ORIGINAL RESEARCH

# Evaluation of the Construction and Application of Standardised Process Nursing Programme in the Management of Enteral Nutrition in Critically Ill Patients

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## ABSTRACT

**Objective** • To observe the effect of implementing standardized flow management in enteral nutrition therapy for critically ill patients.

**Methods** • We selected 241 critically ill patients admitted to our hospital from January 2020 to January 2023. Patients with enteral nutrition without standard process management were set as the control group (n = 109), while those with enteral nutrition and standard process management were set as the observation group (n = 132). The total protein, albumin, prealbumin, and hemoglobin were compared between the two groups on the 7th and 14th day of nutritional therapy. Immune indicators (IgM, IgA, and IgG), NUTRIC score, and the incidence of infectious complications were compared between the two groups.

**Results** • On the 7th and 14th day of treatment, the total protein, albumin, prealbumin, hemoglobin, and immune indicators in the observation group were higher than those in the control group, and the differences were statistically significant ($P < .05$). On the 7th and 14th day of treatment, the NUTRIC score of the observation group was higher than that in the control group, with a statistically significant difference ($P < .05$). The incidence of infectious complications in the observation group was lower than that in the control group, and the difference was statistically significant ($P < .05$).

**Conclusion** • Implementing standardized process management of EN for critically ill patients improves total protein, albumin, prealbumin, hemoglobin, immune indexes, NUTRIC score, and nutritional status, while reducing the incidence of infectious complications. These findings offer valuable insights for clinical practice and advocate for practical application. (*Altern Ther Health Med.* 2024;30(10):225-231).

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## INTRODUCTION

Nutritional support is the cornerstone of treatment for critically ill patients. In recent years, although the importance of clinical nutrition has been gradually recognized, the current status of enteral nutrition (EN) implementation in critically ill patients remains unsatisfactory due to differences in medical standards and understanding of EN in various regions, thus affecting the clinical outcomes of patients.[1-3]

EN is a clinical support method that provides various nutrients by oral or tube feeding through the gastrointestinal tract,[4,5] and tube-fed enteral nutrition is considered to be a standard therapeutic method. EN can not only provide nutritional support for patients but also regulate the immune function to reduce the severity of disease complications, shorten the hospital stay, and improve the prognosis of patients. Compared to parenteral nutrition, enteral nutrition has obvious advantages in the prevention of infection and metabolic complications, maintenance of the gastrointestinal mucosal barrier, intestinal flora balance, water-electrolyte balance, and so on.[6,7] However, the incidence of nutritional intolerance in the early stage of enteral nutrition in critically ill patients is 30.5%-65.7%, which is one of the important reasons for the prolongation of hospital stay and the increase in mortality rate. Critically ill patients are susceptible to gastrointestinal ischemia and hypoxia due to hemodynamic abnormality, and all kinds of stress factors will affect the gastrointestinal tract function, resulting in nutritional intolerance, which will lead to complications such as inhalation pneumonia, electrolyte, and acid-base balance disorders. Critically ill patients cannot eat, intestinal peristalsis is weakened, nutritional status is poor, and resistance is low.[8,9] Enteral nutrition (EN) offers several advantages, including simplicity, the promotion of intestinal function, the release of gastrointestinal hormones to improve

portal circulation, and the prevention of intestinal mucosal atrophy and bacterial translocation. Additionally, it provides the benefit of oral feeding.[10,11] Studies have shown that nutritional support for critically ill patients plays an important role in reducing morbidity and mortality, reducing complications, and promoting rehabilitation. Therefore, supplementation of nutrients for critically ill patients should be preferred to enteral nutrition. In the process of implementing enteral nutrition for critically ill patients in the Department of Intensive Care Medicine (ICU) of our hospital, it was found through the quality inspection of the department, the head nurse's checkup, and the nurse's handover that there were potential nursing risks in many aspects of the implementation of enteral nutrition for critically ill patients such as a long time for the configuration of nutrient solution, the nutrient tubes were dislodged or clogged, and the nutrient solution temperature and speed did not meet the requirements, nutrient tubes are not clearly labeled, the implementation of the checking system is not strict, and the operation of instruments is not skilled. In clinical practice, the above potential nursing risks lead to or accelerate the occurrence of enteral nutrition complications in critically ill patients, and complications become an important factor affecting the prognosis of patients, and even exacerbate the condition of the patients. From January 2020 to January 2023, our department implemented a standardized nursing process for the enteral nutritional support of critically ill patients to effectively prevent the occurrence of complications and it has achieved satisfactory results.

## MATERIALS AND METHODS

### General information

This study used a convenience sampling method to select critically ill patients who were hospitalized in our comprehensive ICU, emergency ICU, and neurosurgery ICU from January 2020 to January 2023, and a total of 241 patients were enrolled, of which 136 were male and 66 were female. There were 46 cases of cardiovascular diseases including multiple injuries, 68 cases of acute respiratory diseases, 41 cases of neurological diseases, and 87 cases of other causes. The patients enrolled were randomly divided into an observation group and a control group. Randomization of patients is usually accomplished by random number generation, computer software, or other random assignment methods. Specifically, patients could be randomly assigned with the use of random-number tables or with the use of specialized randomization software.

Ensuring the transparency and fairness of the randomization process is critical to reducing bias and improving the internal validity of the study.

### Methods

**Basic treatment.** Both groups of patients were given conventional treatment: (1) follow the doctor's instructions to select an enteral nutrition solution; (2) standardize the implementation of enteral nutrition nursing operations: 1) check the exposed length and location of the nasogastric tube before nasal feeding, pumping back for gastric piggyback or bleeding, etc.; 2) check the smoothness of the nasogastric tube; 3) follow the doctor's instructions for the infusion of nutritional solution in segments or the use of the nutritional pump for pumping; (3) to maintain the smoothness of the nasogastric tube: 1) fix the nasogastric tube appropriately, to avoid folding, drawing, or pressure; 2) change the nutritional infusion pump tube daily; 3) prevent unplanned extraction from occurring, to ensure the effectiveness of fixing the tube placement of the nasal tube.

**Control group.** The patients in the control group adopted the conventional nursing process, without the implementation of a standardized EN management process, after admission to the ICU 48 h hemodynamic stabilization, the nurse complies with the dietary instructions of the physician in charge to notify the family to send their diets, with the filling of the empty needle through the gastric tube intermittent push feeding, within 7 d to increase the target amount of calories and protein to the each patient, and the entire management process was conducted independently by the attending physician and the nursing staff..

**Observation group.** Implement the standardized nursing process, the specific contents are as follows.

(1) Set up a safety nursing project team: According to the hospital safety management committee and nursing quality, organize the enteral nutrition safety nursing team, set the director of the nursing department as the team leader, and the nurses of all specialties and the head nurse of the ICU as the team members, and formulate a scientific standardized nursing process according to the risk factors of critically ill patients in various departments involved in the implementation of enteral nutrition nursing.

(2) The NUTRIC scoring standard is applied to nutritional risk screening within 24 h after admission to the department, and the assessment includes nutritional status assessment, assessment of the risk of aspiration, gastrointestinal function grading, and the timing of initiating nutritional therapy based on the grading, and assessment of metabolic status of critically ill patients. (1) Nutritional status assessment: for NUTRIC >5 points, the nutritional status of the patient is assessed according to the patient's intake, pathological state of the disease, biochemical indexes, physical examination, organ function, and so on. (2) Assessment of aspiration risk: Using the aspiration risk assessment table, patients with moderate risk of aspiration and above should be given post-pyloric feeding, while patients with mild risk of aspiration should be given nasogastric tube feeding for the time being, and post-pyloric feeding should be given after the risk is upgraded. (3) Evaluate the patient's gastrointestinal function grading and the timing of initiating nutritional therapy based on the grading: NUTRIC score >5 points, start early enteral nutrition (EEN), initial nutrient infusion rate 25 mL/h, using standard whole protein formula; moderate or severe impairment of gastrointestinal function (AGIII~I), and NUTRIC score >5

points, also start EEN, initial nutrient infusion rate 10~15 mL/h, using short skin type formula; moderate or severe impairment of gastrointestinal function (AGIIV), and NUTRIC score >5 points, do not start EEN but start parenteral nutrition (PN), short skin type formulation was used; whereas, if the nutritional risk was low (NUTRIC score <5), EEN was not initiated but PN was initiated after 7~10 d.

(3) Monitoring and treatment: The nutritional physician, physician in charge, and the nurse participated in the collaborative dynamic monitoring of nutritional therapy implementation following assessment of the patient's gastrointestinal tolerance. The nutritional plan was adjusted based on the patient's gastrointestinal tolerance, adjusted the rate of infusion of EN fluid, concentration, total volume, and gastrointestinal intolerance of the corresponding treatment. Repeat the assessment, implementation, monitoring, and treatment of the closed loop, to reduce the unnecessary interruption of the EN.

(4) The specific implementation plan is as follows: Patients are prone to complications such as diarrhea, vomiting, or nausea in nutritional support, which is mainly due to the pollution of nutritional solution configuration, very high infusion speed, or too high concentration of the nutritional solution. Therefore, in clinical care nursing staff should ensure that enteral nutritional solution is ready to be used now, and in the process of configuration of enteral nutritional preparations, it should be ensured that they are operated in an aseptic environment. When nasal feeding, the temperature of the nutritional solution is maintained at about 41°C, the infusion speed should be slowed down, the concentration should be reduced when starting nasal feeding, and the infusion tube and related instruments should be replaced every day. Additionally, in clinical care some patients appear irritable while others may have bad emotions, there are incidents of unauthorized pulling out of the tube, or turning over when the catheter inadvertently falls off, or detachment of the catheter. In such cases, nursing staff should promptly fix the catheter and should check the position of the catheter before changing the liquid. It should be ensured that the configuration of the nutrient solution is uniform and there is no tube blockage due to factors such as too thin tube diameter and too high concentration of nutrient solution, nursing staff should choose special nasal feeding tubes with less irritation, soft texture, and suitable diameter, and the tubes should be rinsed before and after dripping. This study has received approval from the Ethics Committee of the Third Hospital of Shanxi Medical University. Signed written informed consent was obtained from the patients and/or guardians.

**Observation indicators.** Improve serum nutritional indexes before nutritional support treatment: total protein, albumin, prealbumin, hemoglobin; immune indexes: IgM, IgA, IgG; nutritional screening table: NUTRIC score (without IL-6 index). After 7 d of treatment, serum nutritional, and immunological indicators were reviewed; after 14 d of treatment, serum nutritional and immunological indicators, anthropometric indicators, and NUTRIC score were reviewed; and, complications such as diarrhea and constipation, gastric retention, upper gastrointestinal bleeding, and aspiration pneumonia were recorded.

**Table 1.** Baseline Information of Patients in Two Groups

| Group | Control group | Observation group | *P* value |
|---|---|---|---|
| Cases | 109 | 132 | |
| Sex | | | |
| Male, n(%) | 63(57.8) | 73(55.3) | .497 |
| Female, n(%) | 46(45.0) | 59(44.7) | |
| Age, n(%) | 59.0 ± 13.2 | 62.1 ± 15.6 | .101 |
| Apache II Score, mean (SD) | 18.1 ± 7.1 | 19.2 ± 7.5 | .247 |
| Nutric≥5, n(%) | 89(81.7) | 117(88.6) | .126 |
| Weight, mean (SD) | 59.6 ± 9.7 | 61.2 ± 11.2 | .242 |
| Height, mean (SD) | 161.2 ± 11.2 | 163.7 ± 21.2 | .268 |
| BMI/(kg/m$^2$), mean (SD) | 23.1 ± 2.9 | 23.6 ± 3.1 | .20 |
| Admission diagnosis, n(%) | | | .945 |
| Cardiovascular/vascular, n(%) | 21(19.2) | 25(18.9) | |
| Respiratory, n(%) | 31(28.4) | 37(28.0) | |
| Central nervous system, n(%) | 17(15.6) | 24(18.2) | |
| Other, n(%) | 41(37.6) | 46(34.8) | |
| Mechanical ventilation, n(%) | 87(79.8) | 99(75.0) | .375 |
| Vasopressor agents, n(%) | 57(52.3) | 63(47.7) | 1.0 |
| New abdominal surgery, n(%) | 6(5.5) | 11(8.3) | .393 |

The NUTRIC score (without IL-6 index) contains indicators such as age factor,[12] acute physiology and chronic health evaluation-II (APACHE-II) score,[13] concomitant diseases, and length of hospital stay before admission to the ICU. The NUTRIC score of 0-5 suggests a low risk of malnutrition while 6-10 suggests a high nutritional risk and is associated with poor prognosis.

### Statistical methods

The data were analyzed and processed using statistical software SPSS 26.0, and the results are presented as mean ± standard deviation. A *t* test was employed to compare the means between the two groups.; the counting information was expressed as rate (%), and the $\chi^2$ test was used between the two groups, and the difference was indicated to be of statistical significance when $P < .05$.

## RESULTS

### Baseline information of patients in two groups

There was no significant difference in baseline information between the two groups. The majority of patients (89 out of 109 patients) control group (81.7%) and 117 out of 230 patients in the intervention group (88.6%) were at high risk of malnutrition. Patients in both the observation and control groups had a Glasgow Coma Scale (GCS) score of ≤12 or a drinking water swallowing test of ≥3. There was no statistically significant difference in gender, age, GCS score, and water drinking test between the two groups ($P > 0.05$). Table 1 shows the demographic and clinical characteristics of the included patients.

### Comparison of total protein and albumin between the two groups of patients

The total protein and albumin levels of both groups increased at day 14 of treatment compared to the pre-treatment and day 7 levels. However, a decrease in total protein and albumin was observed at day 7 of treatment

**Table 2.** Comparison of Total Protein and Albumin Between the Two Groups of Patients (g/L, ± s)

| Treatment time | Total protein | | Albumin | |
|---|---|---|---|---|
| | Control group | Observation group | Control group | Observation group |
| Before treatment | 59.21 ± 5.13 | 58.97 ± 5.73 | 34.77 ± 4.09 | 33.74 ± 4.53 |
| Treatment for 7 days | 57.01 ± 3.97[a] | 57.36 ± 5.31[c] | 32.71 ± 3.52[a] | 31.35 ± 4.34[a] |
| Treatment for 14 days | 60.12 ± 3.69[b] | 63.64 + 4.07[a,b,c] | 35.43 ± 2.26[b] | 36.44 ± 2.68[a,b,c] |

[a]$P < .05$ compared with this group before treatment
[b]$P < .05$ compared with this group for 7 d
[c]$P < .05$ compared with the control group for the same treatment time.

**Figure 1.** Comparison of Total Protein and Albumin Levels Between the Two Groups of Patients

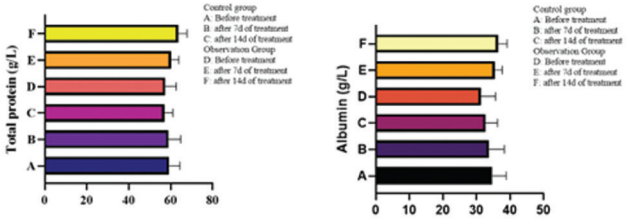
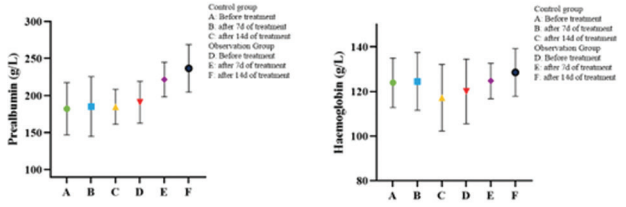



**Table 3.** Comparison of Prealbumin and Hemoglobin Between the Two Groups (g/L, ± s)

| Treatment time | Prealbumin | | Hemoglobin | |
|---|---|---|---|---|
| | Control group | Observation group | Control group | Observation group |
| Before treatment | 182.18 ± 35.21 | 185.07 ± 40.26 | 123.93 ± 11.03 | 124.47 ± 12.97 |
| Treatment for 7 days | 184.83 ± 23.76 | 191.03 ± 28.42[a] | 117.20 ± 14.92[a] | 120.03 ± 14.49[a] |
| Treatment for 14 days | 221.69 ± 23.41[a,b] | 236.77 ± 32.06[a,b,c] | 124.80 ± 7.98[b] | 128.53 ± 10.71[a,b,c] |

[a]$P < .05$ compared with this group before treatment
[b]$P < .05$ compared with this group for 7 d
[c]$P < .05$ compared with the control group for the same treatment time.

**Figure 2.** Comparison of Prealbumin and Hemoglobin Levels Between the Two Groups




compared to the pre-treatment and day 14 levels. Before treatment initiation, the control group exhibited a total protein level of 59.21 ± 5.13 g/L and an albumin level of 34.77 ± 4.09 g/L, while the observation group showed slightly lower levels with total protein at 58.97 ± 5.73 g/L and albumin at 33.74 ± 4.53 g/L.

Following 7 days of treatment, the control group experienced a significant decrease in total protein to 57.01 ± 3.97 g/L ($P$ <0.05), and albumin decreased to 32.71 ± 3.52 g/L ($P$ <0.05). In the observation group, total protein decreased to 57.36 ± 5.31 g/L ($P < .05$) and albumin decreased to 31.35 ± 4.34 g/L ($P < .05$).

Extended treatment to 14 days revealed noteworthy changes. The control group demonstrated a significant increase in total protein to 60.12 ± 3.69 g/L ($P < .05$), and albumin increased to 35.43 ± 2.26 g/L ($P < .05$). In the observation group, total protein increased significantly to 63.64±4.07 g/L ($P < .05$), and albumin increased significantly to 36.44 ± 2.68 ($P < .05$). Please refer to Table 2 and Figure 1.

### Comparison of prealbumin and hemoglobin

**Before Treatment:** At the initiation of the study, the control group displayed prealbumin and hemoglobin levels of 182.18 ± 35.21 g/L and 123.93 ± 11.03 g/L, respectively. In comparison, the observation group exhibited slightly higher levels of prealbumin at 185.07 ± 40.26 g/L and hemoglobin at 124.47 ± 12.97 g/L.

**Treatment for 7 Days:** After 7 days of treatment, noteworthy alterations were observed. The control group experienced a significant increase in prealbumin to 184.83 ± 23.76 g/L ($P < .05$) and hemoglobin decreased to 117.20 ± 14.92 g/L ($P < .05$). In the observation group, prealbumin increased significantly to 191.03 ± 28.42 g/L ($P < .05$) and hemoglobin decreased to 120.03 ± 14.49 g/L ($P < .05$).

**Treatment for 14 Days**: Upon extending the treatment to 14 days, distinctive patterns emerged. The control group demonstrated a significant increase in prealbumin to 221.69 ± 23.41 g/L ($P < .05$) and hemoglobin increased to 124.80 ± 7.98 g/L ($P < .05$). In the observation group, prealbumin increased significantly to 236.77 ± 32.06 g/L ($P < .05$) and hemoglobin increased to 128.53 ± 10.71 g/L ($P < .05$). Please refer to Table 3 and Figure 2.

### Comparison of immune indexes between the two groups

The levels of IgA, IgM, and IgG in both patient groups on the 14th day of treatment were higher than those observed before treatment and on the 7th day of treatment. Conversely, the levels of IgA, IgM, and IgG on the 7th day of treatment were lower than those recorded before treatment and on the 14th day of treatment (Figure 3). Specifically, in the observation group, IgA and IgG levels on the 14th day (C) were lower than those on the 7th day (B) and before treatment (A). For the control group, IgA levels on the 14th day (F) were lower than those on the 7th day (E) and before treatment (D). There were significant differences in IgA between the control group and the observation group on the 7th and 14th day of treatment and before treatment ($P < .05$), and between the observation group and the control group on the 14th day of treatment ($P < .05$). There were significant differences in IgM between the control group and the observation group on the 7th and 14th day of treatment and before treatment ($P < .05$), and also between the observation group and the control group on the 7th and 14th day of treatment ($P < .05$). There were significant differences in IgG between the control group and the observation group on the 7th and 14th day of treatment and before treatment ($P < .05$), and between the observation group and the control group on the 14th day of treatment ($P < .05$). See Table 4 and Figure 3.

**Table 4.** Comparison of Immune Indexes Between the Two Groups (g/L, ± s)

| Group | Cases | Treatment time | IgA | IgM | IgG |
|---|---|---|---|---|---|
| Observation group | 132 | Before treatment | 1.80 ± 0.37 | 1.28 ± 0.21 | 10.97 ± 1.41 |
| | | Treatment for 7 days | 1.69 ± 0.23[a,c] | 1.14 ± 0.37[ac] | 10.04 ± 1.33[a] |
| | | Treatment for 14 days | 2.05 ± 0.22[a,b,c] | 1.44 ± 0.41[a,b,c] | 12.04 ± 1.36[a,b,c] |
| Control group | 109 | Before treatment | 1.71 ± 0.41 | 1.16 ± 0.31 | 10.88 ± 1.39 |
| | | Treatment for 7 days | 1.62 ± 0.32[a] | 1.04 ± 0.21[a] | 9.78 ± 1.38[a] |
| | | Treatment for 14 days | 1.92 ± 0.30[a,b] | 1.27 ± 0.36[a,b] | 11.43 ± 1.41[a,b] |

[a]$P < .05$ compared with before treatment
[b]$P < .05$ compared with 7 d treatment
[c]$P < .05$ compared with the control group at the same treatment time.

**Figure 3.** Comparison of Immunoglobulin Levels Between the Two Groups

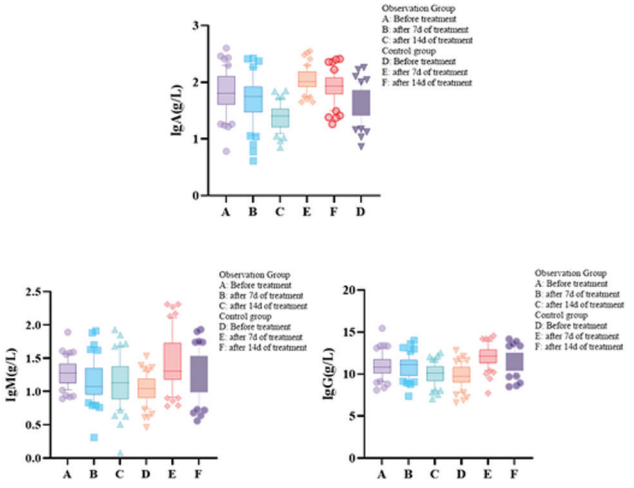



**Table 5.** Comparison of Nutric Nutritional Scores Between the Two Groups (Points, ± s)

| Group | Cases | Before treatment | Treatment for 14 days |
|---|---|---|---|
| Control group | 109 | 6.77 ± 1.10 | 4.47 ± 1.28[a] |
| Observation group | 132 | 6.83 ± 1.05 | 4.06 ± 1.06[a,b] |

[a]Before treatment, $P < .05$
[b]Compared with the control group for the same treatment time, $P < .05$

### Comparison of NUTRIC nutritional scores between the two groups

NUTRIC scores of both groups at 14 days after treatment were lower than those before treatment, and there was a statistical difference between the observation group and the control group at 14 days after treatment ($P < .05$). See Table 5.

### Comparison of complications between the two groups

The incidence of diarrhea and gastric retention in the control group was significantly higher than that in the observation group, with statistical significance ($\chi^2 = 8.48$, $P < .003$). There was no significant difference in constipation, upper gastrointestinal hemorrhage, and aspiration pneumonia ($P > .75$). There was a significant difference in the total incidence of complications between the two groups ($\chi^2 = 4.87$, $P < .05$). See Table 6, Table 7, and Figure 4.

**Table 6.** Comparison of Complications Between the Two Groups (n)

| Group | Cases | Diarrhea | Constipation | Gastric retention | Upper gastrointestinal hemorrhage | Aspiration pneumonia |
|---|---|---|---|---|---|---|
| Control group | 109 | 27 | 15 | 14 | 7 | 5 |
| Observation group | 132 | 14 | 11 | 7 | 10 | 9 |
| $\chi^2$ | | 8.48 | 0.10 | 4.46 | 0.12 | 0.54 |
| *P* value | | .001 | .75 | .03 | .73 | .46 |

**Table 7.** Comparison of Total Complications Between the Two Groups [n, (%)]

| Group | Cases | Complications occur | No complications occurred |
|---|---|---|---|
| Control group | 109 | 35(32.11%) | 74(67.89%) |
| Observation group | 132 | 26(19.7%) | 106(80.30%) |
| $\chi^2$ | | | 4.87 |
| *P* value | | | .03 |

**Figure 4**. Comparison of Complications Between the Two Groups

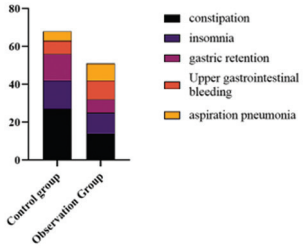
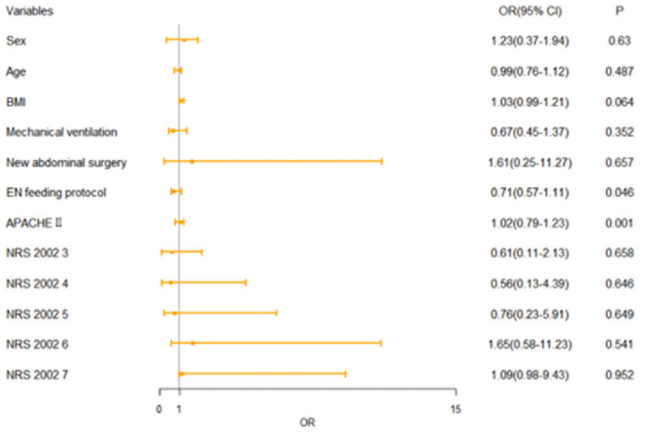



**Table 8.** Multivariate Logistic Regression Modelling of Risk Factors for Physiological Indicators of Prognosis

| Variables | Odds ratio | Lower | Upper | *P* value |
|---|---|---|---|---|
| Sex | 1.23 | 0.37 | 1.94 | .63 |
| Age | 0.99 | 0.76 | 1.12 | .487 |
| BMI | 1.03 | 0.99 | 1.21 | .064 |
| Mechanical ventilation | 0.67 | 0.45 | 1.37 | .352 |
| New abdominal surgery | 1.61 | 0.25 | 11.27 | .657 |
| EN feeding protocol | 0.71 | 0.57 | 1.11 | .046 |
| APACHE II | 1.02 | 0.79 | 1.23 | .001 |
| NRS 2002 3 | 0.61 | 0.11 | 2.13 | .658 |
| NRS 2002 4 | 0.56 | 0.13 | 4.39 | .646 |
| NRS 2002 5 | 0.76 | 0.23 | 5.91 | .649 |
| NRS 2002 6 | 1.65 | 0.58 | 11.23 | .541 |
| NRS 2002 7 | 1.09 | 0.98 | 9.43 | .952 |

**Figure 5.** Multivariate Logistic Regression Modelling of Risk Factors for Physiological Indicators of Prognosis



**Multivariable logistic regression**

To investigate the factors influencing the prognostic physiological indicators, we employed a multivariate logistic regression model. In this model, after adjusting for the baseline characteristics and other prespecified factors, we found that the implementation of EN feeding was associated with better physiological outcomes (OR: 0.71, 95% CI = 0.57-1.11, $P = .046$). In addition, the APACHE II score was found to be independently associated with physiological indexes (OR: 1.02, 95% CI: 0.79–1.23, $P = .001$), indicating a potential impact on the prognosis; see Table 8 and Figure 5.

## DISCUSSION

Under the stressful state of patients, the central autonomic nervous system such as the hypothalamic-pituitary-adrenal cortex axis regulates dysfunction, leading to a high catabolism state in the body;[14] while anabolism is limited, negative nitrogen balance can rapidly appear. If not timely supplemented with energy, it very easily leads to malnutrition, and immune function suppression, seriously affecting the treatment process and prognosis of the primary disease of patients.[15] Therefore, standardized and refined nutritional support is very important. The primary task of nutritional support is to conduct nutritional screening, to evaluate whether the patient needs nutritional support.[16] The nutritional risk of patients largely determines their specific nutritional needs. At present, the main nutritional screening methods include the Nutritional Risk Screening 2002 scale (NRS2002), NUTRIC scoring system,[12] subjective global assessment (SGA), mini nutritional assessment (MNA), etc. NRS2002 is the first international nutritional assessment tool developed based on evidence-based medicine, which only contains three aspects of assessment, namely, nutritional status, disease severity, and age factors, with simple clinical application and a high positive rate of screening nutritional risk. When the NUTRIC scoring system is applied to critically ill patients, it can accurately evaluate the degree of nutritional risk of patients and specify the correct nutritional program. ICU patients have a variety of diseases and their severity is complex and variable. The NUTRIC scoring system is not only related to the nutritional status of patients but also to the severity and prognosis of the disease and is the most widely used critically ill scoring system in clinical practice. It can predict the clinical outcome and mortality of patients by quantifying the severity and prognosis of the disease.

In critically ill patients, the early metabolic rate of the body increases, and nutrient consumption increases. EEN treatment can stimulate the secretion from the gastrointestinal tract, maintain the integrity of the structure and function of the gastrointestinal mucosal barrier, ensure the balance of intestinal flora, maintain the stability of visceral blood flow, reduce the occurrence of stress ulcer, effectively block the vicious cycle of malnutrition, and reduce the probability of intestinal infection.[16,17] In recent years, studies have proposed that albumin is an inflammatory marker. Albumin can be combined with immunoglobulin in serum to increase its stability and assist in improving the immune function of the body. Prealbumin is also an acute-phase protein with a half-life of only 1.9 days, which is highly sensitive to the acute changes in the patient's condition and nutritional status and can reflect the nutritional changes of the body promptly.[18]

The levels of total protein and albumin in the two groups of patients on the 14th day of treatment were higher than those before treatment and on the 7th day of treatment but the levels of total protein and albumin on the 7th day of treatment decreased compared to those before treatment. It was considered that the half-life of total protein and albumin was longer, which could not timely reflect the status of nutritional supplementation, while the half-life of prealbumin being short, it could make acute changes to the nutritional status of patients, demonstrating that the early implementation of low-calorie enteral nutrition (EN) combined with supplemental parenteral nutrition (SPN) can mitigate nutritional depletion induced by acute stress in critically ill patients. However, continuous low-calorie nutritional intake cannot improve the nutritional status, and gradually transitioning to adequate nutrition can improve the nutritional level of patients, achieving the purpose of nutritional support treatment.[19]

The study findings revealed elevated levels of IgA, IgM, and IgG in both patient groups on the 14th day of treatment compared to pre-treatment and the 7th day of treatment. Conversely, the levels of IgA, IgM, and IgG on the 7th day of treatment were lower than those before treatment and on the 14th day of treatment. There was a significant difference in IgA between the observation group and the control group after 14 days of treatment ($P < .05$). There was a significant difference in IgM between the observation group and the control group after 7 and 14 days of treatment ($P < 0.05$). Similarly, a significant difference was observed in IgG between the observation group and the control group after 7 and 14 days of treatment ($P < .05$), and also between the observation group and the control group after 14 days of treatment ($P < .05$). Considering that low-calorie nutritional support treatment may not be able to completely resist the loss of immune cells during acute stress in the short term, the long half-life of immunoglobulin, and the treatment time being too short on the 7th day, could result in a short-term decline in the mid-term of the study. However, a gradual transition to adequate feeding can still improve the level of immunoglobulin in patients, which proves that standardized and refined EN treatment can effectively optimize the immune function of patients and improve their immunity.

In addition, the nutritional scores of the two groups at the end of the trial were significantly lower than those at the beginning of the trial, and the difference was statistically significant ($P < .05$), and the observation group was significantly different from the control group ($P < .05$), indicating that the improvement of nutritional status of the two groups was considerably different. The administration of the above two types of enteral nutrition preparations for

standardized and refined EN support treatment can improve the nutritional level of patients, achieve clinical benefits, and improve the prognosis of patients.

Although the long-term outcomes of critically ill patients were not observed in this study, this provides a potential area for future research. To gain a more complete understanding of the disease course and treatment effect on patients, it is suggested that future studies could consider incorporating long-term follow-up and evaluation to assess the impact of treatment measures over a broader time horizon. In addition, there are still many unknown factors for individualized treatment and nutritional management of critically ill patients. Future research could aim to better understand the differences among patient subgroups to develop more precise treatment strategies. For example, the impact of different disease types, age groups, gender, and other factors on treatment outcomes can be explored, to provide more specific guidance to the medical team. In summary, future research can provide a more comprehensive understanding and guidance for the long-term treatment and rehabilitation of critically ill patients by extending the period of research and further exploring the differences between the patient subgroups.

In conclusion, the implementation of standardized process management in EN treatment of critically ill patients can improve the levels of total protein, albumin, prealbumin, and hemoglobin. It can also help to improve the immune indexes, NUTRIC score, and nutritional status of patients, and reduce the incidence of infectious complications. Promoting the adoption of standardized process management for enteral nutrition (EN) in clinical settings is highly recommended. While acknowledging the strengths of this study, it is essential to note certain limitations. The study design did not include long-term prognosis monitoring for critically ill patients, indicating a prospective avenue for future research.

## ETHICAL COMPLIANCE

This study was approved by the ethics committee of Third Hospital of Shanxi Medical University. Signed written informed consents were obtained from the patients and/or guardians.

## AUTHOR DISCLOSURE STATEMENT

The authors have no potential conflicts of interest to report relevant to this article.

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CZ and WW designed the study and performed the experiments, LH and JL collected the data; RZ, SZ, and CH analyzed the data; and CZ and WW prepared the manuscript. All authors read and approved the final manuscript.

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## REFERENCES

1. Allen K, Hoffman L. Enteral Nutrition in the Mechanically Ventilated Patient. *Nutr Clin Pract*. 2019;34(4):540-557. doi:10.1002/ncp.10242
2. Bischoff SC, Austin P, Boeykens K, et al. ESPEN practical guideline: home enteral nutrition. *Clin Nutr*. 2022;41(2):468-488. doi:10.1016/j.clnu.2021.10.018
3. Pash E. Enteral Nutrition: Options for Short-Term Access. *Nutr Clin Pract*. 2018;33(2):170-176. doi:10.1002/ncp.10007
4. Channabasappa N, Girouard S, Nguyen V, Piper H. Enteral Nutrition in Pediatric Short-Bowel Syndrome. *Nutr Clin Pract*. 2020;35(5):848-854. doi:10.1002/ncp.10565
5. Nisim AA, Allins AD. Enteral nutrition support. *Nutrition*. 2005;21(1):109-112. doi:10.1016/j.nut.2004.09.015
6. Jordan EA, Moore SC. Enteral nutrition in critically ill adults: literature review of protocols. *Nurs Crit Care*. 2020;25(1):24-30. doi:10.1111/nicc.12475
7. Ruiz SS. *Nutr Hosp*. 2018;35(Spec no2):27-33. doi:10.20960/nh.1957
8. Bischoff SC, Austin P, Boeykens K, et al. ESPEN guideline on home enteral nutrition. *Clin Nutr*. 2020;39(1):5-22. doi:10.1016/j.clnu.2019.04.022
9. Pitta MR, Campos FM, Monteiro AG, Cunha AGF, Porto JD, Gomes RR. Tutorial on Diarrhea and Enteral Nutrition: A Comprehensive Step-By-Step Approach. *JPEN J Parenter Enteral Nutr*. 2019;43(8):1008-1019. doi:10.1002/jpen.1674
10. Williams NT. Medication administration through enteral feeding tubes. *Am J Health Syst Pharm*. 2008;65(24):2347-2357. doi:10.2146/ajhp080155
11. Erstad BL. Enteral nutrition support in acute pancreatitis. *Ann Pharmacother*. 2000;34(4):514-521. doi:10.1345/aph.19144
12. Al-Dorzi HM, Arabi YM. Nutrition support for critically ill patients. *JPEN J Parenter Enteral Nutr*. 2021;45(S2):47-59. doi:10.1002/jpen.2228
13. Mederos MA, Reber HA, Girgis MD. Acute Pancreatitis: A Review. *JAMA*. 2021;325(4):382-390. doi:10.1001/jama.2020.20317
14. Lopes MCBR, Ceniccola GD, Araújo WMC, Akutsu R. Nutrition support team activities can improve enteral nutrition administration in intensive care units. *Nutrition*. 2019;57:275-281. doi:10.1016/j.nut.2018.04.017
15. Guenter P, Lyman B. ENFit Enteral Nutrition Connectors. *Nutr Clin Pract*. 2016;31(6):769-772. doi:10.1177/0884533616673638
16. Irving SY, Simone SD, Hicks FW, Verger JT. Nutrition for the critically ill child: enteral and parenteral support. *AACN Clin Issues*. 2000;11(4):541-558. doi:10.1097/00044067-200011000-00007
17. Gliwska E, Guzek D, Przekop Z, Sobocki J, Głąbska D. Quality of Life of Cancer Patients Receiving Enteral Nutrition: A Systematic Review of Randomized Controlled Trials. *Nutrients*. 2021;13(12):4551. doi:10.3390/nu13124551
18. Marian M. Pediatric nutrition support. *Nutr Clin Pract*. 1993;8(5):199-209. doi:10.1177/0115426593008005199
19. Doley J. Enteral Nutrition Overview. *Nutrients*. 2022;14(11):2180. doi:10.3390/nu14112180