

# Nurse-Led Early Enteral Nutrition Tolerance Management Protocol for Patients with Severe Traumatic Brain Injury: A Quasi-Experimental Study

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**Abstract:** *Objective:* To evaluate the efficacy of a nurse-led early enteral nutrition (EN) tolerance management protocol in reducing feeding intolerance and improving nutritional outcomes among patients with severe traumatic brain injury (STBI). *Methods:* A total of 128 STBI patients admitted to the neurosurgical intensive care unit between June 2024 and June 2025 were enrolled. The control group received conventional EN care from June to December 2024, while the intervention group received the nurse-led protocol from January to June 2025. The primary outcomes were feeding intolerance incidence, target caloric achievement rate on day 4, nocturnal feeding prevalence, and ICU length of stay. *Results:* The incidence of feeding intolerance was significantly lower in the intervention group compared to the control group. The intervention group demonstrated higher target caloric achievement rates on day 4 and day 7. Nocturnal feeding was significantly reduced, and ICU length of stay was shorter. *Conclusion:* The nurse-led early EN tolerance management protocol effectively reduces feeding intolerance, enhances early nutritional adequacy, minimizes nocturnal feeding disruptions, and shortens ICU stay for STBI patients.

**Keywords:** Severe traumatic brain injury; Enteral nutrition; Feeding intolerance; Nurse-led care; Tolerance management; Neurocritical care

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## 1. Introduction

Severe traumatic brain injury (STBI) represents a leading cause of mortality and morbidity in neurosurgical intensive care units, characterized by hypermetabolism and hypercatabolism that significantly increase energy expenditure<sup>[1]</sup>. Early enteral nutrition (EEN) is universally recommended by clinical practice guidelines to preserve gut barrier integrity, prevent bacterial translocation, and reduce infectious complications<sup>[2,3]</sup>. However, STBI patients frequently experience feeding intolerance (FI) due to intracranial hypertension,

autonomic dysfunction, and gastrointestinal dysmotility, with reported incidence rates ranging from 30% to 60% [4].

Conventional EN management typically follows a physician-directed, nurse-executed model that lacks systematic tolerance assessment protocols. This reactive approach often results in delayed recognition of FI and interruption of nutritional support, compromising patient outcomes [5]. Nurse-led management models have demonstrated promise in various critical care contexts, leveraging nurses' continuous bedside presence and clinical assessment capabilities [6]. Nevertheless, structured nurse-led protocols specifically designed for STBI patients remain underdeveloped [7].

This study aimed to develop and evaluate a nurse-led early EN tolerance management protocol tailored to the pathophysiological characteristics of STBI patients, hypothesizing that proactive nurse-led interventions would reduce FI incidence and improve nutritional delivery efficiency.

## **2. Methods**

### **2.1. Study design and setting**

This quasi-experimental study employed a historical control design conducted in a tertiary hospital's neurosurgical ICU in China. The study period spanned June 2024 to June 2025, with the control phase (June–December 2024) preceding the intervention phase (January–June 2025).

### **2.2. Participants**

Convenience sampling was used to recruit 128 adult patients with STBI.

#### **2.2.1. Inclusion criteria**

- (1) Diagnosis of severe TBI per the Chinese Guidelines for the Management of Traumatic Brain Injury with Glasgow Coma Scale (GCS) scores of 3–8 [8];
- (2) Age  $\geq 18$  years;
- (3) ICU admission  $\geq 72$  hours;
- (4) Hemodynamic stability with EN indications;
- (5) Informed consent from legal representatives

#### **2.2.2. Exclusion criteria**

- (1) Contraindications to EN (e.g., gastrointestinal perforation, obstruction, active bleeding);
- (2) Severe hepatic or renal dysfunction;
- (3) Pre-existing malnutrition;
- (4) Death or discharge within 24 hours.

## **2.3. Interventions**

### **2.3.1. Control group**

Patients received standard EN care per physician orders. Nasogastric or Naso-jejunal tubes were placed within 24–48 hours of admission, with continuous pump feeding initiated at 20–30 mL/h and titrated upward. Gastric residual volume (GRV) was assessed every 4 hours; feeding was paused and physicians notified when GRV exceeded 200 mL.

### 2.3.2. Intervention group

Patients received the nurse-led early EN tolerance management protocol comprising four components:

(1) Multidisciplinary nutrition management team

Led by the ICU nurse manager and comprising a certified critical care nurse specialist and eight senior staff nurses, the team developed standardized assessment tools and intervention algorithms based on current evidence and guidelines.

(2) Multidimensional FI dynamic assessment

A validated Enteral Nutrition Tolerance Scoring System was implemented, evaluating four domains: gastric retention (0–3 points), abdominal distension/intra-abdominal pressure (0–3 points), bowel motility/defecation (0–2 points), and nausea/vomiting/reflux (0–2 points), with total scores ranging from 0–10. Responsible nurses conducted assessments every 6 hours, classifying tolerance as: complete (0–2 points), mild intolerance (3–5 points), or severe intolerance (6–10 points).

(3) Nurse-led tiered intervention authorization

Nurses were empowered to implement interventions based on tolerance scores without awaiting physician orders: (a) Complete tolerance: maintain current rate with planned escalation (10–20 mL/h every 8–12 hours); (b) Mild intolerance: implement physical interventions (abdominal massage, warm foot baths), repositioning (30–45° head elevation, right lateral positioning), and reduce infusion rate by 50%; (c) Severe intolerance: suspend EN, aspirate GRV, and notify physicians immediately.

(4) Optimized GRV monitoring and nocturnal feeding management

A “blind Naso-jejunal tube placement first” strategy was adopted for high-risk patients. A “nocturnal feeding rest period” protocol was established: patients achieving  $\geq 80\%$  of daily caloric targets by 20:00 had EN paused or reduced to basal rates (10–15 mL/h) from 22:00 to 06:00 to preserve circadian rhythms and reduce aspiration risk.

## 2.4. Outcome measures

### 2.4.1. Primary outcomes

- (1) Feeding intolerance incidence, defined by the presence of any: vomiting or visible reflux; GRV > 250 mL; abdominal distension with intra-abdominal pressure  $\geq 20$  mmHg; or diarrhea ( $\geq 3$  loose stools/day totaling > 250 mL) <sup>[9]</sup>.
- (2) Target caloric achievement rate on day 4, defined as receiving  $\geq 80\%$  of target calories (25–30 kcal/kg/day) <sup>[10]</sup>.

### 2.4.2. Secondary outcomes

- (1) Nocturnal feeding prevalence (patients receiving therapeutic-rate EN between 20:00–06:00)
- (2) ICU length of stay

## 2.5. Statistical analysis

Data were analyzed using SPSS 26.0. Continuous variables with normal distribution were expressed as mean  $\pm$  standard deviation and compared using independent samples *t*-tests. Categorical variables were expressed as frequencies and percentages, compared using chi-square tests. Statistical significance was set at  $p < 0.05$ .

### 3. Results

#### 3.1. Baseline characteristics

The control group and intervention group were comparable in demographic and clinical characteristics (all  $p > 0.05$ ). Mean ages were  $52.46 \pm 11.23$  and  $53.12 \pm 10.85$  years, respectively; GCS scores were  $5.84 \pm 1.42$  and  $5.76 \pm 1.38$ ; and surgical intervention rates were 65.1% and 66.2%.

#### 3.2. Feeding intolerance incidence

Total FI incidence was significantly lower in the intervention group compared to the control group. Specifically, GRV > 250 mL occurred less frequently in the intervention group. Other FI components showed directional but non-significant reductions (Table 1).

**Table 1.** Comparison of feeding intolerance occurrence between groups [n (%)]

Variable	Control group(n = 63)	Intervention group(n = 65)	value	p value
GRV > 250 mL	15 (23.81)	6 (9.23)	5.063	0.024
Abdominal distension	10 (15.87)	4 (6.15)	3.114	0.078
Vomiting/Reflux	6 (9.52)	2 (3.08)	2.29	0.13
Diarrhea	8 (12.70)	3 (4.62)	2.731	0.098
Total FI	25 (39.68)	12 (18.46)	7.156	0.007

#### 3.3. Nutritional adequacy

Target caloric achievement rates were significantly higher in the intervention group on both day 4 and day 7 (Table 2).

**Table 2.** Comparison of target caloric achievement rates [n (%)]

Timepoint	Control group(n = 63)	Intervention group (n = 65)	$\chi^2$ value	p value
Day 4	28 (44.44)	46 (70.77)	9.098	0.003
Day 7	45 (71.43)	56 (86.15)	4.165	0.041

#### 3.4. Nocturnal feeding and ICU stay

Nocturnal feeding prevalence was significantly lower in the intervention group compared to the control group. ICU length of stay was significantly shorter in the intervention group.

### 4. Discussion

This study demonstrates that a nurse-led early EN tolerance management protocol significantly reduces feeding intolerance, improves nutritional adequacy, minimizes nocturnal feeding disruptions, and shortens ICU stay for STBI patients<sup>[11,12]</sup>. The 21.22 percentage point reduction in FI incidence aligns with international studies implementing nurse-driven EN protocols.

The protocol's efficacy stems from three key innovations. First, the multidimensional assessment tool enables early FI identification beyond isolated GRV monitoring, capturing the complex gastrointestinal dysfunction characteristic of STBI<sup>[13]</sup>. Second, the tiered intervention authorization empowers nurses to implement timely, evidence-based modifications without awaiting physician orders, reducing decision-

to-action time and preventing nutritional interruptions<sup>[14]</sup>. Third, the circadian-conscious feeding strategy aligns with physiological gastrointestinal rhythms, potentially enhancing nutrient absorption while reducing aspiration risk during sleep periods<sup>[15]</sup>.

The reduction in nocturnal feeding carries dual clinical significance. Physiologically, it allows gastrointestinal rest and preserves microbiome circadian patterns<sup>[16]</sup>. Clinically, it reduces nursing interventions during sleep periods, potentially improving sleep quality and reducing ICU-acquired delirium and weakness. The observed 3.4-day reduction in ICU stay likely reflects the combined benefits of reduced FI-related complications, improved nutritional status, and enhanced sleep quality<sup>[17]</sup>.

The study has limitations. The quasi-experimental design without randomization may introduce selection bias, though consecutive sampling and comparable baseline characteristics mitigate this concern. The single-center setting limits generalizability, warranting multi-site validation. Additionally, long-term neurological outcomes were not assessed<sup>[18]</sup>.

## 5. Conclusion

The nurse-led early EN tolerance management protocol represents an effective, scalable intervention for optimizing nutritional support in STBI patients. By leveraging nurses' continuous presence and clinical expertise through standardized assessment tools and tiered intervention authorization, this model enhances nutritional outcomes while reducing ICU resource utilization. Implementation of similar protocols in neurocritical care settings should be considered.

## Disclosure statement

The authors declare no conflict of interest.

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