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FACTORS INFLUENCING ENTERAL FEEDING INTOLERANCE IN NEUROCRITICAL PATIENTS BASED ON ADMISSION DATA

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Abstract: Objective: To identify risk factors for feeding intolerance (FI) among neurocritical patients based on admission data.Methods: A retrospective study was conducted using convenience sampling to analyze neurocritical patients who were admitted to the neurology department of a tertiary hospital in Suzhou and received enteral nutrition between January 2018 and December 2022. Univariate and multivariate logistic regression analyses were performed to determine independent predictors of FI.Results: A total of 291 patients were included, of whom 119 (40.9%) developed FI. Univariate analysis showed that age, history of diabetes, history of stroke, Glasgow Coma Scale (GCS) score, and Nutritional Risk Screening 2002 (NRS-2002) score were significantly associated with FI ($P<0.05$). Multivariate logistic regression identified history of diabetes (OR=2.687), history of stroke (OR=2.352), lower GCS score (OR=0.750), and higher NRS-2002 score (OR=1.467) as independent risk factors for FI.Conclusion: History of diabetes, history of stroke, lower GCS score, and higher NRS-2002 score are major risk factors for FI in neurocritical patients. Early identification of these high-risk characteristics using admission data may support timely, targeted interventions to improve feeding tolerance and enhance the effectiveness of enteral nutrition.
Keywords: Neurocritical patients; Enteral nutrition; Feeding intolerance; Nursing

1 INTRODUCTION

Neurocritical patients often present with dysphagia and impaired consciousness, resulting in restricted or absent oral intake[1]. Early initiation of enteral nutrition is essential for maintaining the integrity of the gastrointestinal mucosal barrier and preventing gut-derived infections[2]. However, due to multiple pathological factors—such as elevated intracranial pressure, dysregulation of the brain–gut axis, and central nervous system suppression[3]—these patients are highly susceptible to feeding intolerance (FI), most commonly occurring within 1–3 days after the initiation of enteral nutrition, with an incidence reported as high as 50%[4]. FI not only compromises the safety and effectiveness of enteral nutrition but may also delay recovery and adversely affect patient outcomes. Therefore, early identification of patients at high risk for FI is crucial for optimizing enteral nutrition strategies.Admission-stage clinical data—including demographic characteristics, comorbidities, neurological status, and nutritional risk—are easy to obtain, stable, and suitable for early risk assessment and rapid clinical decision-making. However, previous studies have largely focused on gastrointestinal function and disease severity–related dynamic indicators, with insufficient attention to high-risk factors that can be identified at admission.Accordingly, this study aimed to identify accessible and clinically meaningful independent risk factors for FI in neurocritical patients based on admission information. Univariate and multivariate logistic regression analyses were performed to screen predictors of FI, with the goal of supporting early risk assessment, guiding feeding strategies, and promoting individualized management to improve the safety and effectiveness of enteral nutrition.

2 SUBJECTS AND METHODS

2.1 Study Population

This retrospective study used a convenience sampling method to include neurocritical patients who were hospitalized in the neurology department of a tertiary hospital in Suzhou and received enteral nutrition between January 2018 and December 2022. The inclusion criteria were as follows: (1) age ≥18 years; (2) confirmed diagnosis of neurological disease; (3) issuance of a “critical condition” medical order after admission; and (4) initiation of enteral nutrition via a nasogastric tube within 24 hours of admission. The exclusion criteria were: (1) contraindications to enteral nutrition, such as intestinal obstruction, gastrointestinal ischemia, severe diarrhea, or intractable vomiting; (2) receipt of enteral nutrition prior to admission; and (3) discontinuation of enteral nutrition for reasons other than feeding intolerance. A total of 291 patients met the criteria and were included in the final analysis. This study was approved by the Ethics Committee of the hospital (Approval No. 2024-618).

2.2 Enteral Nutrition Procedure

Commercial enteral nutrition formulas were administered according to physician orders and delivered continuously via an enteral feeding pump. The initial infusion rate was set at 20–50 mL/h, and the feeding solution was maintained at

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38°C using a heater. During feeding, the head of the patient's bed was elevated to at least 30°. The responsible nurse assessed gastrointestinal tolerance every 4 hours, including gastric residual volume, vomiting, diarrhea, and aspiration.If the patient exhibited good tolerance, the infusion rate was increased to 50–80 mL/h on the following day and further adjusted to 80–120 mL/h on the third day, progressing toward the target feeding volume based on the patient's condition. If signs of gastrointestinal intolerance occurred, enteral feeding was immediately stopped. Tolerance was reassessed after 6 hours, and the infusion rate and total volume were readjusted accordingly.

2.3 Criteria for Feeding Intolerance

Currently, there is no universally accepted international standard for defining feeding intolerance (FI). Based on clinical practice and the European Society of Intensive Care Medicine (ESICM) abdominal compartment group's definition of FI[5], the criteria used in this study for determining FI in neurocritical patients receiving enteral nutrition were as follows:Vomiting: expulsion of gastric contents accompanied by visible gastric material;Diarrhea: ≥3 bowel movements per day with watery or loose stool consistency;Abdominal distension: decreased bowel sounds, abdominal bloating, or tympanic percussion note;Gastric retention: gastric residual volume >250 mL within 4 hours;Gastrointestinal bleeding: coffee-ground gastric contents, recurrent hematemesis or melena, or unexplained reductions in hemoglobin.

2.4 Instruments and Data Collection

Based on literature review, availability of clinical data, and expert consultation, a self-designed General Information Questionnaire was developed, consisting of three components:Demographic and medical history information: sex, age, body mass index (BMI), admission temperature, admission diagnosis, smoking history, alcohol use, history of hypertension, diabetes, heart disease, and stroke;Admission assessment indicators: Glasgow Coma Scale (GCS) score, Braden Pressure Ulcer Risk Score, Nutritional Risk Screening 2002 (NRS-2002) score, Barthel Index (BI), and Morse Fall Scale (MFS) score;Neurological assessments: results of the Kubota water-swallowing test and limb muscle strength evaluation.Data were obtained from the Haitai electronic medical record system and the inpatient nursing information system. Two trained researchers independently entered the data in duplicate and performed cross-checking to ensure accuracy and completeness.

2.5 Statistical Analysis

Data were analyzed using SPSS version 24.0. Quantitative variables with a normal distribution were expressed as mean ± standard deviation and compared between groups using the independent-samples t test. Quantitative variables with a non-normal distribution were expressed as median and percentiles, and between-group comparisons were performed using the Mann–Whitney U test. Categorical variables were described as frequencies and percentages, and compared using the chi-square test or Fisher's exact test.Univariate analysis and collinearity diagnostics were conducted in SPSS 24.0. A variance inflation factor (VIF) ≥10 was considered to indicate severe multicollinearity among independent variables. Variables with $P < 0.1$ in univariate analysis were included in the multivariate logistic regression model. A P value < 0.05 was regarded as statistically significant.

3 RESULTS

3.1 General Characteristics of the Study Population

A total of 291 patients were included in this study, among whom 119 (40.9%) developed feeding intolerance (FI). Patients were divided into an FI group (n = 119) and a non-FI group (n = 172) based on the occurrence of FI. The general characteristics of the two groups are presented in Table 1.

3.2 Univariate Analysis of Factors Associated With Feeding Intolerance in Neurocritical Patients

Univariate analyses were conducted to compare demographic characteristics, admission assessment indicators, and neurological evaluation variables between patients who developed FI and those who did not. Significant differences were observed between the two groups in age, history of diabetes, history of stroke, GCS score, and NRS-2002 score ($P < 0.05$). Detailed results are shown in Table 1.

Table 1 Univariate Analysis of Factors Associated With Feeding Intolerance in Neurocritical Patients

Variable	Category	FI group (n = 119)	Non-FI group (n = 172)	Statistic	*P*
Sex, n (%)	Male	72 (24.7)	93 (32.0)	1.186[1]	0.276
	Female	47 (16.2)	79 (27.1)		
Age, n (%)	<65 years	22 (7.6)	57 (19.6)	7.635[1]	0.006
	≥65 years	97 (33.3)	115 (39.5)		
BMI, n (%)	Underweight	18 (6.2)	15 (5.1)	4.945[1]	0.084
	Normal	81 (27.8)	123 (42.3)		
	Overweight	20 (6.9)	34 (11.7)		

Temperature, °C, M (P25, P75)	—	36.8 (36.5, 37.3)	36.9(36.6, 37.3)	−0.496[2]	0.620
Admission diagnosis, n (%)	Cerebral infarction	103 (35.4)	148 (50.8)	1.077[1]	0.584
	Cerebral hemorrhage	10 (3.4)	11 (3.8)		
	Others	6 (2.1)	13 (4.5)		
Smoking history, n (%)	Yes	17 (5.8)	32 (11.0)	0.973[1]	0.333
	No	102 (35.1)	140 (48.1)		
Alcohol history, n (%)	Yes	12 (4.1)	19 (6.5)	0.068[1]	0.794
	No	107 (36.8)	153 (52.6)		
Hypertension, n (%)	Yes	92 (31.6)	124 (42.6)	1.001[1]	0.317
	No	27 (9.3)	48 (16.5)		
Diabetes, n (%)	Yes	46 (15.8)	38 (13.0)	9.397[1]	0.002
	No	73 (25.1)	134 (46.1)		
Heart disease, n (%)	Yes	40 (13.8)	44 (15.1)	2.210[1]	0.137
	No	79 (27.1)	128 (44.0)		
History of stroke, n (%)	Yes	34 (11.7)	27 (9.3)	7.036[1]	0.008
	No	85 (29.2)	145 (49.8)		
Kubota water-swallowing test, n (%)	<grade 3	15 (5.2)	33 (11.3)	2.525[1]	0.112
	≥grade 3	106 (36.4)	137 (47.1)		
Muscle strength, n (%)	<grade 3	39 (13.4)	45 (15.5)	1.497[1]	0.221
	≥grade 3	80 (27.5)	127 (43.6)		
GCS score, M (P25, P75)	—	11 (9, 12)	12 (11, 14)	−5.509[2]	<0.001
Braden score, M (P25, P75)	—	12 (11, 14)	13 (11, 15)	−0.668[2]	0.504
NRS-2002 score, M (P25, P75)	—	3 (2, 4)	3 (2, 3)	−5.188[2]	<0.001
BI score, M (P25, P75)	—	0 (0, 20)	0 (0, 30)	−1.295[2]	0.195
MFS score, M (P25, P75)	—	50 (35, 50)	50 (35, 55)	−0.194[2]	0.881

NOTE:[1] Chi-square statistic,[2] Z statistic

3.3 Logistic Regression Analysis of Factors Associated With Feeding Intolerance in Neurocritical Patients

The five variables with $P < 0.05$ identified in the univariate analysis were examined for multicollinearity, and no significant multicollinearity was detected. Variables that showed statistically significant differences in the univariate analysis were then entered into a multivariate logistic regression model, with variable coding presented in Table 2. The results indicated that history of diabetes, history of stroke, Glasgow Coma Scale (GCS) score, and Nutritional Risk Screening 2002 (NRS-2002) score were independent predictors of feeding intolerance (FI) in neurocritical patients (Table 3).

Table 2 Variable Coding for Logistic Regression Analysis

Variable	Coding Method
Age	<65 years = 0; ≥65 years = 1
History of diabetes	No = 0; Yes = 1
History of stroke	No = 0; Yes = 1
GCS score	Entered as a continuous variable
NRS-2002 score	Entered as a continuous variable

Table 3 Logistic Regression Analysis of Factors Associated With Feeding Intolerance in Neurocritical Patients

Variable	β	SE	Wald χ^2	P value	OR	95% CI
Age	0.163	0.341	0.230	0.632	1.177	0.604–2.296
History of diabetes	0.988	0.297	11.057	0.001	2.687	1.501–4.812
History of stroke	0.855	0.326	6.862	0.009	2.352	1.240–4.459
GCS score	−0.288	0.065	19.952	<0.001	0.750	0.661–0.851
NRS-2002 score	0.383	0.129	8.876	0.003	1.467	1.140–1.888

4 CONCLUSION AND DISCUSSION

4.1 Current Status of Feeding Intolerance in Neurocritical Patients Receiving Enteral Nutrition

Neurocritical patients have a high incidence of feeding intolerance (FI) due to multiple influencing factors, including autonomic dysfunction, impairment of the gastrointestinal mucosal barrier, and medication effects. In this study, the incidence of FI was 40.9%, which is consistent with the 30%–50% incidence reported in relevant guidelines[6], indicating that FI poses a substantial clinical risk in this population. In addition, we found that the peak occurrence of FI was within 1–3 days after the initiation of enteral nutrition, whereas the incidence markedly decreased during days 4–7. This pattern is consistent with the finding of Li[7]. During the early phase of enteral nutrition, patients are often in an acute stress state accompanied by gut microbiota imbalance and gastrointestinal dysfunction, which may be key mechanisms underlying the high early incidence of FI[8]. Therefore, clinical staff should strengthen monitoring and intervention during the early stage of enteral nutrition, identify high-risk patients promptly, and ensure the safe and effective implementation of nutritional support.

4.2 Analysis of Factors Influencing Feeding Intolerance in Neurocritical Patients

4.2.1 History of diabetes

This study found that patients with a history of diabetes were more likely to develop FI, consistent with the findings of Bu[9]. Previous studies[10] have shown that hyperglycemia enhances antral contractility while disrupting the coordination of gastric–duodenal contractions, resulting in delayed gastric emptying. Elevated blood glucose also reduces smooth muscle tone in the stomach, further impairing gastrointestinal motility and increasing the risk of gastric retention. Moreover, diabetes is often accompanied by autonomic neuropathy, which may lead to gastroparesis, diarrhea, and fecal incontinence, further increasing the likelihood of FI. Therefore, in patients with diabetes, clinicians should closely monitor blood glucose levels during enteral nutrition and implement timely interventions to maintain glycemic stability, thereby reducing the risk of FI and enhancing feeding safety.

4.2.2 History of stroke

Our findings indicate that patients with a history of stroke are more susceptible to FI, which is consistent with the results reported by Hu [11]. Several mechanisms may underlie this association. Post-stroke dysphagia, impaired consciousness, prolonged immobilization, and reduced gastrointestinal motility can collectively lead to delayed gastric emptying and diminished feeding tolerance. In addition, stroke-related disruptions in brain–gut axis regulation, along with the frequent use of sedatives and opioids, may further exacerbate gastrointestinal dysfunction and increase the likelihood of FI. Therefore, comprehensive gastrointestinal assessment and early, individualized feeding strategies are particularly crucial for this population. Nonetheless, the precise mechanisms linking stroke to FI warrant further investigation.

4.2.3 Glasgow Coma Scale (GCS) score

This study identified lower GCS scores as a risk factor for FI. The GCS is a key tool for evaluating a patient's level of consciousness and the severity of neurological impairment, with lower scores indicating more critical illness. Previous studies[12] have shown that when the GCS score is <8, patients are more likely to experience intestinal barrier dysfunction and bacterial translocation, which can lead to impaired gastrointestinal motility and substantially increase the risk of FI. Therefore, during the administration of enteral nutrition, clinicians should closely monitor patients with low GCS scores, promptly adjust feeding methods and infusion rates, and implement preventive strategies to reduce the incidence of FI and improve feeding tolerance.

4.2.4 NRS-2002 score

In this study, a higher NRS-2002 score was identified as a predictive factor for FI. The NRS-2002 incorporates age, disease severity, and nutritional status, and is widely used for screening malnutrition risk[13]. Neurocritical patients are often in a hypermetabolic state during the early stage of illness and commonly present with impaired consciousness and dysphagia upon admission, predisposing them to malnutrition[14]. Inadequate nutritional intake weakens various organ systems, including gastrointestinal digestive and absorptive functions, thereby increasing the risk of FI. Hence, strengthening nutritional assessment and implementing targeted interventions for high-risk patients with elevated NRS-2002 scores are essential measures to reduce the incidence of FI.

5 CONCLUSION

In summary, a history of diabetes or stroke, lower GCS scores, and higher NRS-2002 scores were identified as major factors associated with FI in neurocritical patients. These findings may assist clinicians in the early identification of high-risk individuals and in formulating individualized nutritional management strategies. As a single-center retrospective study based on admission data with only internal validation, the present study has certain limitations. The generalizability of the findings requires further confirmation through multicenter studies with larger sample sizes.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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