ORIGINAL ARTICLE

# Impact of Visual Nutritional Indicator on the Nutritional Therapy in Intensive Care Unit

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## Abstract

**Background:** We wanted to evaluate if a visual nutritional indicator (VNI), which shows the total amount of calories and protein, can improve the quality of nutritional therapy (NT) and result in better clinical outcomes prospectively.

**Materials and methods:** We randomly assigned patients to VNI or non-VNI (NVNI) groups. In the VNI group, VNI was attached to the patient's bed for the attending physician. The primary goal was a higher supply of calories and proteins. The secondary goals were the shorter length of intensive care unit (ICU) stay, mechanical ventilation, and renal replacement therapy.

**Results:** The total calorie supply was 18.6 kcal/kg and 15.6 kcal/kg in the VNI and NVNI groups, respectively ($p = 0.04$). The total protein supply was 0.92 g/kg and 0.71 g/kg, respectively ($p = 0.05$). The length of ICU stay was 5.6 days and 5.3 days in the VNI and NVNI groups, respectively ($p = 0.09$). The length of mechanical ventilation was 3.6 days and 3.8 days, respectively ($p = 0.07$). The length of renal replacement therapy was 5.7 days and 6.3 days, respectively ($p = 0.13$). The mortality on the seventh day was 14.6% and 16.1% in the VNI and NVNI groups, respectively ($p = 0.08$). The mortality on the thirtieth day was 20 and 20.8%, respectively ($p = 0.87$).

**Conclusion:** Visual nutritional indicator, indicating the total amount of calories and protein provided, can improve the quality of NT but fail to obtain a better clinical outcome.


**Keywords:** Clinical outcome, Nutritional support team, Nutritional therapy, Visual nutritional indicator.

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## Introduction

Nutrition has a fundamental impact on the prognosis of patients. For better nutritional therapy (NT), the nutritional support team (NST), which is a multidisciplinary team composed of a physician, nurse, nutritionist, pharmacist, and administrative staff of the hospital, is warranted. If the NST has the authority to prescribe NT for the patient, the NST may have a positive effect on the nutrition and prognosis of patients.[1] The request for NT has increased over time, probably owing to improved medical consciousness of the potential risks of malnutrition and the availability of a specialized NST.[2] However, the NST's role varies according to the hospital's circumstances. If the NST does not have the authority to prescribe NT and has the role of a consulting physician, such as in our country, even though the NST provides an evidence-based opinion about NT and attempts to improve the prognosis of patients, the prescription of NT by the attending physician (AP) is not well modified, and the overall nutritional status of patients may become poor.[3] There are several methods of delivery of the NST's opinion to the AP, such as text messages, pop-up messages in the order communication system (OCS), and direct telephone communication. Pop-up message in the OCS is frequently neglected, and the AP does not try to ascertain the NST's consultation results. Direct telephone communication is extremely time-consuming and requires considerable effort for the NST. Each hospital has different NST systems and human resources and has to find the best method to deliver the NST's opinion to the AP, who prescribes daily NT.

A visual nutritional indicator (VNI) is a simple figure that shows the adequacy of NT for the patients. A VNI usually uses colors and numbers and is widely used in food marketing. The red color has a warming effect and can alert consumers to avoid junk foods or abnormally high-calorie diets.[4] In the hospital, a VNI can show the total amount of calories and proteins and can alert the AP about malnutrition in the patient. This study aimed to evaluate the effect of VNI to improve the clinical outcomes of critically ill patients by provoking the AP to improve NT.

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## Materials and Methods

This was a nonblinded randomized prospective cohort study. Patients admitted to the ICU of Chosun University Hospital from May 1, 2020, to December 15, 2020, were enrolled in the study. The hospital has an open-ICU system, and the department of the patients is mixed. The inclusion criteria were enteral nutrition (EN) or parenteral nutrition (PN) for >3 days. The exclusion criteria were (A) NT during inter-hospital transfer, (B) severe malnutrition defined as serum albumin level <2.5 mg/dL and body weight <60% of the predicted body weight, and (C) change of department or AP during the study period.

Patients were randomly allocated to the VNI group and non-VNI (NVNI) group using a computer program. In the VNI group, a VNI was attached to the board of the foot side of the patient's bed. Two black arms of the VNI show the total amount of calories and proteins for the previous 24 hours. The red and orange colors indicated underfeeding and overfeeding, respectively. The green color indicated the best state of NT, and the yellow-green color indicated favorable NT. The two arms were moved every day at seven o'clock in the morning before the routine rounding of AP (Fig. 1). The primary goal was a higher supply of calories and proteins. The secondary goals were a shorter length of ICU stay, length of mechanical ventilation, length of renal replacement therapy, and lower mortality at the seventh and thirtieth days. Paired *t*-test and logistic regression analysis were used.

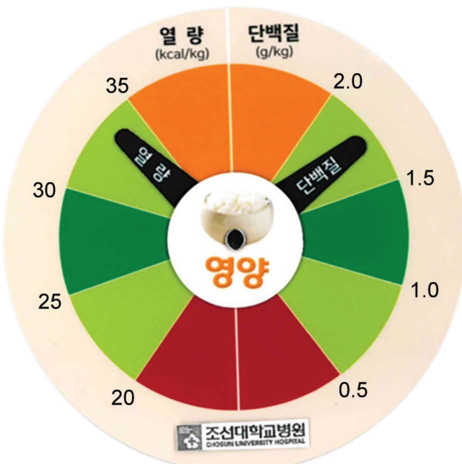


**Fig. 1:** Visual nutritional indicator. Left black arm of indicator shows the total amount of calorie (kcal/kg), and right arm shows the protein provision (g/kg). The red and orange colors indicate underfeeding and overfeeding, respectively. The green color indicates the best state of nutrition support, and the yellow green color indicates the favorable status

## Results

A total of 531 patients were admitted to the ICU during the study period. Particularly, 329 patients satisfied the inclusion criteria. Moreover, 48 patients who received NT during the inter-hospital transfer and 11 patients who had severe malnutrition were excluded from the study. Eight patients in the VNI group and two patients in the NVNI group changed their AP or department during the study period and were excluded from the study. Thus, 130 patients in each group were analyzed (Fig. 2). The mean ages of the VNI and NVNI groups were 71 and 69, respectively ($p = 0.98$). The male-female ratios were 85:45 and 76:54 in the VNI and NVNI groups, respectively ($p = 0.67$). Body mass indices (BMIs) were 23.8 and 23.5, respectively ($p = 0.88$). The vital signs of the VNI group were as follows: blood pressure, 97/56 mm Hg; heart rate, 89 beats/minute; respiratory rate, 17 per minute; and body temperature, 36.4°C. In the NVNI group, the vital signs were as follows: Blood pressure, 101/58 mm Hg; heart rate, 91 beats/minute; respiratory rate, 15 per minute; and body temperature, 36.2°C ($p = 0.94$). The APACHE II scores were 19.7 and 19.1 in the VNI and NVNI groups, respectively ($p = 0.78$). The causes of ICU admission were sepsis, hemorrhagic shock, traumatic brain injury, multiple traumas, surgical complications, and open-heart surgery ($p = 0.86$). The patients had underlying diseases of hypertension, diabetes mellitus, ischemic heart disease, stroke, and chronic obstructive pulmonary disease ($p = 0.87$). The allocation was even, and there was no statistical difference in age, sex, BMI, vital signs, APACHE II score, cause of ICU admission, and underlying disease (Table 1). The total calorie supply was 18.6 kcal/kg and 15.6 kcal/kg in the VNI and NVNI groups, respectively ($p = 0.04$). The total protein supply was 0.92 g/kg and 0.71 g/kg, respectively ($p = 0.05$). The length of ICU stay was 5.6 days and 5.3 days in the VNI and NVNI groups, respectively ($p = 0.09$). The length of mechanical ventilation was 3.6 days and 3.8 days, respectively ($p = 0.07$). The length of renal replacement therapy was 5.7 days and 6.3 days, respectively ($p = 0.13$). The mortality on the seventh day was 14.6 and 16.1% in the VNI and NVNI groups, respectively ($p = 0.08$). The mortality on the thirtieth day was 20 and 20.8%, respectively ($p = 0.87$) (Table 2).

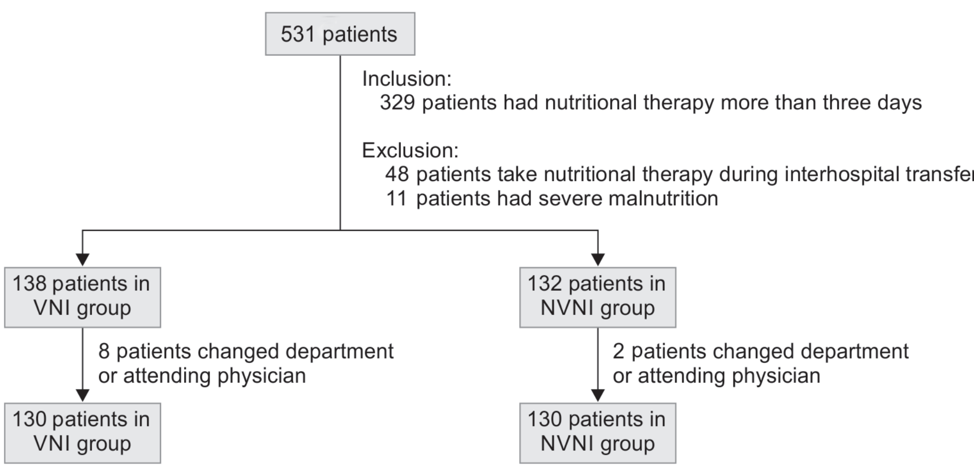


**Fig. 2:** Patients' allocation. A total of 531 patients were admitted to the ICU during the study period. Particularly, 329 patients satisfied the inclusion criteria. Moreover, 48 patients who had NT during the interhospital transfer and 11 patients who had severe malnutrition were excluded from the study. Eight patients in the VNI group and two patients in the NVNI group changed their attending physician or department during the study period and were excluded from the study. Thus, 130 patients in each group were analyzed. NT, nutritional therapy; NVNI, non-visual nutritional indicator group; VNI, visual nutritional indicator group

**Table 1:** Characteristics of the patients

| *Characteristics* | *VNI (N = 130)* | *Non-VNI (N = 130)* | *p-value* |
|---|---|---|---|
| Age (years) | 71 ± 3.2 | 69 ± 2.9 | 0.98 |
| Sex (male:female) | 85:45 | 76:54 | 0.67 |
| BMI | 23.8 | 23.5 | 0.88 |
| Vital signs upon admission | | | 0.94 |
| SBP (mm Hg) | 97 | 101 | |
| DBP (mm Hg) | 56 | 58 | |
| Heart rate (per minute) | 89 | 91 | |
| Respiratory rate (per minute) | 17 | 15 | |
| Body temperature (°C) | 36.4 | 36.2 | |
| APACHE II score | | | 0.78 |
| Cause of ICU admission | 19.7 ± 6.3 | 19.1 ± 5.1 | 0.86 |
| Sepsis | | | |
| Hemorrhagic shock | 51 (39.2%) | 53 (40.8%) | |
| Traumatic brain injury | 32 (24.6%) | 29 (22.3%) | |
| Multiple trauma | 21 (16.2%) | 19 (14.6%) | |
| Surgical complication | 14 (10.8%) | 17 (13.1%) | |
| Open heart surgery | 9 (6.9%) | 7 (5.4%) | |
| Underlying disease | 3 (2.3%) | 5 (3.8%) | 0.87 |
| Hypertension | 58 | 47 | |
| Diabetes mellitus | 67 | 58 | |
| Ischemic heart disease | 41 | 47 | |
| Stroke | 23 | 21 | |
| COPD | 25 | 18 | |

APACHE, Acute Physiology and Chronic Health Evaluation; BMI, body mass index; COPD, chronic obstructive pulmonary disease; DBP, diastolic blood pressure; ICU, intensive care unit; SBP, systolic blood pressure

**Table 2:** Clinical outcomes

| *Parameters* | *VNI (N = 130)* | *Non-VNI (N = 130)* | *p-value* |
|---|---|---|---|
| Total calorie supply (kcal/kg) | 18.6 ± 8.2 | 15.6 ± 5.2 | 0.04 |
| Total protein supply (g/kg) | 0.92 ± 2.2 | 0.71 ± 1.2 | 0.05 |
| Length of ICU stay (day) | 5.6 ± 3.2 | 5.3 ± 2.8 | 0.09 |
| Length of MV (day) | 3.6 ± 1.7 | 3.8 ± 2.1 | 0.07 |
| Length of RRT (day) | 5.7 ± 3.2 | 6.3 ± 2.7 | 0.13 |
| Mortality at the seventh day, *N* (%) | 19 (14.6) | 21 (16.1%) | 0.08 |
| Mortality at the thirtieth day, *N* (%) | 26 (20) | 27 (20.8) | 0.87 |

MV, mechanical ventilation; RRT, renal replacement therapy

## Discussion

An NST is a multidisciplinary team composed of a physician, nurse, dietician, nutritionist, pharmacist, and administrative staff of the hospital. The NST manages the wide spectrum of NT of the patients, such as nutritional assessment, detection of malnutrition, preoperative and postoperative NT, and modification of the administration system related to nutrition. The impact of NT on the prognosis of patients is well-known.[5–7] However, the usual nutritional status of the patients who had long fasting is poor even though the NST is in full activity.[8,9] This is true, especially in institutions where the NST has the role of a consulting physician. The AP, not the NST, is usually responsible for prescribing NT. In this circumstance, the delivery method of the NSTs' opinion to the prescribing physician to modify NT prescription is important. To date, several tools are used to assist in nutritional decision-making, such as nutrition protocols, text messages, direct telephone communication, pop-up message in the OCS, or visual indicator system. To improve the quality of NT, each hospital has to find the best way of improving the AP's prescription of NT.

Moullet et al. analyzed physicians' perceptions about managing EN in the pediatric ICU (PICU) before and after the application of the nutritional protocol and computerized system with two-stage interviews. They found that the nutrition protocol and computerized system by the NST helped physicians in the PICU to manage nutritional support and increase their attention to nutrition.[10] Chojecka et al. assessed the effects of computerized provider order entry (CPOE) for PN on extremely low-birth-weight neonates in a tertiary neonatal ICU. They retrospectively analyzed preterm infants born over a 1-year period before and after the introduction of CPOE. Significantly more energy ($p < 0.001$), protein ($p < 0.001$), lipid ($p < 0.03$), and carbohydrate ($p < 0.02$) were administered in the CPOE group. The CPOE group had lower weight loss ($p < 0.001$), significant improvement in linear growth, and faster regain of birth weight ($p < 0.01$) compared with the manually calculated group. The CPOE positively influences the quality of PN and significantly reduced initial weight loss, time to regaining birth weight, and linear growth.[11] The nutritional protocol using a computerized system has great power to improve the quality of NT. The studies were conducted on neonates in the PICU, and there was little diversity. However, an adult ICU has much more complex diversity. Patients have different hemodynamic and gastrointestinal functions. It is difficult to develop a universal nutrition protocol to guide the NT prescription in adults, especially in an open-type ICU. Furthermore, it requires a computerized system.

In addition to the simple computerized calculation of NT, the information technology of OCS can help physician's decision-making for NT. Papandreou et al. evaluated the effect of the decision support system for NT on neonatal growth. Their decision support system led to the appropriate composition and administration of PN. Compliance with the guidelines was observed. The decision support system ameliorated intercommunication among physicians and enabled health professionals to facilitate the complex task of prescription. It provided consistency of PN prescriptions and appropriate dosing of all nutrients. It also provided real-time PN interventions and minimized exposure to human errors.[12] Mackay et al. investigated the frequency and severity of PN errors after OCS implementation. The frequency of PN errors in 7 years was 230 in 84,503 PN prescriptions (0.27%), which was much lower compared with the national data that showed 74 of 4,730 (1.6%) prescriptions in 1.5 years before OCS implementation. Order communication system (OCS) and compounding programs eliminated all transcription and related errors.[13] The computer system has a promising positive effect on physician's NT prescriptions. However, they need hardware and software for OCS and education to use the system. It is not suitable for some underdeveloped countries or any hospital with financial problems.

We can use text messages to the AP to improve the quality of NT. We did not find a study that evaluated the effect of text messages to alert the physician for their poor NT prescription. One study evaluated a text message designed for physicians in Nigeria to help smokers quit. Using a pre–post study design, all physicians ($N = 946$) in three tertiary care hospitals located in three geopolitical zones in Nigeria were sent two to three text messages weekly in a 13-week period to provoke the intervention in smoking cessation to their patients. A brief and low-cost text messaging intervention helped physicians to foster smoking treatment among their patients.[14] This indicates that a text message can change physicians' awareness and practice for their NT prescription.

There are much easier and cost-effective intervention methods. Modern people are familiar with traffic lights of red, orange, and green colors. The red color has a warming effect. The green color indicates a favorable state. These color effects are used almost worldwide and are familiar to the youth. Because of its universality, the traffic light colors are used in not only traffic signals but also various divisions, such as food, medicine, and activity. Lagman-Bartolome et al. used traffic light colors for physicians and patients in the application of the Canadian Headache Society guidelines. Green indicated mild headache: "I can still go." Yellow indicated moderate headache: "I have to slow down." Red indicated severe headache: "I have to stop." The traffic light system led to more effective earlier treatment with a reduction in migraine-associated disability. This study showed that a simple traffic light system is easy for patients and practitioners to understand and follow, leading to more effective medication choices and improved treatment outcomes.[15] Sucianti et al. evaluated the effect of traffic light nutrition labels on the acceptability and understanding of nutritional information among patients with hypertension. They used red light for high-salt food. There were significant differences in the increase of nutrition label understanding between the control and intervention groups ($p = 0.047$), and there were differences in the average acceptability score. This showed that traffic light colors are favorable signals for acceptability and understanding of nutrition.[16] We supposed that a VNI using traffic light colors can provoke the physician to modify their NT prescription. The results were promising. It increased the total calorie and protein supply. However, it failed to result in a better prognosis. We think that there are several reasons. The VNI failed to achieve adequate NT for the patients. The patients were still in an underfeeding state. A VNI only provides information about the adequacy of NT. For improvement of the patient's prognosis, in addition to the total amount, delicate information is required in terms of route, speed of supply, and adjunct management. We recommend the study to prove whether VNI with adequate NT information can improve the prognosis of patients. We believe that a VNI can have a maximal effect when education on NT is provided simultaneously. The method of education on NT can be customized according to the circumstances of the hospital. If the circumstance of NT education is poor, a brief audit during rounding can increase the quality of NT. Vega et al. evaluated the quality improvement of protein provision through bedside rounding audits, regular education, and monthly quality improvement meetings. The percent of time meeting protein goals by day 5 was 22, 33, and 71%, and the overall percent of time meeting protein goals was 35, 39, and 75% in groups I, II, and III, respectively (group II vs group III; $p < 0.01$). Simple education during rounding can increase the quality of NT.[17]

This study has limitations. Because of the study design, blinding the participant and researcher was not possible. The ICU was an open type, and the patients had severe diversity in terms of the department, cause of ICU admission, and duration of NT. In a closed ICU, intensivists are usually experts in NT, and the effect of VNI may be trivial.

In conclusion, a VNI indicating the total amount of calories and protein provided can improve the quality of NT. A VNI can be a promising intervention if an OCS and NT protocol is unavailable. However, to obtain a better clinical outcome, education on proper NT should be simultaneously provided to the prescribing physician.

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## Author Contribution

1. Seongpyo Mun 2. Seran Kook Conceptualization: 2, Data curation: 1,Formal Analysis: 1, Funding acquisition: 1, Investigation: 1, Methodology: 1, Project administration: 1, Resources: 1, Software: 1, Supervision: 1, Validation: 1, Visualization: 1, Writing–original draft: 1, 2, Writing–review & editing: 1, 2.

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