

Effectiveness of a multidisciplinary team for nutrition support in a trauma intensive care unit

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Background: We evaluated clinical and nutritional outcomes according to multidisciplinary team involvement in nutrition support in a regional trauma intensive care unit (TICU).

Methods: We retrospectively compared the outcomes for 339 patients admitted to the TICU for >5 days depending on nutrition support team (NST) involvement (n = 176) and non-NST involvement (n = 163).

Results: The mean age and injury severity score (ISS) were 57.3 ± 16.7 years and 18.6 ± 9.7 , respectively. Fifty-three patients (15.6%) had shock on admission and 182 (53.7%) underwent surgery during TICU admission. Some patients were admitted to neurosurgery (46%), general surgery (35.4%), and other (18.6%) departments. There were significant differences in the ISS, Acute Physiology and Chronic Health Evaluation (APACHE) II score, shock on TICU admission, and initial laboratory results. After propensity score matching, the total delivered/required caloric ratio and total delivered/required protein ratio were significantly higher in the NST group than in the non-NST group (calorie: 80.4% vs. 66.7%, $P = 0.007$; protein: 93.1% vs. 68.3%, $P < 0.001$). The NST group had an adequate protein supply more frequently than the non-NST group (protein: 48.0% vs. 25.8%, $P = 0.002$). There was no significant difference in survival, even after adjustment for risk factors using Cox proportional hazard analysis.

Conclusions: The results of our study suggest that multidisciplinary team involvement in nutrition support in TICU patients may improve nutritional, but not clinical, outcomes.

Key Words: injuries; intensive care unit; multidisciplinary team; nutrition support

INTRODUCTION

Malnutrition is identified in approximately 30%–55% of hospitalized patients, and nutritional status is closely related to clinical outcomes for patients [1-3]. In multiple studies, malnutrition has been reported as an important risk factor for mortality and morbidity in critically ill patients [4,5]. Therefore, the National Health Insurance (NHI) of Korea established provisions for the reimbursement of multidisciplinary teams for nutrition support in critically ill patients in 2015, and nutrition support teams (NSTs) now conduct nutritional assessments and nutrition support for patients in each hospital [6]. It has also been reported that nutrition support reduces mortality and the incidences of infectious complications in trauma patients [7-10]. However, a recent multi-center study showed that adequate support of energy and protein

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was provided for only 50%–60% of trauma patients [11]. Seventeen regional trauma centers were announced by the Korean government in 2012. Currently, 11 trauma centers have been opened and supported by the Korean Ministry of Health and Welfare, with each center containing at least 20 beds in the trauma intensive care units (TICUs) [12]. However, since the NST project by the NHI in Korean trauma centers was just recently introduced and its recommendations were not mandatory for the attending physicians, the effectiveness of multidisciplinary teams for NST is still unclear. In addition, literature regarding nutritional issues in injured patients admitted to the TICU is limited. Therefore, the purpose of this study was to evaluate clinical and nutritional outcomes according to involvement of a multidisciplinary team for nutrition support in injured patients admitted to the TICU.

MATERIALS AND METHODS

Patient Selection and Data Collection

In this observational study, the medical records of injured patients (ages > 18 years) who were admitted to the TICU of a regional trauma center in a tertiary university hospital from January 2015 to December 2015 were analyzed retrospectively. The design of this study was approved by the Institutional Review Board of Wonju Severance Christian Hospital (IRB No. CR318059), and the need for informed consent was waived due to the retrospective nature of the study. For evaluation of patients' nutritional outcomes without the effects of early death or transfer to another hospital, patients who were discharged or transferred within 5 days were excluded from our study.

The clinical characteristic data collected included age, sex, injury severity score (ISS), Acute Physiology and Chronic Health Evaluation (APACHE) II score on TICU admission, occurrence of shock at the time of TICU admission, surgery during TICU admission, and admission department. Nutritional information, such as weight, height, body mass index, timing of nutrition initiation, initial nutritional route (parenteral nutrition [PN], tube feeding, oral, or mixed: enteral nutrition [EN] and PN), calculated energy requirement (kcal/day), protein requirement (g/day), and consultation to NST, was also identified. Energy requirements were calculated using either a simplistic formula (25–30 kcal/kg) or the Harris-Benedict equation. Adequate amounts of calories and protein were defined as achievement of 70%–110% of the calculated amounts during TICU admission.

KEY MESSAGES

- Nutrition support team in critically ill injured patients improved nutritional, but not clinical, outcomes.
- In order to solve these problems, it is necessary to ensure continuity in nutrition support for patients by organizing the nutrition support team round with the multidisciplinary round in the intensive care unit.

Outcome Evaluations

The primary study end-point was nutritional outcomes, which included total delivered/required caloric ratio (%) and total delivered/required protein ratio (%) during TICU admission, and the rate of adequate calorie and protein supply during TICU admission. The secondary end-point was clinical outcomes, which were duration of TICU stay, duration of hospitalization, ICU mortality rate, and mortality rate.

TICU System

The 20-bed TICU in this study was a semi-closed type. In general, injured patients were admitted to each department (department of trauma surgery, neurosurgery, orthopedic surgery, and cardiothoracic surgery) depending on their main injury site, and patients were only referred to a surgical intensivist if the physician in charge decided that a transfer was necessary.

Nutrition Support Team

Patients were indicated for the NST program if they had hypoalbuminemia (<3.0 g/dl), were on PN or EN, were admitted to the ICU, or if malnutrition was suspected by the physician. Although there were indications as noted above, multidisciplinary consult services were only conducted if the physician in charge determined that NST consult was necessary. An alert in the order communication system was received after 48 hours from TICU admission if NST consultation was required. The NST provided information about energy and protein targets, nutritional route, and other recommendations associated with patient condition at a multidisciplinary round twice a week. The NST in our hospital consisted of a trauma surgeon (surgical intensivist), a clinical nutritionist, a pharmacist, and a ward nurse. The trauma surgeon assessed patient status, and recommended start timing and the route of nutrition. The clinical nutritionist calculated the amount of nutrition required and the recommended EN prescription. The pharmacist monitored issues with prescribed medications and PN use. Acceptance of these recommendations was

decided by the attending physician. All of the NST members were required to attend educational training and were certified in total nutrition therapy for critical professionals.

Statistical Analysis

Continuous variables were presented as the mean value \pm standard deviation and categorical variables were presented as frequency (percentage). The two groups according to NST consultation were compared using the two-sample t-test, chi-square test, or Fisher's exact test. To reduce bias in patient selection, propensity score matching was performed. Propensity scores were estimated for each patient using multivariate logistic regression analysis. The covariates included in the calculation were age, sex, occurrence of shock at the time of TICU admission, admission department, ISS, APACHE II score, and length of TICU stay. A one to one matched analysis using nearest-neighbor matching with a caliper distance of 0.05 without replacement was performed based on the estimated propensity score of each patient group. Survival curves were constructed using the Kaplan-Meier method for comparison between the curves. Multivariable analysis of outcomes was performed using the Cox proportional hazards regression model. Statistical significance was accepted for two-sided P-values of <0.05 . Statistical analyses were performed using SAS 9.4 software (SAS Inc., Cary, NC, USA) and IBM SPSS ver. 23.0 (IBM Inc., Armonk, NY, USA).

RESULTS

Patient Characteristics

Among 565 injured patients admitted to the TICU, 153 patients who had any missing variable, and 73 patients who died, were discharged, or were transferred to another hospital within 5 days of admission, were excluded from this study. The final enrolled population included 339 patients (Figure 1). The mean age of patients was 57.3 ± 16.7 years and there were 267 males (78.8%). The mean ISS and APACHE II scores were 18.6 ± 9.7 and 13.3 ± 6.9 , respectively. Fifty-three patients (15.6%) were in shock at the time of TICU admission, and 182 patients (53.7%) underwent surgery during TICU admission. Nutritional support was initiated 2.4 ± 1.8 days after TICU admission. The initial nutrition was PN in 279 patients (82.3%), oral route in 44 patients (13.6%), and tube feeding in five patients (1.5%). The ICU mortality rate was 8.6% and the overall mortality rate was 9.4%. Consultation with the NST occurred for 176 patients (NST group), and 163 patients did not receive NST consultation (non-NST group) (Table 1).

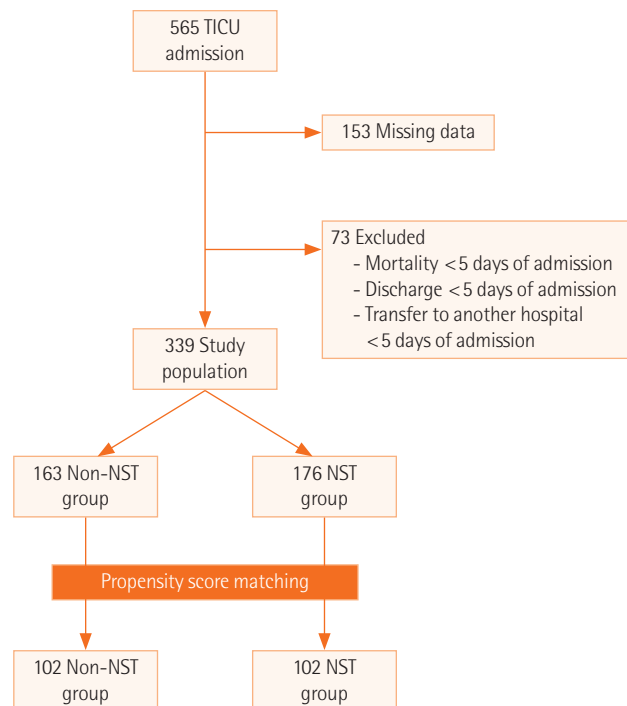


Figure 1. Patient flowchart. TICU: trauma intensive care unit; NST: nutrition support team.

Comparison between Non-NST group and NST Group

When the non-NST group and NST group were compared, there were significant differences in patient characteristics, including ISS, APACHE II score, occurrence of shock at the time of TICU admission, surgery in the TICU, initial hemoglobin, initial serum albumin, and the initial nutrition route. The ICU mortality rate and overall mortality rate were also significantly higher in the NST group than in the non-NST group (21.5% vs. 6.3% and 14.2% vs. 4.3%, respectively) (Table 1).

Nutritional and Clinical Outcomes between the Non-NST Group and NST Group after Propensity Score Matching

After propensity score matching, there were no significant differences in the ISS, APACHE II score, the occurrence of shock at the time of TICU admission, surgery in the TICU, initial hemoglobin, and serum albumin (Table 2). The total delivered/required caloric ratio and total delivered/required protein ratio were significantly higher in the NST group than in the non-NST group (calorie: 80.4% vs. 66.7%, $P=0.007$; protein: 93.1% vs. 68.3%, $P<0.001$). Adequate protein supply was more common in the NST group than in the non-NST group (48.0% vs. 25.8%, $P=0.002$) (Table 3). However, there was no significant difference in survival between the 2 groups ($P=0.740$) (Figure 2). After adjustment for age, sex, occurrence of shock, admis-

Table 1. Patient characteristics according to NST consultation before propensity score matching

Variable	Total (n=339)	Non-NST (n= 163)	NST (n= 176)	P-value
Age (yr)	57.3±16.7	56.3±16.9	58.2±16.4	0.297
Male sex	267 (78.8)	38 (23.3)	34 (19.3)	0.369
ISS	18.6±9.7	16.2±9.1	20.8±9.6	<0.001
APACHE II score	13.3±6.9	12.0±6.4	14.6±7.2	<0.001
Shock at the time of TICU admission	53 (15.6)	17 (10.4)	36 (20.5)	0.011
Surgery during TICU admission	182 (53.7)	77 (47.2)	105 (59.7)	0.022
Initial hemoglobin (g/dl)	11.9±2.1	12.3±2.2	11.6±1.9	0.002
Initial serum albumin (g/dl)	3.4±0.7	3.5±0.6	3.3±0.7	0.041
Admission department				0.098
Neurosurgery	156 (46.0)	67 (41.1)	89 (50.6)	
General surgery	120 (35.4)	67 (41.1)	53 (30.1)	
Other	63 (18.6)	29 (17.8)	34 (19.3)	
Weight (kg)	66.4±12.0	66.5±11.8	66.2±12.2	0.821
Height (cm)	166.9±8.8	166.6±8.8	167.0±8.9	0.702
BMI (kg/m ²)	23.7±3.3	23.9±3.5	23.6±3.2	0.499
Timing of nutrition start (day)	2.4±1.8	2.4±1.6	2.3±2.1	0.796
Initial nutrition route				<0.001
PN	279 (82.3)	120 (73.6)	159 (90.3)	
Oral	44 (13.6)	35 (21.5)	11 (6.3)	
Tube feeding	5 (1.5)	1 (0.6)	4 (2.3)	
Mixed	11 (3.2)	6 (3.7)	4 (2.3)	
Calculated calorie requirement (kcal)	1,516±202	1,534±205	1,501±200	0.143
Calculated protein requirement (g)	74.5±11.7	74.5±10.9	74.6±12.3	0.897
Total delivered/required caloric ratio in TICU (%)	80.4±38.7	64.1±36.3	93.8±35.5	<0.001
Total delivered/required protein ratio in TICU (%)	88.8±51.0	65.5±49.5	108.1±43.7	<0.001
Adequate energy supply	118 (36.9)	39 (27.1)	79 (44.9)	0.001
Adequate protein supply	102 (31.8)	36 (24.8)	66 (37.5)	0.015
Duration of TICU admission (day)	10.4±12.4	5.5±4.8	14.9±15.3	<0.001
Duration of hospitalization (day)	24 (6–86) ^a	22.6±15.7	34.5±20.8	<0.001
ICU mortality	29 (8.6)	6 (6.3)	23 (21.5)	0.002
Overall mortality	32 (9.4)	7 (4.3)	25 (14.2)	0.002

Values are presented as mean ± standard deviation or number (%).

NST: nutrition support team; ISS: injury severity score; APACHE: Acute Physiology and Chronic Health Evaluation; TICU: trauma intensive care unit; BMI: body mass index; PN: parenteral nutrition; ICU: intensive care unit.

^aMedian (range).

sion department, ISS, and APACHE II score by Cox proportional hazards analysis, there was no significant difference in survival between the two groups (Table 4).

DISCUSSION

After propensity score matching analysis to adjust for ISS and severity at the time of TICU admission between the NST group

and the non-NST group, the clinical characteristics of the two groups were similarly corrected. A multidisciplinary approach using a NST increased the nutrition received, including the total delivered/required caloric and protein ratios, and the rate of adequate calorie supply. This change seemed to be due to the fact that the NST provided adequate information about energy and protein targets, and these recommendations were repeatedly mentioned by the multidisciplinary team. However,

er, there was no improvement in the nutrition route or clinical outcomes, such as the mortality rate and length of hospital

Table 2. Patient characteristics according to NST consultation after propensity score matching

Variable	Non-NST (n=102)	NST (n=102)	P-value
Age (yr)	56.3±17.2	58.3±16.7	0.395
Male sex	80 (78.4)	79 (77.5)	0.866
ISS	19.0±9.8	20.0±10.2	0.510
APACHE II score	12.9±7.0	12.1±6.6	0.405
Shock at the time of TICU admission	13 (12.8)	9 (8.8)	0.367
Surgery during TICU admission	54 (52.9)	50 (49.0)	0.575
Initial hemoglobin (g/dl)	12.0±2.2	11.8±1.8	0.533
Initial albumin	3.4±0.7	3.5±0.7	0.624
Admission department			0.031
Neurosurgery	45 (44.1)	46 (44.1)	
General surgery	46 (45.1)	33 (32.4)	
Others	11 (10.8)	24 (23.5)	
Weight (kg)	66.7±12.3	66.9±12.7	0.874
Height (cm)	167.3±8.2	167.1±9.2	0.861
BMI (kg/m ²)	23.7±3.6	23.9±3.4	0.719
Timing of nutrition start (day)	2.5±1.7	2.4±2.1	0.557
Initial nutrition route			0.003
PN	83 (81.4)	90 (88.2)	
Oral	15 (14.7)	9 (8.82)	
Tube feeding	0	2 (1.96)	
Mixed	4 (3.92)	1 (0.98)	
Calculated calorie requirement (kcal)	1,554±213	1,515±212	0.213
Calculated protein requirement (g)	75.1±11.1	75.5±12.7	0.827

Values are presented as mean±standard deviation or number (%). NST: nutrition support team; ISS: injury severity score; APACHE: Acute Physiology and Chronic Health Evaluation; TICU: trauma intensive care unit; BMI: body mass index; PN: parenteral nutrition.

Table 3. Nutritional and clinical outcomes according to NST consultation after propensity score matching

Variable	Non-NST (n=102)	NST (n=102)	P-value
Total delivered/required caloric ratio in TICU (%)	66.7±37.6	80.4±30.1	0.007
Total delivered/required protein ratio in TICU (%)	68.3±54.7	93.1±36.0	<0.001
Adequate calorie supply in TICU	28 (31.8)	44 (43.1)	0.109
Adequate protein supply in TICU	23 (25.8)	49 (48.0)	0.002
Duration of TICU admission (day)	6.6±5.5	8.7±10.3	0.074
Duration of hospitalization (day)	23.4±15.9	29.4±19.8	0.018
ICU mortality	5 (4.9)	8 (7.8)	0.390
Overall mortality	6 (5.9)	9 (8.8)	0.421

Values are presented as mean±standard deviation or number (%). NST: nutrition support team; TICU: trauma intensive care unit; ICU: intensive care unit.

stay. This result may have been due to several reasons. First, the NST was not able to change nutrition orders and could only make recommendations regarding nutritional issues, because the NST did not have authority to prescribe. Compliance with recommendations made by the NST had an impact on clinical outcomes. Second, it is difficult to conduct NST

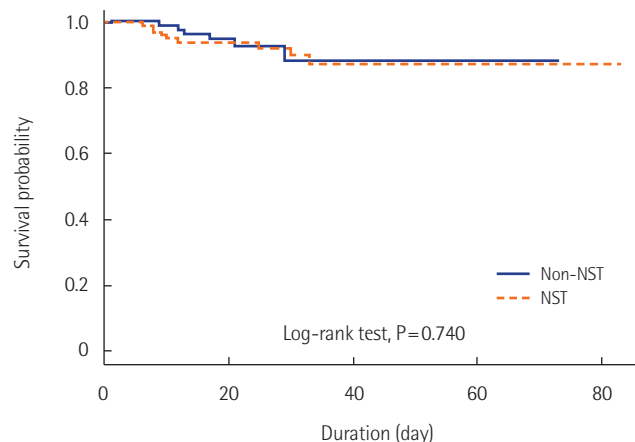


Figure 2. Comparison of survival between patients admitted to the trauma intensive care unit in the nutrition support team (NST) group and non-NST group.

Table 4. Mortality according to NST treatment

Variable	Overall mortality	
	HR (95% CI)	P-value
Crude model	1.19 (0.42–3.40)	0.740
Adjusted model	2.11 (0.66–6.78)	0.211

Crude model: adjusted for age and sex; Adjusted model: adjusted for age, sex, major shock, ISS, and APACHE II. NST: nutrition support team; HR: hazard ratio; CI: confidence interval; ISS: injury severity score; APACHE: Acute Physiology and Chronic Health Evaluation.

rounds more than twice a week with the current reimbursement plan for the NST program. Therefore, it is difficult to continuously check nutrition status, and this appears to have failed to improve clinical outcomes since continuous and detailed nutrition support was difficult.

EN is desired over PN in trauma patients, and it is associated with decreased infections, decreased mechanical ventilation days, and a shorter length of ICU stay [13-16]. However, the results of the present study showed that 82.3% of patients initially received PN and nutrition was initiated 2.4 days after admission on average. This is very different to the results of a recent large, multi-national, multi-institutional study, in which 81% of trauma patients received EN [11]. In Korea, PN is used in a high proportion of surgical patients, and PN is commonly used in patients receiving EN [17]. Reimbursement provided for the NST program by the NHI began on a large scale in 2015 to address these nutritional problems [6]. However, Korean physicians' perceptions of PN complications in trauma patients are inconsistent, and a consensus for active use of EN has not been reached [18]. As a result, the change in practice appears to be occurring slowly. In our study, approximately 50% of patients underwent surgery during their TICU admission. Preoperative midnight fasting was requested by anesthesiologists for most surgeries, except for emergency surgery before TICU admission. Recent recommendations are that patients can consume a clear liquid diet up until 2 hours before elective surgery in order to minimize perioperative fasting. However, anesthesia has not yet been performed following this policy in the hospital used in our study [19,20]. For this reason, it is thought that patients were initiated on PN, instead of EN, because there was a possibility that they would require an operation during their TICU stay.

Reimbursement for the NST program in Korea, which began in 2015, has had a positive impact on nutritional practice, but it has not completely addressed fundamental nutrition problems [6]. In addition, multidisciplinary rounds are only performed twice a week [6]. As the physicians in charge have a limited understanding of nutrition therapy, compliance with recommendations given by the NST is also low [18]. In order to solve these problems, it is necessary to ensure continuity in nutrition support for patients by organizing the NST round with the multidisciplinary round in the ICU. It is also important to educate physicians, nurses, pharmacists, and nutritionists who manage critically ill patients and to promote NSTs [21].

This study has some limitations. First, it does not show the overall outcome of NST operation in all institutions, because it was performed at a single institution. Second, it was difficult

to include information regarding complications, and there was also selection bias between the NST group and the non-NST group, because this was a retrospective study. Third, it is difficult to know whether the recommendations were reflected in the patient's actual management, since this study did not include information about compliance with NST recommendations by the physicians in charge. Despite these limitations, the results of this study showed the current state of nutrition support in a Korean TICU and provided meaningful information on the effects of the NST project by the NHI on outcomes in trauma patients.

In conclusion, a multidisciplinary team approach for nutrition support significantly increased the nutritional intake of TICU patients. However, additional prospective studies with actual nutrition support or other factors affecting clinical outcomes are needed in order to confirm the impact of NST on clinical outcomes.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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AUTHOR CONTRIBUTIONS

Conceptualization: EO, HS, JYJ. Data curation: EO, HJY, JYJ. Formal analysis: JSM, DRK, JYJ. Methodology: EO, HS, DRK, JYJ. Project administration: HS, JYJ. Visualization: JSM, JYJ. Writing—original draft: EO, JYJ. Writing—review & editing: all authors.

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