—Regular Articles—

Usefulness of a Nutrition Assessment System for Parenteral/Enteral Nutrition Therapy

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Since a nutrition support team (NST) began to work in our hospital in March, 2003, we constructed our original nutrition assessment system that supports the prescription formulation of total parenteral nutrition (TPN). However, in daily NST activities, the re-evaluation of this system became necessary because of a high incidence of enteral nutrition (EN) and marked revisions in the dietary reference intakes in Japanese (7th revision). Therefore, we improved this system and added a prescription formulation support function that is also applicable to EN, and also added a function that automatically calculates the necessary doses of nutrients that tend to become deficient in patients with decubituses. This new system allowed the selection/evaluation of EN solutions in a short time with consideration of the 7th revision, and readily identified deficient nutrients and their levels in decubitus patients. We used this system in patients with high-level malnutrition complicated by decubituses and observed certain treatment effects.

Key words——nutrition support team; assessment system; dietary reference intake; decubitus

INTRODUCTION

In recent years, attention has been paid to nutritional management by a medical team to improve the quality of medical care such as through the prevention of postoperative complications, early discharge, and cost reduction. A nutritional support team (NST) has been actively introduced into many medical institutions. In our hospital, an NST began to work in March, 2003. We previously constructed a nutrition assessment system[1] with a function that produces nutrition assessment sheets enabling the common understanding of patients' nutritional states among medical staff members and a function that supports the prescription formulation of total parenteral nutrition (TPN). However, the re-evaluation of this system became necessary because of an increase in the incidence of enteral nutrition (EN) and marked revisions in the dietary reference intakes in 2005. In particular, a function that readily calculates various nutrients contained in EN products. Therefore, we improved our previous system and added a prescription formulation support function that is also applicable to EN. We report a patient with a tumor complicated by a decubitus who was treated using this system for the maintenance of the tumor state and improvement of the decubitus.

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METHODS AND RESULTS

System Construction The software used for system construction was The FileMaker® Pro 8 Advanced for Windows® and for Mac OS X, which was also the database (DB) software used for our previously constructed nutrition assessment system. The schema of the present system after improvement of the previously reported system is shown in Fig. 1. In the previous system, the nutritional state of patients was assessed by 4 input screens, *i.e.*, subjective global assessment (SGA), physical situation, blood examination, and anthropometry, and based on the nutrition state, the requirements of the total energy expenditure (TEE), carbohydrate, protein, fat, water, and salt/day were calculated on the nutrition requirement calculation screen. Based on the obtained results, TPN prescription formulation was performed. In the present system, in addition to these

functions, results obtained by calculation on the nutrition requirement calculation screen can be used for EN therapy. In the process of improving this system, DB production for EN was difficult because of the lack of a standard nutrient indication method in companies selling EN products and the absence of the indication of ingredients in some leaflets. Figure 2 shows the outline of the newly produced DB. There were 44 items requiring input, including the product name, calories, the contents of water, protein, fat, carbohydrate, fiber, and N-6 and N-3 fatty acids, osmolarity, Fisher ratio, and the levels of 13 types of vitamins and 15 types of minerals. Based on this DB for EN, a system with a function that supports EN was constructed. Figure 3 shows this system. Compared with drugs for injection, EN solutions contain many nutrients requiring consideration, and their standards change with the recommended dietary allowance, adequate intake, tolerable upper intake level, and estimated average requirement of the dietary reference intakes (2005 edition), gender, and age.

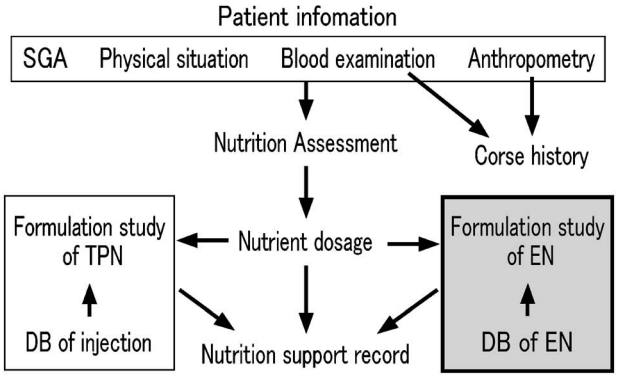

Fig. 1. Schema of the Nutrition Assessment System
The gray areas in the figure indicate improved areas.

This system was constructed so as to allow the comparison and evaluation of these standards readily and instantly. The results calculated as an EN prescription formulation on the nutrient requirement calculation screen are shown in the NST medical record in the left lower area and in the table of assessment results in the middle lower area. Based on these results, EN products are selected from the product list for selection in Fig. 3. To facilitate this selection, the master was improved so that nutrient contents can be compared among various EN products. In addition, as NST records, the requirements of TEE, protein, fat, carbohydrate, water, and the salt equivalent are displayed in the middle lower table in Fig. 3, and differences between these values and the assessment results are shown. A decrease in this difference indicates an increase in the sufficiency rate of TEE and the 3 major

No. 125 Category Drug Aspect Liquid Sales company Otsuka Adoption ◉ Yes ○ No

Pproduct name Racol 200mL Calorie 200 kcal Fluid volume 200 mL(1.0 kcal/mL) Water 170 g

Protein 8.76 g(35.04 kcal) Fat 4.46 g(40.14 kcal) Carbohydrate 31.24 g(124.9 kcal)

Fiber g n-6/n-3 3.17 n-6 950 mg n-3 300 mg Osmolarity 400 Fischer ratio 2.88

Vitamins

Vitamin A 124.2 μg	Vitamin D 0.68 μg	Vitamin B_1 0.76 mg	Vitamin B_2 0.49 mg	Vitamin B_6 0.75 mg
Niacin 6.9 mg	Pantothenic acid 1.92 mg	Folic acid 0.075 mg	Vitamin B_{12} 0.64 μg	Vitamin C 56.2 mg
Vitamin K 125 μg	Vitamin E 1.3 mg	Biotin 7.72 μg		

Minerals

Sodium 147.6 mg	Chlorine 234 mg	Potassium 276 mg	sulfur mg	Magnesium 38.6 mg
Calcium 88 mg	Phosphorous 88 mg	Iron 1.25 mg	Copper 250 μg	Zinc 1.28 mg
Manganese 266 μg	Selenium μg	Chromium μg	Iodine μg	Molybdenum μg

Osmolarity:mOsm/L Vitamin A:Retinol equivalent Niacin:Niacin equivalent (Amount per product)

Fig. 2(A). Basic Picture of Several Nutrients Contained in 200 mL of Racol®

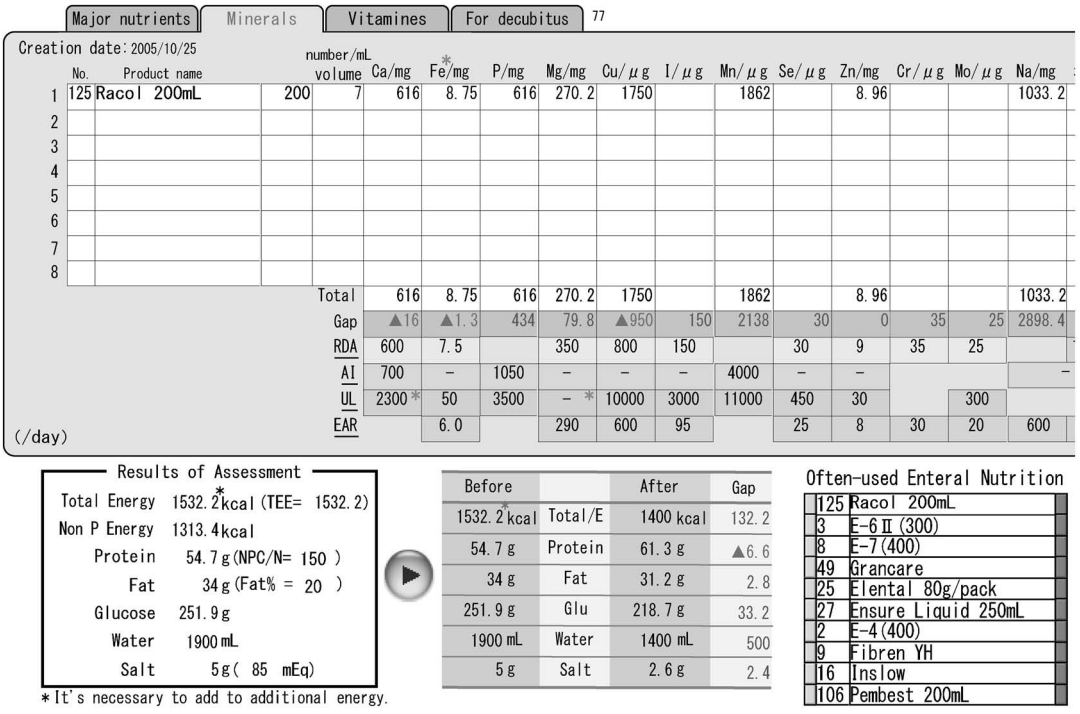

Fig. 3. Supporting System for Prescribing Enteral Nutrition Products
RDA: Recommended Dietary Allowance, AI: Adequate Intake, UL: Tolerable Upper Intake Level, EAR: Estimated Average Requirement.

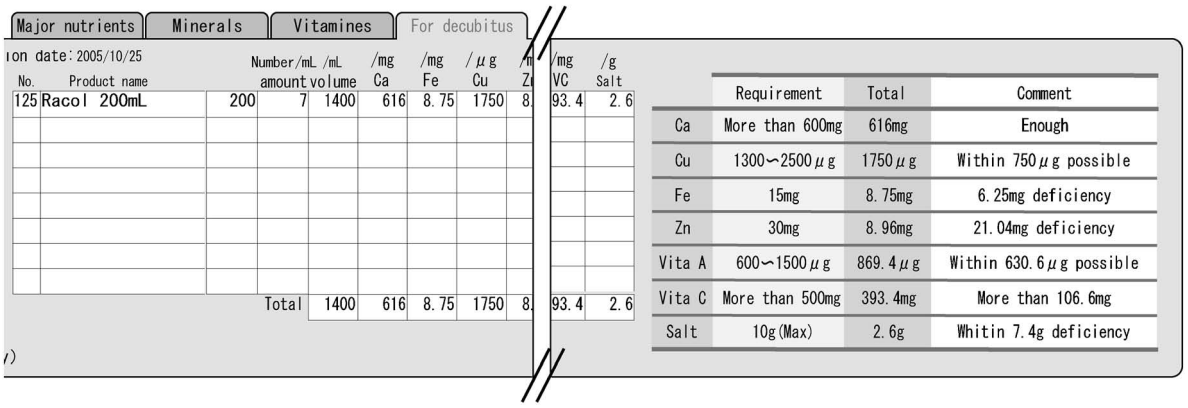

Fig. 4. Supporting System for Malnutrition Therapy of Decubitus

nutrients, which can be readily understood on the screen. As shown in Fig. 4, there is a function that indicates only the requirements of nutrients that tend to be deficient in decubitus patients and automatically calculates the level of deficiency of each nutrient. Patients with general malnutrition in whom this system was used have been previously reported.[2] Therefore, we present below a patient with marked malnutrition complicated by decubituses in whom this system was used.

Case

Patient's Background A 61-year-old male complained of oral bleeding. At the age of 41 years, he developed quadriplegia and dementia as sequelae of a head injury and became bed-confined. At the age of about 50 years, pleomorphic adenoma derived from the salivary gland was detected, and surgery was performed a few times. However, the tumor repeatedly recurred. At the age of 56 years, tracheotomy was performed due to difficulty in breathing because of airway obstruction by the enlarged tumor. He was repeatedly admitted and discharged due to aggravation of the general condition, and underwent percutaneous endoscopic gastrostomy (PEG) because of difficulty in oral nutrition intake a few years earlier.

In February, 2005, he was admitted due to aggrava-

tion of the general condition because of bleeding from the enlarged tumor. Two days before nutritional intervention, since the bleeding volume increased, and the hemoglobin (Hb) level decreased to 5.0 g/dL, emergency blood transfusion was performed.

Course of Nutrition Therapy Intervention by the NST Since the Hb and Alb levels were constantly low due to chronic bleeding from the tumor as the primary disorder, malnutrition screening performed by the NST (Hb$\leq$9.0 g/dL, Alb$\leq$2.7 g/dL) showed that the patient requires nutritional intervention. In addition, he had a large decubitus in the sacral region on admission. After confirming the intention of the patient's family, the NST performed nutrition therapy intervention, aiming to improve his nutritional state to reduce the decubitus.

Nutrition Assessment for Intervention and Nutrition Support by the NST Before NST intervention, 6 bottles/day of Racol® as an EN product (1200 kcal/day) had been administered via the PEG fistula. There was a large decubitus in a concentric circle pattern in the sacral region. The Braden scale was 9, and the decubitus wound area was 27.68 cm^2 (about 5$\times$6 cm). The stage according to the NPUAP (National Pressure Ulcer of Advisory Panel) classification was III, and there was no cutaneous pocket. Nutritional intervention was initiated at the end of May, 2005. To assess nutrition at the time of NST intervention, SGA and anthropometry (knee height, midarm circumference, triceps skinfold thickness) were performed. SGA showed severe malnutrition. Table 1 shows the results of blood examination data and nutrition as-

Table 1. Chemical Laboratory Data of Blood and Nutrition Assessments before Intervention by the Nutrition Support Team

Blood test		
Item	Value	Unit
TP	6.5	g/dL
Alb	1.2	g/dL
ChE	71	IU/L
WBC	5310	/μL
TLC	758	/μL
Hb	5.0	g/dL
TTR	3.2	mg/dL
RBP	1.0<	mg/dL
CRP	5.44	mg/dL
Na^+	130	mEq/L
K^+	3.4	mEq/L
Cl^-	102	mEq/L

Physical status		
Item	Value	Unit
TSF	6	mm
%TSF	67	%
AC	17.6	cm
AMC	15.7	cm
%AMC	67	%
Knee height	46	cm
Estimated body height	161	cm
Estimated body weight	40	kg

A Nutrition Assessment by the NST

- SGA High-level malnutrition
- ODA (Objective data assessment) High-level malnutrition
- Anthropometric Medium-level malnutrition
- Basal energy expenditure 1094.4 kcal/day
- Total energy expenditure (Active factor : 1.0, Stress factor : 1.4) 1532.2 kcal/day
- Nutrient dosage
  Protein 54.7 g/day (NPC/N=150)
  Glucose 251.9 g/day
  Salt 5 g/day
  Fat 34 g/day (Fat% : 20%)
  Water 1900 mL/day

sessment at the intervention. Since Alb level in this patient had been very low (0.8 g/dL) due to increased bleeding 2 days before intervention, an albumin preparation had been administered. Since the measurement of his height and weight was impossible, they were calculated from the knee height using the nutrition assessment system. As a result of the calculation, his basal energy expenditure (BEE) was estimated at 1094 kcal/day. To obtain TEE, the activity factor was set at 1.0, and the stress factor at 1.4 using a case study by the NST, and TEE was calculated to be 1532.2 kcal/day. Since the type of tumor in this patient progresses very slowly, it was unlikely that the tumor further proliferates with an increase in the nutritional intake. Therefore, considering improvement in decubituses to be the primary goal, the stress factor was determined to be 1.4. However, the risk of a further increase in the tumor due to administration of this calculated nutrition could not be completely excluded. Therefore, the NST performed re-evaluation and determined the initial TEE to be 1400 kcal/day and planned to make revisions in nutritional requirements while observing the course of decubituses and influences on the tumor. Based on this TEE, an increase in the dose of Racol® from 6 to 7 bottles/day (1400 kcal) was considered. However, due to the decubitus in the sacral region, the nutritional intake from 7 bottles of Racol® was further evaluated on the administration support screen. As a result, there were no extremely insufficient nutrients compared with the dietary reference intakes in Japanese (2005 edition), but a comparison with the decubitus guidelines showed insufficiencies of vitamin C, iron, zinc, and sodium. Previous studies have reported the intake of V cresc® and Tezon® as foods for insufficient nutrients or the intake of cocoa[3] for Zn deficiency. However, we decided to administer medical drugs rather than foods, considering his economical burden. Ascorbic acid was selected for vitamin C, Incremin® syrup for iron, zinc acetate for zinc, and salt for sodium, and their levels of insufficiency were calculated using the newly constructed system and administered via the PEG fistula. Figure 5 shows the decubitus areas and Alb, transthyretin (TTR), and Hb levels before and after intervention. After intervention, since the amount of exudate from the sacral decubitus increased, the normal skin was macerated, and the decubitus wound area transiently increased, but red granular benign granulation was observed.

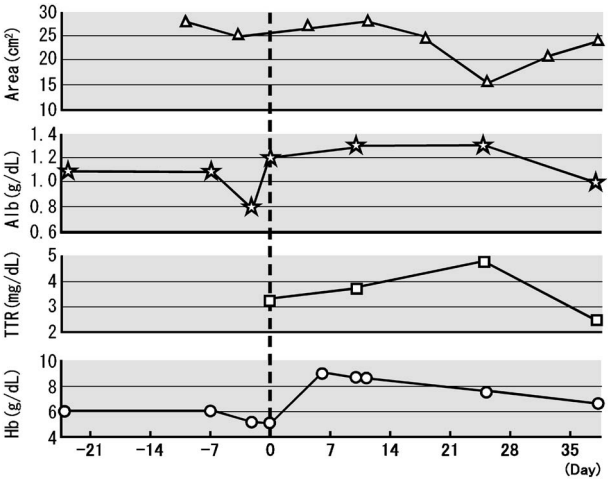

Fig. 5. The Time Course of Changes in Several Parameters due to Intervention by the Nutrition Support Team

The dotted line in the figure indicates day 0 of nutritional intervention by the nutrition support team. From the initiation of nutritional assessment intervention until the 25th day: Treatment using this system by the NST was effective for improving decubituses. After the 25th day of intervention: The general condition was markedly aggravated due to bleeding from the tumor.

After about 1 month, the decubitus area decreased to 15.58 cm^2 (about 4×5 cm). The Alb level had increased to 1.2 g/dL due to albumin administration before intervention, but bleeding persisted. However, after nutritional intervention, the Alb level slightly improved to 1.3 g/dL. TTR can be a parameter of nutritional improvement during a short period due to its short half-life (1.9 days). After intervention, the TTR level increased to 4.7 mg/dL, also showing nutritional improvement. The Hb showed a transient rapid increase due to blood transfusion and nutritional improvement immediately after intervention but gradually decreased thereafter. Twenty-five days after intervention, the patient died of aggravation of the general condition due to bleeding from the tumor as the primary disorder and persisting fever. However, nutritional intervention in this patient may have had no influences on the tumor.

DISCUSSION

In our hospital, 2 years have passed since the initiation of NST activity. We have performed the assessment of the nutrition state of patients, management of blood examination values, and the calculation of nutrient requirements, constructed a system that can be used for TPN prescription formulation, and used it at the time of nutrition intervention by TPN. However, with an increase in cases, the incidence of EN has increased compared with TPN. In 2005, the

dietary reference intakes in Japanese were markedly revised (2005 edition: dietary reference intakes 2005 hereafter), and evaluation of the methods for the use of the revised contents in clinical EN was necessary. With an increase in the use of EN products, we considered that functions for EN based on the dietary reference intakes 2005 should be added to our former system. As a result, the revised contents of the dietary reference intakes 2005 and the amounts of vitamins and minerals in EN products that are actually used in patients could be readily displayed, which allowed the selection and administration of EN products in accordance with appropriate nutrition assessment. However, the dietary reference intakes 2005 are used in healthy Japanese, and their application to patients with malnutrition due to factors such as long-term hospitalization may be difficult, especially in decubitus patients. In this study, the NST in our hospital performed nutrition intervention in a patient with a large facial tumor complicated by a decubitus who could not take nutrients orally. In decubitus treatment, in addition to body pressure dispersion and local control, nutrition management is indispensable. In nutrition management, the determination of the administration doses of nutrients is a major point, because the intakes of calcium, copper, iron, zinc, vitamin A, vitamin C, and salt are considered to be crucial.[4] Based on this evidence, we added a function that readily calculates requirements for deficient nutrients. Using this system, lacking nutrients and measures against these deficiencies in decubitus patients could be readily and rapidly evaluated. In addition, the NST members could readily obtain information on EN products not only as drugs but also as foods, and could make concrete proposals for general nutrition therapy. In this patient, excessive or deficient nutrients and measures against them could be rapidly evaluated using our original nutrition support system. Appropriate supplementation of vitamins and minerals indispensable for decubitus healing resulted in improvement in the decubitus despite low serum albumin and hemoglobin levels. The NST is often managed using the Potluck Party Method[5,6] in many institutions. However, pharmacists in the NST should not only deal with EN products as medical drugs but also select EN products as foods in cooperation with registered dietitians. In addition, for decubitus patients, pharmacists should learn not only nutrition management but also acquire knowledge and techniques over a broad range such as those for local management including management with wound dressing materials.

Considering the usefulness of intervention in nutrition therapy by the NST for preventing decubituses and the time lag until the appearance of the effects of nutritional improvement on the decubitus wound, nutrition improvement measures should be rapidly taken, and our new system can facilitate this.

CONCLUSION

In recent years, electronic medical records have been introduced into many medical institutions. In our hospital, the introduction of electronic medical records is planned. Therefore, we intend to further improve this system so that it will be useful for supporting prescription formulations of TPN and EN in daily clinical treatment. An abstract of this study was reported in the 21st meeting of the Japanese Society for Parenteral and Enteral Nutrition (January, 2006 in Gifu) and the 5th Japan-Korea Joint Symposium for Clinical Information on Parenteral Drugs (July, 2006 in Seoul). The publication of this case was discussed and approved by the Ethical Committee, Faculty of Medicine, Yamagata University.

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