daytime, 12 h during nighttime	4	5.5
Other/24 h	8	11.0
<b>Total number of patients per nurse in day/night shift</b>		
2/2 patient	35	47.9
3/2 patient	18	24.7
3/3 patient	17	23.3
4 or more/3 or more patient	3	4.2
<b>Physicians working in the unit</b>		
Pediatric specialist	10	13.7
Pediatric intensive care specialist	23	31.5
Associate professor and/or professor	40	54.8
<b>Number of patient attendants working in night /day shifts</b>		
1/1 person	13	17.8
1/2 person	20	27.4
1/3 person	7	9.6
2/2 person	11	15.1
2/3 person	12	16.4
3 and more/ 4 and more	10	13.8
The average number of nurses working in units	25.55	15.37
The average number of nurses with intensive care nursing certification	6.14	8.91
The average number of nurses with pediatric intensive care nursing certification	4.49	10.17

enteral nutrition protocol", while 47.9% of the units used the Pediatric Nutrition Risk Assessment Scale. Among the scales used (n=35), 19.2% were Strong Kids Scale, 2.7% were Gomez Scale and 6.8% were Nutritional Risk Score (NRS) 2002. Seventeen point eight percent of them did not specify the name of the scale used. When the target times to initiate enteral nutrition in the PICUs are examined, it was detected that 78.1% of the units had a target time of 24 hours to initiate enteral nutrition after patient admission. Additionally, 42.5% had a target time of within the first 48 hours to reach full energy level. Almost all of the units stated that the gastrointestinal tract (nasogastric/PEG/gastrostomy) was the standard initial feeding route (98.6%). There were 18 units (24.7%) who answered "Yes" to the application of post-pyloric nutrition. 13.7% of these units (n=18) reported that they preferred the post-pyloric route when the gastrointestinal tract could not be tolerated. It was determined that the initially preferred feeding method in the units was mostly intermittent feeding (93.2%). When the criteria used to evaluate feeding tolerance in the units were examined, it was observed that 90.4% of them were based on GRV criteria, 80.8% on increased abdominal pressure criteria, 87.7% on vomiting criteria, 35.6% on diarrhea criteria, and 4.1% on tachypnea criteria. (Table 2).

When enteral feeding practices were evaluated in children placed in the prone position, it was observed that 58.9% of the units fed the children enterally. Twenty-eight of the children on enteral nutrition (n=43,) were fed intermittently. Considering the state of enteral nutrition practice in children with noninvasive ventilation, it was determined that 90.4% of the units provided enteral feeding to children who were on noninvasive ventilation, and 48 of the children (n=66) on enteral feeding were fed intermittently (Table 2).

### **Gastric residual volume (GRV) measurement in the PICUs and applications for GRV**

GRV measurement and applications in the PICUs were examined. The findings revealed that GRV was measured in every patients who routinely started enteral feeding in 61.6% of the units. On the other hand, the findings revealed that in 31.5% of the units, "GRV was measured only in patients with signs of intolerance, which was not routinely checked". GRV measurements were performed "in the assessment of bleeding risk" in 1.4% of the units and "only at the request of a physician" in 5.5% of the units. When the frequency of GRV measurement in intermittently fed patients was examined, it was determined that 50.7% measured before each meal, 13.7% did measurements only if the child vomited, and 11% measured every three hours. Meanwhile, the frequency of

GRV measurement in continuously fed patients was studied and the findings demonstrated that 38.4% of them measured only when the child vomited, 13.7% of them measured every 8 hours, and 12.3% of them measured every 4 hours. 57.5% of the units used the expression "no special injector size" for GRV measurement. When the methods used in the decisions to cessation of feeding or skip meals were examined, it was found that the physicians made the decision in 65.8% of the patients, nurses and physicians together made the decision in 16.4% of the patients, and only the nurses made the decision in 12.3% of the patients. Forty-one point one percent of the units used a threshold value or formula to stop feeding according to the amount of GRV. 16.4% reported that the threshold value used was considered as "If GRV is at least half of the previous feeding amount". Considering the method used when evaluating excessive GRV, 4.1% of the units used the maximum volume in mL. In addition, the amount found by the ratio of the amount of last feeding, to the amount of gastric residue was used in 95.9% of the units. It was observed that 52.1% of the units, when questioned about the method of resuming feeding, which had been stopped due to the high GRV amount, provided the answer "Nutrition is gradually increased according to the tolerance status by switching to minimal enteral nutrition" (Table 3).

### **Discussion**

The purpose of feeding the child in the PICUs should include determining the energy needs correctly and providing them appropriately. Nutritional requirements for each child should be determined according to the progression of the disease and individual needs. It is known that adequate nutrition of children in the ICU affects the prognosis positively and reduces the length of hospital stay, highlighting the significance of this issue (4,5,12).

It was determined that only 24.7% of the units enrolled in the study used a written "pediatric enteral nutrition protocol" (Table 2). Similar to this study, Martinez et al. (11) reported that only 9 units in 31 PICUs used an enteral nutrition protocol in an international multicenter cohort study. The low use of the protocol might result in reaching the targets for enteral nutrition taking longer and affect the prognosis of the patient. Petrillo-Albarano et al. (13) concluded that children on enteral nutrition achieved their nutritional goals in a shorter time and improved enteral nutrition tolerance. In the guide published by ASPEN in 2017, it is recommended to prepare protocols in line with current guidelines to perform the most effective enteral nutrition in PICUs (4). As mentioned in the literature,

<b>Table 2. Evaluation and initiation of enteral nutrition needs of units and enteral nutrition applications in special situations</b>		
<b>Features</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>
<b>Status of using "pediatric enteral nutrition protocol" written in the unit</b>		
Yes	18	24.7
No	55	75.3
<b>Pediatric nutrition risk assessment scale usage status</b>		
<b>Yes</b>	<b>35</b>	<b>47.9</b>
Strong Kids Scale	14	19.2
Gomez Scale	2	2.7
NRS 2002	5	6.8
Waterlow malnutrition scale	1	1.4
"Yes" was said, but the name of the scale was not specified	13	17.8
<b>No</b>	<b>38</b>	<b>52.1</b>
<b>Target time to start enteral feeding after patient admission</b>		
Within the first 24 hours	57	78.1
Within the first 48 hours	8	11.0
Within the first 72 hours	3	4.1
Other/varies according to patient's condition	5	6.8
<b>Target time to reach full energy level</b>		
Within the first 24 hours	22	30.1
Within the first 48 hours	31	42.5
Within the first 72 hours	16	21.9
Other/varies according to patient's	4	5.5
<b>First preferred enteral feeding route as standard</b>		
Gastrointestinal tract (nasogastric/PEG/gastrostomy)	72	98.6
Postpyloric tract (duodenal/jejunal)	1	1.4
<b>Post-pyloric feeding application</b>		
<b>Yes</b>	<b>18</b>	<b>24.7</b>
In cases where the gastrointestinal tract cannot be tolerated	10	13.7
In case of stomach/intestinal surgical operation	3	4.1
In chronic patients who need to receive nutritional support for a long time (home care)	3	4.1
In the presence of a pre-existing jejunostomy in the patient	1	1.4
In patients who are applied continuous feeding method	1	1.4
<b>No</b>	<b>55</b>	<b>75.3</b>
<b>First preferred enteral feeding method as standard</b>		
Intermittent feeding	68	93.2
Continuous feeding	4	5.5
Depends on the patient	1	1.4
<b>Standard feeding frequency</b>		
2 hours apart (12 x feeding)	1	1.4
3 hours apart (8 x feeding)	48	65.8
4 hours apart (6 x feeding)	13	17.8
For 20 hours	1	1.4
For 24 hours	1	1.4
Depends on age/patient	8	11.0
<b>Criteria used to assess enteral feeding tolerance*</b>		
Gastric residual volume	66	90.4
Abdominal pressure increase	59	80.8
Vomiting	64	87.7
Diarrhea	26	35.6
Tachypnea	3	4.1

<b>Table 2. Continued</b>		
<b>Features</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>
<b>Enteral nutrition application status in children given prone position</b>		
<b>Yes, feeding</b>	<b>43</b>	<b>58.9</b>
No special feeding method is preferred	9	12.3
Intermittent feeding	28	38.4
Continuous feeding	6	8.2
No, not feeding	28	38.4
Other/Prone position not used at all	2	2.7
<b>The state of applying enteral nutrition in children undergoing non-invasive ventilation</b>		
<b>Yes, feeding</b>	<b>66</b>	<b>90.4</b>
No special feeding method is preferred	11	15.1
Intermittent feeding	48	65.8
Continuous feeding	4	5.5
<b>No, not feeding</b>	<b>7</b>	<b>9.6</b>

maintaining nutrition in accordance with the protocols of ICUs is a critical parameter that will positively affect the general condition of the patient.

Most of the units (78.1%) participating in the study declared that the target time to start enteral nutrition after patient admission is the first 24 hours. In addition, 98.6% of the units stated that the preferred enteral feeding route is the gastrointestinal route (Table 2). ASPEN's 2017 guideline has reported that enteral nutrition should be initiated in critically ill children within the first 24 to 48 hours after admission, and the gastrointestinal route is the first choice (4). In ESPNIC's 2020 guideline, it is recommended to start enteral nutrition within the first 24 hours after admission of critically ill children to the ICU, if there are no contraindications (12). It is noteworthy that the information taken into consideration and applied by units about enteral nutrition, as described in this study, is in accordance with the recommendations of significant guides listed in the literature.

Three-quarters (75.3%) of the units included in this study did not use the post-pyloric alimentary tract. The units that did use it indicated that they did so "in cases where the gastrointestinal tract could not be tolerated" (Table 2). This result is in line with the guidelines of ASPEN (2017).

When the participants were asked about the enteral nutrition method, which is the first choice as a standard in the unit, 68 units stated that they prefer intermittent feeding, 4 units use continuous feeding, and 1 unit indicated that the feeding style could change depending on the patient's condition (Table 2). In a study investigating enteral nutrition practices in the PICUs of England, it was reported that more than half of the PICUs used continuous feeding, which differs from our findings (9). Campos-Mirño et al. (14) identified that

the continuous feeding method, with a rate of 57.4%, was used more than the intermittent method, similar to the results of the study in England. When different studies are examined, the continuous feeding method is applied more frequently in most of the PICUs around the world (15,16). Recent findings indicate that intermittent feeding is preferred in PICUs since intermittent feeding is closer to the natural feeding rhythm that the body is accustomed to, and the fasting period experienced during intermittent feeding is more beneficial for body metabolism (16). Therefore, this method has been preferred in recent years. In addition, studies comparing intermittent and continuous feeding methods in the past indicated that the bolus method was generally used as the intermittent method, which may adversely affect the results. Since the concept of intermittent feeding has developed further cyclical and bolus feeding methods, it encompasses a wider range than the concept of continuous feeding. It is thought that the intermittent feeding method might, therefore, be preferred more frequently in our country.

When the criteria used by the units that participated in this study to evaluate the tolerance of enteral nutrition were questioned, the primary criterion identified for feeding intolerance was the amount of GRV with 90.4%, which was then followed by vomiting with 87.7%, increased abdominal pressure with 80.8%, and diarrhea with 35.6% (Table 2). Martinez et al. (17) defined nutritional intolerance in their study in a manner similar to the criteria used in our research. In a study by Tume et al. (9), the frequency of the criteria used to define nutritional intolerance was 100% GRV, 67% vomiting, 50% diarrhea, and 44% increased abdominal pressure. Compared to our results, the 10% difference for the GRV criterion, which ranks first, may suggest that this criterion could

<b>Table 3. Gastric residual volume (GRV) measurement and applications for GRV</b>		
<b>Features</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>
<b>GRV measurement status</b>		
It is measured in every patient who is routinely started on enteral feeding	45	61.6
It is measured only in patients with signs/signs of intolerance and not routinely checked	23	31.5
Measured in bleeding risk assessment	1	1.4
Only at the request of a physician	4	5.5
<b>When the frequency of GRV measurement in intermittent fed patients was</b>		
Before each feeding meal	37	50.7
3 hours apart	8	11.0
4 hours apart	3	4.1
6 hours apart	1	1.4
Once per shift	7	9.6
Only if the child is vomiting	10	13.7
Other/ only at the request of a physician/ situations that pose a risk to the child	7	9.6
<b>Frequency of GRV measurement in continuously fed patients</b>		
3 hours apart	5	6.8
4 hours apart	9	12.3
6 hours apart	8	11.0
8 hours apart	10	13.7
1 time in 24 hours	4	5.5
2 times in 24 hours	3	4.1
Only if the child is vomiting	28	38.4
Other/ this method is not applicable/ only at the request of a physician	6	8.2
<b>Does the injector used in GRV measurement have a certain size?</b>		
Yes	31	42.5
No	42	57.5
<b>Methods used in decisions to stop feeding or skip meals</b>		
In this regard, it is acted in accordance with the written procedure	4	5.5
Nurses decide	9	12.3
Physicians decide	48	65.8
Other/ doctor and nurse decide together	12	16.4
<b>Threshold value or formula used for cessation of feeding according to the amount of GRV</b>		
<b>Yes</b>	<b>30</b>	<b>41.1</b>
If GRV is at least half of the previous feeding amount	12	16.4
If GRV appears to be at least 1/3 of the previous feeding consumption	9	12.3
If GRV is equal to or more than the previous feeding amount	1	1.4
If you have a GRV of 400 mL or more	1	1.4
Threshold value or formula not specified even though yes is said	7	9.6
<b>No</b>	<b>43</b>	<b>58.9</b>
<b>Method used when evaluating whether the amount of GRV is excessive</b>		
Maximum volume in "mL"	3	4.1
Ratio of last feeding amount and gastric residue amount	70	95.9
<b>The method of resumption of feeding, which was stopped due to the high amount of GRV</b>		
Nutrition is gradually increased according to the tolerance status by switching to minimal enteral nutrition	38	52.1
In the first 24 hours, feeding is started with low amounts and gradually increased according to the tolerance status	35	47.9

be gradually excluded, as it raises the question of whether GRV measurement is necessary.

In this study, it was observed that only 58.9% of critically ill children placed in the prone position could be fed enterally (Table 2). In critically ill patients placed in the prone position, there is concern that the endotracheal tubes, venous access lines, and nasogastric tubes might be inadvertently displaced or removed. In addition, since the body is in a flatter plane, this position is believed to increase the risk of nutritional complications due to high pressure in the abdominal region and the use of high-dose sedation and paralytic agents. However, Savio et al. (18) claimed that there was no difference between the supine and prone positions in terms of enteral feeding intolerance. Furthermore, Sangers et al. (19) concluded that the amount of GRV was higher in the supine position, compared to the prone position, in a prospective observational study with 147 newborn babies.

The use of non-invasive ventilation (NIV) in PICUs has increased significantly in recent years (20). Although the use of NIV causes a decrease in the intubation process in critically ill patients, it may cause delays in initiating enteral nutrition. During NIV application, administering positive pressure to the mouth and nostrils to allow entry of air into respiratory and gastrointestinal systems may contribute to complications such as increased abdominal pressure and vomiting. Furthermore, the sedation used during NIV administration might increase the risk of aspiration by weakening airway protective reflexes (21). Enteral nutrition was applied during NIV in 90.4% of the units included in this study (Table 2). Kogo et al. (22) compared the mortality of two groups of patients who received NIV: those in whom enteral feeding was initiated and those in whom it was not. It was reported that there was no significant difference in mortality between the two groups. Although there was a risk of enteral feeding complications during NIV administration, enteral feeding could be initiated if undertaken with caution (22). Tume et al. (23) found that enteral nutrition was applied to 80% of the critically ill children who received NIV, with a very low pulmonary aspiration rate of 1.5%.

In 61.6% of the units included in the study, it was detected that the GRV was "measured in every patient who routinely started enteral nutrition", whereas in 31.5% of the units it was "measured only in patients with signs of intolerance, which were not routinely checked" (Table 3). Tume et al. (9) reported that GRV was routinely measured in units at a much higher rate (96%) than our study. This difference might be related to the recent discussions on the necessity of GRV measurements and the fact that the study published before 2020 stated that

GRV was measured routinely in almost all cases. In addition, the "not recommending routine GRV measurement in critically ill children" principle in the ESPNIC12 guideline was published in 2020.

When the frequency of GRV measurement was questioned in the units using intermittent and continuous feeding methods and those participating in the study, the most common answer was "before each meal" (50.7%), which was followed by "only if the child vomits" (13.7%). In the cases that use the continuous feeding method, 38.4% answered "only if the child vomits", which was followed by "8 hours apart" with 13.7%, and "4 hours apart" with 12.3% (Table 3). In their study with newborn babies, Dorling et al. (10) demonstrated that the frequency of GRV measurement in intermittent feeding method was "at regular intervals of 4-6 hours" with a rate of 43.3%, "in the presence of clinical indications" with 28.9% and "every feeding" with a rate of 22.2%. The findings are similar to the findings of our study; however, the answer "before each nutritional meal", was in third place. In the study conducted in England, it was found that 75% of both intermittent and continuous feeding methods were controlled "with an interval of 4 hours", unlike our research (9) In our study, a high rate of GRV measurements "only if the child vomits" in children who are fed continuously was interpreted as an indication that no routine measurement has been made in recent years, due to the recent approach of GRV measurement, and the current recommendations of the guidelines (ESPNIC, 2020).

When the decisions to stop feeding or skip meals due to high GRV were questioned, it was observed that 65.8% were made by the physicians, 16.4% were made by a physician and a nurse together, 12.3% were made by the nurses, and the written protocols were applied to 5.5% (Table 3). Dorling et al. (10) reported that the first decision regarding the GRV content was made by the "nurse in charge of the patient's care", the "specialist physician" in the second place, and the "senior nurse in charge of the shift" in the third place. Although the results of the study seemed similar to our research, it is also important to note that nurses in our country are not effective enough in decision-making.

When the units participating in this study were asked whether there was a threshold value or a formula used for cessation of feeding according to the amount of GRV, 43 (58.9%) of the units stated that they did not use a threshold value or formula, while the remaining 30 units (41.1%) stated that they did. 12 of the units stated "if at least half of the previous feeding amount has GRV", 9 of them stated "if at least 1/3 of the previous feeding amount has GRV", and 7



of them stated that “the content was not written even though it was stated that the threshold value or formula was being used” (Table 3). In their study, Tume et al. (9) questioned the GRV threshold value; the findings were “5mL/kg and more GRV”, “10mL/kg and more GRV”, “Total volume taken in 2/4/6 hours and more GRV”, and “At least 50% of the previous 4-hour feeding amount and more GRV”, in descending order of findings. In this study, it was observed that although most of the units measured GRV, they did not use the threshold value or formula required to make the decision to stop feeding, and those who stated that they used the threshold value or formula used widely varying values. This situation shows that there is no common definition of high GRV in our country, and each institution follows a different approach.

In case of questioning the method used when evaluating whether the amount of GRV was high, it was observed that 95.9% of the participants used “the ratio of the last nutrition amount and the amount of GRV”, while the remaining 4.1% unit used the “maximum volume in mL” method (Table 3). In the study conducted in a PICU in England, the answers were “maximum volume in mL/kg body weight” and “percentage of maximum volume of the applied amount”, respectively (9) The high GRV amount in our study was calculated based on the last feeding amount, instead of taking the child's weight into account, unlike this research.

### Study Limitations

Not all PICUs in Türkiye could be reached. This research was carried out with the nurses in charge of the PICU and may not reflect the approaches and practices of other nurses working in the unit. It has been determined based on the self-reports/statements of the participants who use the nutrition protocol in the units and cannot be presented as definitive information on the nature of the protocols.

### Conclusion

In conclusion, it was determined that routine GRV control in enterally fed patients was frequently performed in PICUs, with 61.6% of the units using it routinely and 31.5% in case of intolerance. It was found that the initially preferred route of the units was the intermittent gastric method of enteral feeding. The use of written enteral nutrition protocols in the PICU was insufficient (24.7%).

In accordance with these results, the use of enteral nutrition protocols in the PICUs should be encouraged. Institutional protocols should be developed and intensive care workers

should be informed through in-service training. To maintain enteral nutrition more effectively, in the PICUs, it might be recommended to establish “nutrition support teams” at the institutional level and to determine evidence-based best practices in enteral nutrition by conducting randomized controlled studies.

### Ethics

**Ethics Committee Approval:** Permission for the research was obtained from the Ethics Committee of Okan University (no:133, date: 17.02.2021).

**Informed Consent:** The online form became available after the approval of the consent form.

### Footnotes

#### Authorship Contributions

Concept: T.Y., D.S.D., Design: T.Y., D.S.D., Data Collection or Processing: T.Y., Analysis or Interpretation: D.S.D., G.U., Literature Search: T.Y., D.S.D., G.U., Writing: T.Y., D.S.D., G.U.

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### References

1. Erkan T. Yoğun bakımdaki çocuk hastanın beslenmesi. *Türkiye Klinikleri J Pediatr Sci.* 2017;13:194-200.
2. Kendirli T. Kritik çocuk hastada beslenme. *Klinik Gelişim Dergisi.* 2011;24:34-43.
3. Mehta NM, Bechard LJ, Zurakowski D, Duggan CP, Heyland DK. Adequate enteral protein intake is inversely associated with 60-d mortality in critically ill children: a multicenter, prospective, cohort study. *Am J Clin Nutr.* 2015;102:199-206.
4. Mehta NM, Skillman HE, Irving SY, Coss-Bu JA, Vermilyea S, Farrington EA, et al. Guidelines for the provision and assessment of nutrition support therapy in the pediatric critically ill patient: society of critical care medicine and American society for parenteral and enteral nutrition. *JPEN J Parenter Enteral Nutr.* 2017;41:706-42.
5. Bozkurt G. Yoğun bakımdaki çocuğun beslenmesi. *Yoğun Bakım Hemşireliği Dergisi.* 2010;14:72-8.
6. Önal Z, Durmaz Uğurcan Ö. Enteral beslenme ve enteral ürünler. *Türkiye Klinikleri J Pediatr Sci.* 2017;13:173-7.
7. Mehta NM, Bechard LJ, Cahill N, Wang M, Day A, Duggan CP, et al. Nutritional practices and their relationship to clinical outcomes in critically ill children--an international multicenter cohort study\*. *Crit Care Med.* 2012;40:2204-11.
8. Mikhailov TA, Gertz SJ, Kuhn EM, Scanlon MC, Rice TB, Goday PS. Early enteral nutrition is associated with significantly lower hospital charges in critically ill children. *JPEN J Parenter Enteral Nutr.* 2018;42:920-5.

9. Tume LN, Arch B, Woolfall K, Latten L, Deja E, Roper L, et al. Gastric residual volume measurement in U.K. PICUs: a survey of practice. *Pediatr Crit Care Med.* 2019;20:707-13.
10. Dorling J, Tume L, Arch B, Woolfall K, Latten L, Roper L, et al. Gastric residual volume measurement in British neonatal intensive care units: a survey of practice. *BMJ Paediatr Open.* 2020;4:e000601.
11. Martinez EE, Bechard LJ, Mehta NM. Nutrition algorithms and bedside nutrient delivery practices in pediatric intensive care units: an international multicenter cohort study. *Nutr Clin Pract.* 2014;29:360-7.
12. Tume LN, Valla FV, Joosten K, Jotterand Chaparro C, Latten L, Marino LV, et al. Nutritional support for children during critical illness: European Society of Pediatric and Neonatal Intensive Care (ESPNIC) metabolism, endocrine and nutrition section position statement and clinical recommendations. *Intensive Care Med.* 2020;46:411-25.
13. Petrillo-Albarano T, Pettignano R, Asfaw M, Easley K. Use of a feeding protocol to improve nutritional support through early, aggressive, enteral nutrition in the pediatric intensive care unit. *Pediatr Crit Care Med.* 2006;7:340-4.
14. Campos-Miño S, López-Herce Cid J, Figueiredo Delgado A, Muñoz Benavides E, Coss-Bu JA; Nutrition Committee, Latin American Society of Pediatric Intensive Care (SLACIP). The Latin American and Spanish Survey on Nutrition in Pediatric Intensive Care (ELAN-CIP2). *Pediatr Crit Care Med.* 2019;20:e23-9.
15. Bear DE, Hart N, Puthuchery Z. Continuous or intermittent feeding: pros and cons. *Curr Opin Crit Care.* 2018;24:256-61.
16. Veldscholte K, Cramer ABG, Joosten KFM, Verbruggen SCAT. Intermittent fasting in paediatric critical illness: The properties and potential beneficial effects of an overnight fast in the PICU. *Clin Nutr.* 2021;40:5122-32.
17. Martinez EE, Pereira LM, Gura K, Stenquist N, Ariagno K, Nurko S, Mehta NM. Gastric emptying in critically ill children. *JPEN J Parenter Enteral Nutr.* 2017;41:1100-9.
18. Savio RD, Parasuraman R, Lovesly D, Shankar B, Ranganathan L, Ramakrishnan N, et al. Feasibility, tolerance and effectiveness of enteral feeding in critically ill patients in prone position. *J Intensive Care Soc.* 2021;22:41-6.
19. Sangers H, Jong PM, Mulder SE, Stigter GD, Berg CM, Pas AB et al. Outcomes of gastric residuals whilst feeding preterm infants in various body positions. *Journal of Neonatal Nursing.* 2013;19:337-41.
20. Ganu SS, Gautam A, Wilkins B, Egan J. Increase in use of non-invasive ventilation for infants with severe bronchiolitis is associated with decline in intubation rates over a decade. *Intensive Care Med.* 2012;38:1177-83.
21. Leroue MK, Good RJ, Skillman HE, Czaja AS. Enteral nutrition practices in critically ill children requiring noninvasive positive pressure ventilation. *Pediatr Crit Care Med.* 2017;18:1093-8.
22. Kogo M, Nagata K, Morimoto T, Ito J, Sato Y, Teraoka S, et al. Enteral nutrition is a risk factor for airway complications in subjects undergoing noninvasive ventilation for acute respiratory failure. *Respir Care.* 2017;62:459-67.
23. Tume LN, Eveleens RD, Mayordomo-Colunga J, López J, Verbruggen SCAT, Fricaudet M, et al. Enteral feeding of children on noninvasive respiratory support: a four-center european study. *Pediatr Crit Care Med.* 2021;22:e192-202.