

Prevalence and risk factors of enteral nutrition intolerance in intensive care unit patients: a retrospective study

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Abstract

Background: Feeding intolerance (FI) among intensive care unit (ICU) patients undergoing early continuous enteral nutrition (EN) is related to poor outcomes. This study aimed to explore the prevalence and risk factors of FI in ICU patients.

Methods: We retrospectively enrolled 1057 patients who received early continuous EN via a nasogastric tube between January 2014 and August 2019. The prevalence of FI during the first 7 days of ICU stay was calculated, and the risk factors were investigated using multivariate logistic regression analysis.

Results: The prevalence of FI during the first 7 days of ICU stay was 10.95%. FI occurred in 159 of 1057 (15.04%) patients on ICU day 2, 114 of 977 (11.67%) patients on ICU day 3, and 86 of 715 (12.03%) patients on ICU day 7. Mechanical ventilation (MV) (odds ratio [OR]: 1.928, 95% confidence interval [CI]: 1.064–3.493, $P = 0.03$) was an independent risk factor for FI defined by a gastric residual volume (GRV) of 200 mL and/or vomiting, and acute renal failure (OR: 3.445, 95% CI: 1.115–10.707, $P = 0.032$) was an independent risk factor of FI defined by a GRV of 500 mL and/or vomiting. Continuous renal replacement therapy (CRRT) was an independent predictor regardless of the FI defined by a GRV of 200 mL (OR: 2.064, 95% CI: 1.233–3.456, $P = 0.006$) or 500 mL (OR: 6.199, 95% CI: 2.108–18.228, $P = 0.001$) in the ICU patients.

Conclusions: FI occurs frequently in early ICU days, especially in patients receiving MV and CRRT. However, further investigation of a consensus definition of FI and risk factors is still warranted in future studies.

Keywords: Continuous enteral nutrition; Feeding intolerance; Intensive care unit; Risk factor; Continuous renal replacement therapy

Introduction

Critically ill patients staying at the intensive care unit (ICU) for >48 h are at risk of malnutrition.^[1] Early enteral nutrition (EN) is reported to be a key factor in maintaining the normal gut mucosal barrier function, and it is considered as a proactive therapeutic strategy, which could reduce disease severity, diminish complications, and favorably impact patient outcomes.^[2] Therefore, in their guidelines, the Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition (ASPEN) recommends early initiation of EN within 24 to 48 h in critically ill patients who are unable to maintain

volitional intake and avoiding inappropriate cessation.^[3] However, feeding cessation occurs frequently, with feeding intolerance (FI) being one of the most common reasons.^[4] Previous studies^[5–7] reported that FI is associated with adverse outcomes in critically ill patients, including an increased mortality rate, longer duration of mechanical ventilation (MV) and vasoactive support, and inadequate nutrition. Hence, the present study aimed to explore the prevalence and risk factors of early continuous enteral FI in ICU patients to help intensive care staff identify the patients at a high risk of developing FI.

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Methods

Ethical approval

The study design was approved by the appropriate Institutional Review Board of Peking Union Medical College Hospital (No. JS-2148). The requirement for informed consent was waived owing to the retrospective nature of the study.

Participants

Patients admitted to our hospital from January 2014 to August 2019 were identified using the electronic medical recording system. All the patients who initiated continuous EN during 48h following admission via a nasogastric tube and stayed in the ICU for >2 days were enrolled. Patients with orogastric tubes or nose-jejunum tubes, those who did not receive EN during the entire stay at the ICU or the first 7 days in the ICU, those who stayed at the ICU for fewer than 2 days, and patients whose medical records contained missing data were excluded.

Feeding protocol

In the medical center from where the data were collected, the energy target was defined as $25 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ as recommended.^[3] EN via a nasogastric tube was initiated as soon as possible in all the patients. EN was administered continuously at a constant feeding rate for 24 h using a peristaltic pump. Patients were cared for in a semi-recumbent position (angle of at least 30° of the head) if the patient's hemodynamic status was stable. Gastric residual volume (GRV) was measured by aspiration using a 20-mL syringe every 4 h, all the aspirated fluid was discarded. EN was discontinued once the GRV exceeded 200 mL until the next measurement of GRV, and medications or change to nose-jejunum tubes were considered as needed.

Study design and data extraction

In the present retrospective cohort study, patients were identified from the medical records in the hospital information system of the medical ICU. The data extracted for each patient from ICU days 1 to 7 included demographic characteristics (age, sex, body mass index [BMI], ICU days, and death status), disease characteristics, and treatment (Acute Physiology and Chronic Health Evaluation [APACHE] II score, Sequential Organ Failure Assessment [SOFA] score, specialty of diagnosis, chronic disease, diagnosis on admission, MV, prone position ventilation, sedation drug use, dynamic gastric drug use, and continuous renal replacement therapy [CRRT]), and EN information (initial feeding rate of EN, vomiting, and GRV). We did not regulate the type of formula. In the data collected, the type of EN formula included both with and without amino acids and fiber content.

Definitions

We defined FI as the occurrence of vomiting and/or a GRV exceeding 200 mL, which is mostly reported as a cut-off value in clinical practice.^[8-14] However, when we explored

the risk factors for FI, we repeated the analysis using vomiting and/or a GRV exceeding 500 mL to define FI.

Statistical analyses

Normally distributed continuous variables are presented as mean \pm standard deviation and skewed data as median (range); categorical variables are represented as frequencies and proportions. Univariate analysis of the categorical data was performed using the chi-squared test or Fisher exact test depending as appropriate. Comparisons between groups for continuous variables were performed using Student *t* tests. A multivariate logistic regression analysis that used a stepwise method to select potential variables was performed to identify the independent risk factors for FI. All significant factors in the univariate analysis, and factors based on evidence and clinical practice, including APACHE II score, SOFA score, BMI, diagnosis on admission, acute renal failure (ARF), MV, prone position ventilation, sedation drug use, gastric dynamic drug use, and CRRT, were included in the multivariate model for predicting the FI.

Owing to the gap of the GRV threshold used in clinical practice and suggestion of guidelines, a sensitivity analysis restricted to data using a GRV threshold of 500 mL and/or vomiting to define FI was performed, and a multivariate regression analysis was repeated. All the statistical analyses were performed using SPSS version 25.0 (IBM Corporation, Armonk, NY, USA). A two-sided $P < 0.05$ was considered statistically significant.

Results

Of the 3151 patients identified during the study period, 2094 were excluded from further analysis since they did not receive EN during the first 7 days of ICU stay, received EN by nose-jejunum tubes, spent <2 days in the ICU, or had missing data. Only 1057 patients who received EN via a nasogastric tube during the first 2 ICU days were included [Figure 1]. The characteristics of the patients included in this study are shown in Table 1.

Feeding intolerance

EN of all the patients was initiated during 48 h following ICU admission. The proportion of patients with FI by ICU days in the first week is presented in Figure 2. The prevalence of FI during the first 7 days of ICU stay was 10.95%. FI occurred in 159 of 1057 patients on ICU day 2, among whom 11 patients vomited and the GRV of 148 patients exceeded 200 mL. The prevalence of FI on ICU day 3 was 11.67% (114/977); on ICU day 7, the incidence of FI was 12.03% (86/715).

Risk factors

The results of the univariate and multivariable logistic regression analyses of risks factors associated with FI defined by a GRV of 200 mL and/or vomiting are presented in Table 2. Age, SOFA score, MV, prone position ventilation, CRRT, sedation drug use, and initial feeding rate of EN were identified as significant factors in the univariate analysis; however, the odds ratio (OR)

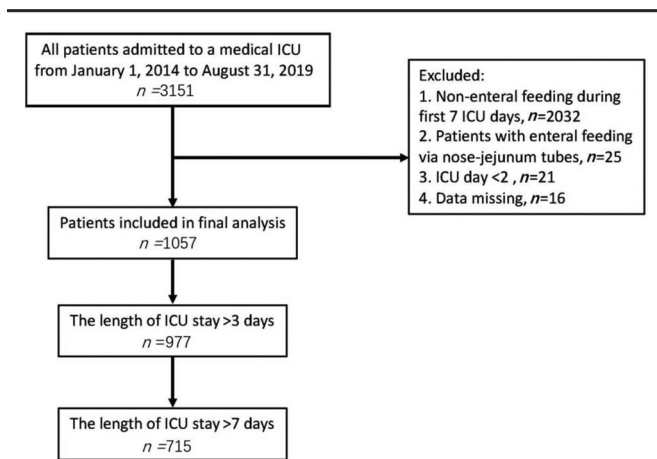


Figure 1: Flowchart of patient selection. ICU: Intensive care unit.

Table 1: Distributions of demographic, etiological, and baseline characteristics of patients who received early continuous enteral nutrition via a nasogastric tube.

Characteristic	Patients (n = 1057)
Sex, n (%)	
Female	470 (44.5)
Male	587 (55.5)
Age (year), mean (SD)	56.1 (19.4)
BMI, n (%)	
Underweight	91 (8.6)
Normal	665 (62.9)
Overweight	252 (23.8)
Obesity	49 (4.7)
APACHE II, mean (SD)	21.2 (7.3)
SOFA, mean (SD)	8.7 (3.9)
ICU days, median (range)	10 (6, 18)
MV hours, median (range)	193 (93, 403)
Chronic disease at ICU admission, n (%)	
Respiratory	56 (5.3)
Cancer or immune deficiency	111 (10.5)
Heart	368 (34.8)
Diabetes	130 (12.3)
Others	392 (37.1)
Diagnosis on admission, n (%)	
Pulmonary infection	317 (30.0)
Sepsis/septic shock	191 (18.1)
Kidney failure	178 (16.8)
Cardiac arrest	43 (4.1)
Heart failure	24 (2.3)
Surgical post-operation	18 (1.7)
Others	286 (27.0)
Death, n (%)	138 (13.1)

APACHE: Acute Physiology and Chronic Health Evaluation; BMI: Body mass index; ICU: Intensive care unit; MV: Mechanical ventilation; SD: Standard deviation; SOFA: Sequential Organ Failure Assessment.

value of age, SOFA score, and initial feeding rate of EN were very close to one. The univariate analysis results indicated that patients receiving CRRT and MV, prone position ventilation, and sedation drugs had a higher risk of developing FI. However, in the multivariable analysis,

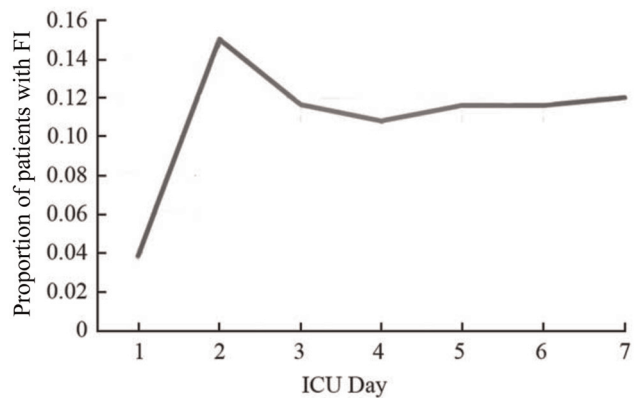


Figure 2: Proportion of patients with FI by ICU days in the first week. FI: Feeding intolerance; ICU: Intensive care unit.

only MV (OR: 1.928, 95% confidence interval [CI]: 1.064–3.493, $P = 0.03$) and CRRT (OR: 2.064, 95% CI: 1.233–3.456, $P = 0.006$) were identified as factors independently associated with FI in ICU patients.

The results of the sensitivity analysis restricted to data using a GRV threshold of 500 mL and/or vomiting to define FI to explore the risk factors are presented in Table 3. Age and CRRT were still identified as significant factors in the univariate analysis, and the OR value of age was very close to 1. ARF was also a significant factor. In the multivariable analysis, both CRRT (OR: 6.199, 95% CI: 2.108–18.228, $P = 0.001$) and ARF (OR: 3.445, 95% CI: 1.115–10.707, $P = 0.032$) were identified as independent risk factors.

Discussion

The definition of FI has not been consistent. It has mainly been defined according to a large GRV, the presence of gastrointestinal (GI) symptoms, and inadequate delivery of EN. In a systematic review of 72 studies, the FI was defined based on a large GRV in most of the studies.^[5] Although it is recommended by ASPEN guidelines that EN should not be withheld for a GRV of <500 mL, the median GRV threshold reportedly used in clinical practice was 200 to 250 (range, 75–500) mL, which was considered large.^[5,8-14] Monitoring GRV and holding or interrupting EN for a large GRV is one of the most conventional and widely accepted nursing practices in the ICU. However, owing to the lack of a standard monitoring method, it has been reported that GRV assessment does not accurately reflect the total volume of the contents available, and the value of the measured volume could be influenced by many factors, including investigator-related and tube-related factors.^[15] In a simulated laboratory study,^[16] which analyzed 108 GRVs, the actual content was underestimated by 19% on average and varied across the tube size and viscosity. One study^[17] showed that GRVs obtained from large-diameter sump tubes are approximately 1.5 times greater than those obtained from 10-Fr (the perimeter of catheter is 10 mm) tubes. Hence, it is not reliable to define FI only by GRV measurement as the ASPEN guidelines suggest. GI symptoms (including diarrhea and bleeding) do not reflect

Table 2: Univariate and multivariate analyses of factors associated with FI defined by a GRV of 200 mL and/or vomiting.

Characteristics	Patients (n = 977)		Univariate analysis		Multivariable analysis	
	Non-FI (n = 863)	FI (n = 114)	OR (95% CI)	P value	OR (95% CI)	P value
Male, n (%)	476 (55.5)	64 (56.1)	1.041 (0.702–1.542)	0.843		
Age (years), mean ± SD	57 ± 19	50 ± 19	0.982 (0.972–0.992)	<0.001		
BMI, n (%)						
Normal	546 (63.3)	71 (62.3)	Ref			
Underweight	72 (8.3)	13 (11.4)	1.252 (0.580–2.700)	0.567		
Overweight	207 (24.0)	25 (21.9)	1.738 (0.681–4.438)	0.248		
Obesity	38 (4.4)	5 (4.4)	1.260 (0.537–2.958)	0.595		
Diagnosis on admission, n (%)						
Sepsis	150 (17.4)	25 (21.9)	Ref			
Pneumonia	280 (32.5)	35 (30.7)	1.001 (0.615–1.663)	0.964		
Neurological	107 (12.4)	13 (11.4)	0.664 (0.084–5.261)	0.698		
Renal/metabolic	39 (4.5)	5 (4.4)	1.022 (0.378–2.760)	0.966		
Others	287 (33.2)	36 (31.6)	1.022 (0.486–2.151)	0.954		
APACHE II score, mean ± SD	21 ± 7	22 ± 7	1.010 (0.984–1.038)	0.453		
SOFA score, mean ± SD	9 ± 4	10 ± 4	1.077 (1.021–1.136)	0.006		
Diabetes, n (%)	113 (13.1)	10 (8.8)	1.567 (0.795–3.088)	0.194		
ARF, n (%)	124 (14.4)	19 (16.7)	1.192 (0.703–2.021)	0.515		
MV, n (%)	623 (72.2)	97 (85.1)	2.198 (1.286–3.758)	0.004	1.928 (1.064–3.493)	0.030
Prone position ventilation, n (%)	32 (3.7)	10 (8.8)	2.497 (1.193–5.227)	0.015		
CRRT, n (%)	136 (15.8)	27 (23.7)	1.659 (1.038–2.652)	0.034	2.064 (1.233–3.456)	0.006
Initial feeding rate of EN (%), median (range)	50 (30, 60)	40 (30, 50)	0.984 (0.972–0.997)	0.013		
Gastric dynamic drugs, n (%)	10 (1.2)	4 (3.5)	3.102 (0.957–10.058)	0.059		
Sedation drugs, n (%)	420 (48.7)	72 (63.2)	1.808 (1.208–2.706)	0.004		

APACHE: Acute Physiology and Chronic Health Evaluation; ARF: Acute renal failure; BMI: Body mass index; CI: Confidence interval; CRRT: Continuous renal replacement therapy; EN: Enteral nutrition; FI: Feeding intolerance; GRV: Gastric residual volume; MV: Mechanical ventilation; OR: Odds ratio; SD: Standard deviation; SOFA: Sequential Organ Failure Assessment.

GI dysmotility. The most common cause of diarrhea could be the infusion of sorbitol-based medicines or associated with antibiotic administration; moreover, bleeding also does not predict motility disorders.^[18] Besides, defining FI based on inadequate delivery of caloric requirements is also considered problematic since it can only be assessed retrospectively. The reasons for cessation are often poorly defined, and many reasons other than disordered GI motility or absorption could lead to inadequate delivery of EN.^[5] The different definitions of FI are reportedly associated with different predictive powers of adverse outcomes, and a complex assessment of GI symptoms (including a large GRV) is the “best” definition of FI for the prediction of ICU mortality.^[19] In the medical center from where the data were collected, EN was discontinued and interventions were performed once the GRV exceeded 200 mL. If the FI was defined as a cut-off value of 500 mL, the FI incidence could be underestimated; therefore, we defined FI as the occurrence of vomiting and/or a GRV exceeding 200 mL.

It has been reported that FI occurred at a median of 3 days following the initiation of EN,^[20] and guidelines^[3] also emphasize the importance of caloric intake during the first 7 days. Hence, we focused only on the FI incidence in the first 7 ICU days. Moreover, as it is reported that FI occurred more on ICU day 3,^[20,21] and some of the patients in this study initiated EN on ICU day 2 and

received EN < 24 h on ICU day 2, which could have influenced the FI, we analyzed the data obtained on ICU day 3, including 977 patients for independent risk factors of FI.

The major findings of this retrospective study are that in the ICU patients receiving early continuous EN during the 48 h following admission, FI occurred frequently and the prevalence of FI during the first 7 days of ICU admission was 10.95%. Moreover, we found that MV was an independent risk factor for FI defined by a GRV of ≥ 200 mL and/or vomiting, and ARF was an independent risk factor for FI defined by a GRV of 500 mL and/or vomiting. However, CRRT was an independent predictor of FI regardless of whether FI was defined by a GRV of 200 mL or 500 mL for ICU patients. The inflammatory response might be an explanation for the association of MV and renal replacement therapy with FI.^[22,23] However, further studies with data on inflammation parameters collected prospectively are needed to validate our findings.

Early EN is universally considered a key proactive therapeutic strategy in the ICU. FI is one of the most common reasons for feeding cessation and incomplete nutrition goals. Our study demonstrated that the prevalence of FI during the first 7 days of ICU admission was 10.95% when we defined FI as the occurrence of vomiting and/or a GRV exceeding 200 mL; if the GRV is not

Table 3: Sensitivity analysis of factors associated with FI defined by a GRV of 500 mL and/or vomiting.

Characteristic	Patients (n = 977)		Univariate analysis		Multivariable analysis	
	Non-FI (n = 946)	FI (n = 31)	OR (95% CI)	P value	OR (95% CI)	P value
Male, n (%)	527 (55.7)	13 (41.9)	0.574 (0.278–1.185)	0.134		
Age (years), mean (SD)	56 ± 19	47 ± 20	0.976 (0.959–0.994)	0.010		
BMI, n (%)						
Normal	595 (62.9)	22 (71.0)	Ref			
Underweight	83 (8.8)	2 (6.5)	1.534 (0.354–6.645)	0.567		
Overweight	185 (19.6)	5 (16.1)	1.0 (0.138–7.268)	>0.999		
Obesity	83 (8.8)	2 (6.5)	1.122 (0.213–5.900)	0.892		
Diagnosis on admission, n (%)						
Sepsis	169 (17.9)	6 (19.4)	Ref			
Pneumonia	297 (31.4)	5 (16.1)	0.847 (0.316–2.268)	0.740		
Neurological	85 (9.0)	3 (9.7)	1.590 (0.342–7.380)	0.554		
Renal/metabolic	42 (4.4)	2 (6.5)	1.136 (0.248–5.208)	0.870		
Others	353 (37.3)	15 (48.3)	0.842 (0.234–3.021)	0.791		
APACHE II score, mean ± SD	21.3 ± 7.2	20.6 ± 7.4	1.047 (0.978–1.121)	0.187		
SOFA score, mean ± SD	8.7 ± 3.8	9.8 ± 4.7	1.072 (0.974–1.181)	0.155		
Diabetes, n (%)	120 (12.7)	3 (9.7)	1.356 (0.406–4.529)	0.621		
ARF, n (%)	132 (14.0)	11 (35.5)	3.392 (1.589–7.240)	0.002	3.445 (1.115–10.707)	0.032
MV, n (%)	697 (73.3)	23 (74.2)	1.027 (0.454–2.326)	0.949		
Prone position ventilation, n (%)	41 (4.3)	1 (3.2)	0.736 (0.098–5.529)	0.766		
CRRT, n (%)	149 (15.8)	14 (45.2)	4.405 (2.126–9.129)	0.001	6.199 (2.108–18.228)	0.001
Initial feeding rate of EN, median (range)	50 (30, 60)	30 (20, 50)	0.977 (0.943–1.011)	0.180		
Gastric dynamic drugs, n (%)	13 (1.4)	1 (3.2)	2.392 (0.303–18.886)	0.408		
Sedation drugs, n (%)	475 (50.2)	17 (54.8)	1.204 (0.587–2.471)	0.613		

APACHE: Acute Physiology and Chronic Health Evaluation; ARF: Acute renal failure; BMI: Body mass index; CI: Confidence interval; CRRT: Continuous renal replacement therapy; EN: Enteral nutrition; FI: Feeding intolerance; GRV: Gastric residual volume; MV: Mechanical ventilation; OR: Odds ratio; SD: Standard deviation; SOFA: Sequential Organ Failure Assessment.

considered, the FI of vomiting was 1.7% on ICU day 3 and 1.6% on ICU day 7, which is similar to the results of 2.1% in a previous study.^[24] This rare occurrence of vomiting could be attributed to the fact that EN was held or ceased once GRV exceeded 200 mL. Wang *et al*^[6] reported that the prevalence of FI was higher in ICU patients (36%) than that in non-ICU patients (27%). This could be attributable to additional factors, which reduce GI motility, including the use of sedatives, vasopressors, and a more aggressive approach to EN.^[25] A systematic review of 72 studies^[5] reported that the prevalence of FI in ICU patients ranged from 2% to 75%, with a pooled proportion of 38.3%, which was due to the varied definitions of FI. We also found that FI occurred most frequently on ICU day 2 (15.04%, n = 1057), followed by ICU days 7 (12.03%, n = 715), and 3 (11.67%, n = 977). On ICU day 2, some patients solely initiated EN and did not receive continuous EN for 24 h; thus, we considered the high FI incidence on day 2 may be related to an impaired GI function due to the disease in the acute phase but not due to EN. One multicenter, multiyear analysis including 785 ICUs worldwide reported that the FI incidence rate increased from ICU day 1 to days 4 and 5 and declined daily thereafter.^[26] A multicenter, prospective, observational study^[21] also reported that the prevalence of FI reached a peak on ICU day 3 (39.2%, n = 196) during the first 7 ICU days. Owing to the minor difference in FI incidence among these ICU days and the number of patients

enrolled, we believe that FI occurred more frequently on ICU day 3.

It has been reported that the enteral caloric intake during the first 7 days is associated with important infectious outcomes.^[27] Previous studies^[5-7,21,28,29] demonstrate that FI is associated with nutrition inadequacy, increased length of ICU stay, increased mortality rate, and other poor outcomes in both surgical and medical ICU patients. Therefore, it is important to identify ICU patients at a high risk of FI at an early stage.

We found that in the univariate analysis, age, SOFA score, prone position ventilation, sedation drug use, and initial feeding rate of EN were identified as significant factors of FI. As the OR value of age and SOFA score were very close to 1, we believe the difference does not represent any clinical significance; moreover, all of them were not independent risk factors in this study. However, it has been reported that the SOFA score is closely related to the GI system, and the combination of GI parameters and the SOFA score improves mortality prediction.^[30] Decreasing age was unexpectedly found to be an independent risk factor for FI in another study.^[6] We presumed the initial feeding rate of EN could be associated with FI; however, the OR value of univariate analysis was very close to 1; thus, it was not demonstrated as an independent risk factor of FI in this study. Moreover, ICU admission

prescription of calories is not reported as an independent factor either.^[26] Although sedation during EN was only significant in the univariate analysis in this study, it is reported to be an independent risk factor for vomiting and an increased GRV,^[31] since they could directly or indirectly inhibit GI functions, ultimately inducing FI.^[32,33]

Our study also demonstrated that MV was an independent predictor of FI in ICU patients. Previous studies^[33-35] have reported that MV can cause GI tract ischemia and induce FI, particularly in patients undergoing positive end-expiratory pressure therapy. Our study confirmed that the incidence of FI in patients who underwent MV was nearly twice as high in those who did not.

CRRT is a predominant form of renal replacement therapy in the ICU owing to its accurate volume control, steady acid-base and electrolyte correction, and achievement of hemodynamic stability in patients with severe acute kidney injury, chronic kidney disease, and sepsis in the ICU.^[36] We observed in this study that ARF and CRRT were independent risk factors for FI. Patients with ARF had a 3.445 times higher risk for FI than those without ARF. Patients, who underwent CRRT had a 2.064 times higher risk of FI defined by a GRV of 200 mL than those who did not, had a 6.199 times higher risk of FI defined by a GRV of 500 mL. Previous studies have not reported on the relationship between CRRT and FI. In the medical center from where the data were collected, patients with ARF and acidosis were the major candidates of CRRT. There could be some association between renal function and digestive system dysfunction, which causes FI to some extent. Fluid balance is reported to be important and may result in GI dysfunction in critically ill patients, which may cause FI,^[37] while almost all patients with ARF receiving CRRT are faced with fluid balance complications owing to anuria. One case report^[38] studied a pediatric patient who experienced continuous FI following intraperitoneal kidney transplantation. The most likely diagnosis and the mechanism underlying the development of clinical symptoms were recurrences of nephrotic syndrome secondary to *de novo* formation of anti-nephrin antibodies.^[39] Moreover, serum lactate levels were reportedly associated with an increased risk of EN FI,^[40] while lactic acidosis is very common in patients with acidosis who require CRRT. Elevated serum lactate levels indicate the presence of hypoxia in tissues and GI dysfunction in patients with hemodynamic instability, which further affects their tolerance to EN. All these abovementioned reasons indicate why CRRT was detected as an independent risk factor of FI. However, the relationship between CRRT and FI in ICU patients still warrants further investigation in future studies.

Considering the negative consequence of FI in ICU patients, ICU staff needs to recognize FI earlier and manage it. Medical staff should pay more attention to patients who have one or more independent risk factors. If a large GRV appears or patients show FI symptoms, such as vomiting and diarrhea, which are not attributed to the administered medicines, it is advised to transiently reduce the nutritional target and consider prokinetic agents, if

needed,^[28,41] or change the route of EN from a nasogastric tube to a nose-jejunum tube, particularly in those with delayed gastric emptying.^[6] Besides, for patients at a high risk of FI, a daily physical examination is very important to confirm the passage of stool, gas, and bowel regimen, and document any improvement in the initial signs and symptoms of the observed FI.^[18]

The present study had several limitations. First, largely owing to this study's retrospective design, additional clinical trials are warranted to verify the relationship between risk factors and FI. Second, the discrepancy in the GRV cut-off value between clinical practice and guidelines needs to be verified and one parameter to guide the delivery of EN in critical illness should be recommended; therefore, a consistent definition of FI and more clinical evidence are warranted. Third, the present study sampled patients only from a single medical ICU, and the findings of our study might not be generalizable to those of other ICU patients.

In conclusion, FI occurred frequently in ICU patients during the first 7 ICU days. Of all the independent risk factors for FI, there is a need to pay more attention to patients receiving MV and CRRT. There is currently no consensus on the definition of FI, it is most frequently monitored based on GI symptoms and GRV assessment. However, the method and frequency of GRV measurement are not standardized. A consensus definition of FI and its measurement need to be investigated in future studies, and further research on the risk factors for FI is warranted in prospective trials.

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Conflicts of interest

None.

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