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The Importance of Nutrition in Neurological Disorders and Nutrition Assessment Methods

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HIGHLIGHTS

- For neurological patients, it is important to identify nutritional deterioration at an early stage.
- Changes in their body composition should be taken into account in the nutritional assessment.
- It is necessary to understand the characteristics and scope of each nutrition assessment tool.

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ABSTRACT

Neurological disorders can change patients' nutritional status by directly or indirectly affecting dietary intake through mechanisms such as dysphagia, movement disorders, cognitive impairment, and depression. Malnutrition contributes to complications, resulting in delayed rehabilitation and increased morbidity and mortality. It is important to prevent malnutrition in patients with neurological disorders and to improve their nutritional status by identifying nutritional deterioration at an early stage and implementing appropriate nutritional interventions. This review examines the nutritional screening and assessment process in patients with neurological disorders, with a particular focus on stroke patients undergoing rehabilitation. Nutritional assessment, the first step of clinical nutrition management, identifies nutritional problems and their causes, signs, and symptoms through an overall evaluation including anthropometric measurements, dietary assessments, biochemical assessment, nutrition-related physical examinations, and functional assessment data. Based on the assessment, a nutritional intervention plan is established. By synthesizing the assessment results of selected subjective and objective indicators, nutritional screening tools to screen patients at risk of malnutrition and nutritional assessment tools to diagnose malnutrition were developed. It is important to use those tools with a clear understanding of their characteristics and scope.

Keywords: Neurologic Disease; Nutrition Assessment; Nutrition Screening

INTRODUCTION

Neurological disorders can change patients' nutritional status by directly or indirectly affecting dietary intake through mechanisms such as dysphagia, movement disorders, cognitive impairment, and depression. Malnutrition contributes to complications, which delay rehabilitation and thereby lead to increased morbidity and mortality. It is necessary to identify patients at risk for malnutrition at an early stage during rehabilitation, as well as in the acute phase immediately after traumatic brain injury and stroke, and provide appropriate nutritional interventions, including nutritional support [1]. Patients with chronic neurological disorders such as dementia are also at high risk of developing malnutrition due to reduced nutritional intake and increased energy consumption. The cognitive function

of individuals with severe dementia is impaired, making it difficult to perform the physical activities necessary for daily life, including preparing meals and even the act of eating; as a result, dementia patients often experience weight loss, which is associated with a poor prognosis [2]. Patients with Parkinson's disease also gradually develop dysphagia, digestive problems, fatigue, depression, and impaired cognitive function, making food intake difficult and leading to malnutrition [3]. Therefore, it is important to prevent malnutrition in patients with neurological disorders and improve their nutritional status by identifying nutritional deterioration at an early stage and implementing appropriate nutritional interventions. This review examines the nutritional screening and assessment process in patients with neurological disorders, with a particular focus on stroke patients undergoing rehabilitation.

PREVALENCE OF MALNUTRITION IN PATIENTS WITH NEUROLOGICAL DISORDERS AND ITS EFFECTS ON THEIR CLINICAL COURSE

The prevalence of malnutrition in patients hospitalized for stroke ranges from 1.95% to 60.5%, depending on the assessment tool and diagnostic criteria [4-6]. Studies have reported that nutritional status at the time of stroke and traumatic brain injury affects the progress of acute-stage treatment [4,7-9]. Malnutrition during rehabilitation affects the progress of medical treatment and is associated with increased rates of mortality, readmission, and discharge to other institutions and higher medical costs [6,10,11]. In a study that followed 1,056 ischemic stroke patients aged 65 or older for 4.74 years, malnutrition was a significant risk factor for mortality [6]. In Australia, a study of 57 elderly patients in a rehabilitation hospital showed that patients with malnutrition had higher rates of readmission and transfer to long-term care institutions instead of being discharged home [10]. In Japan, a study on elderly patients aged 65 or older participating in rehabilitation, including stroke patients reported a correlation between malnutrition at admission and Functional Independence Measure (FIM) scores at discharge [12]. In a study that analyzed medical costs up to 3 months and 12 months after stroke, patients with malnutrition had higher medical costs than those with good nutritional status; these increased costs were linked to hospitalization in long-term care institutions, long-term medication prescriptions, and a higher frequency of emergency room visits [11]. Therefore, delays in treatment and increased morbidity due to malnutrition during rehabilitation increase medical costs.

CAUSES OF MALNUTRITION IN PATIENTS WITH NEUROLOGICAL DISORDERS

Neurological disorders can cause problems in chewing and swallowing or impair functionality in daily life (e.g., the ability to handle utensils for eating). Depression, which is often seen in patients with chronic neurological disorders, also increases the risk of malnutrition. Impairment of cognitive function makes it difficult to purchase and prepare food and increases the risk of malnutrition, which in turn impedes the recovery of cognitive function [13]. Apraxia, communication difficulties due to language function impairment, breathing difficulties, and dietary restriction associated with therapeutic diets can reduce nutrient intake. Gastroparesis due to Parkinson's disease [14] or diabetes can lead to decreased intake due to symptoms such as decreased appetite, early satiety, nausea,

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vomiting, regurgitation, and abdominal distension. Constipation frequently occurs as a result of delayed gastric emptying, decreased intestinal motility, decreased abdominal muscle strength, autonomic nerve dysfunction, and adverse effects of medications. Reduced food and water intake itself can cause constipation. Dysphagia makes it difficult to consume sufficient amounts of food or beverage, and it should be noted that water intake can be insufficient when viscosity modifiers are used. If porridge or gruel is mixed to adjust the texture of solid food according to the patient's swallowing function, the nutrient density of the food is lowered, contributing to a decrease in nutritional intake. Thus, the symptoms of patients with neurological disorders affect their nutritional status, making it necessary to consider those symptoms in nutritional assessments.

NUTRITIONAL ASSESSMENTS IN PATIENTS WITH NEUROLOGICAL DISORDERS

A nutritional assessment is a systematic process of collecting, assessing, and interpreting the data necessary to identify nutrition-related problems, their causes, and their severity. Using data collected from a nutritional assessment, the patient's nutritional problems and their causes are identified, and a goal and plan for nutritional intervention are established and implemented. Nutritional monitoring and evaluations should also be conducted to determine whether a nutritional intervention has successfully resolved a patient's nutritional problems. Therefore, data including nutrition intake status, physical measurements, clinical and biochemical examinations, medical diagnoses, and the patient's clinical status should be reviewed together.

Anthropometric measurement

It is relatively easy and economical to evaluate height, weight, body mass index (BMI), and the ratio of a patient's current weight to his or her ideal or usual body weight. If height and weight cannot be measured in the standing-up position due to the symptoms of a neurological disorder, height can be estimated by measuring spine length [15], and an in-bed scale or wheelchair scale can be used to measure weight. However, it should be noted that it is difficult to identify underlying weight loss if a patient also has body fluid accumulation such as ascites or edema. Recent weight change is more clinically important than the percentage of the ideal body weight. Kishimoto et al. [16] found that, among 293 patients hospitalized for rehabilitation after stroke, the FIM score showed a tendency to improve in patients who maintained or increased their weight compared to those who lost over 5% of their weight in 6 months, and a positive correlation was identified between weight maintenance and higher intake compared to patients' energy requirements [16]. In general, if an adult loses more than 5% of his or her weight within a month or 10% or more in 6 months, an overall assessment of nutritional status is required. Rapid weight loss within several days indicates a possibility of dehydration. In particular, the adequacy of fluid intake should be assessed in patients who experience dysphagia for liquid.

Body composition changes over the long term in the presence of paralysis. Muscle mass decreases and the body fat ratio increases due to the absence of movement, which can increase the risk of chronic diseases such as obesity, diabetes, and cardiovascular disease. Therefore, it is important to maintain an adequate weight when a patient's medical status stabilizes after the acute phase and rehabilitation starts [17]. Patients' muscle mass and body fat ratio may be different from those of members of the general public at the same

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weight, resulting in a different amount of energy consumption. Therefore, an assessment of body composition helps to establish nutritional intake goals. Measurements of the triceps skin-fold thickness, mid-arm circumference, and mid-arm muscle circumference, as well as body composition analysis using bio-electrical impedance, can be used. The triceps skinfold thickness should be evaluated at regular intervals by an experienced person to obtain meaningful results, and it may be affected by changes in body fluid such as edema. Bio-electrical impedance analysis can be used to evaluate body composition relatively accurately, rapidly, and safely. This method applies the principle that the resistance to electric current varies according to body composition, including body fat, muscle, and water. Since some results are estimated in the calculations, the characteristics of the machine and measurement error must be considered. Dual-energy X-ray absorptiometry can measure short- and long-term changes in body composition and body fat mass. It is considered the gold standard for body composition analysis, since it provides accurate information on body fat distribution in the extremities and trunk, but it is mainly used for research purposes.

Nutrition-related biochemical assessment and physical examination

The results of biochemical assessment and swallow function test are checked to determine whether nutritional intervention plan should be adjusted. Nitrogen balance reflects changes in nutritional status related to protein in the body relatively well, and it can be used as an indicator for nutritional monitoring and evaluation to determine the patient's baseline nutritional status and the effects of nutritional interventions. An accurate assessment is enabled by accurate measurements of protein intake from all kinds of sources and collection of complete 24-hour urine volume. It is difficult to make an accurate assessment if there is renal dysfunction or increased nitrogen loss due to diarrhea, vomiting, or burns. Although visceral proteins (most notably, prealbumin) are often included in the results of biochemical tests, it is difficult to use these parameters as indicators of nutritional status, since their synthesis decreases when acute-phase protein synthesis increases due to physical stress.

In a nutrition-related physical examination, the clinician checks symptoms related to nutritional status including edema, loss of muscle or body fat, and micronutrient deficiencies. The degree of subcutaneous fat loss can mainly be assessed by observing the eye rims, upper arm, ribs, and ilium, and muscle mass loss can be assessed by observing the temple, clavicle, scapula, the back of the hand, the knee area, the thigh, and the calf [18].

Dietary assessment

Nutritional intake is calculated using a nutrition analysis program after examining the patient's food intake through a food diary, 24-hour recall, and food frequency questionnaire. A food diary should be kept for a period of 3–7 days, including the weekend, and this method is more reliable than 24-hour recall and food frequency questionnaire, which rely on the patient's memory. An analysis of meals can provide information on nutritional intake, as well as recent meal patterns and changes therein. Since nutritional interventions center on adjusting a patient's nutritional intake by adjusting meal plan, supplying nutritional supplements, and providing nutritional support, an accurate assessment of intake is important for an appropriate nutritional intervention. These results should also be used complementarily to the results of other nutrition-related tests and anthropometric assessment results.

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DIAGNOSIS OF MALNUTRITION

Malnutrition is simply defined as a nutrition imbalance. Malnutrition in adults results from insufficient intake, increased nutrients demands, and decreased nutrient absorption and utilization. An inflammatory response is also an important risk factor of malnutrition and may contribute to a decreased response to nutritional interventions and an increased risk of death. Since nutritional status cannot be accurately assessed using only one test result or indicator, nutritional problems and their causes, signs, and symptoms should be identified by assessing the results of anthropometric measurements, biochemical tests, analysis of nutrient intake, and a functional assessment. By synthesizing the results of assessments of selected subjective and objective indicators, nutritional screening tools to screen patients at risk of malnutrition and nutritional assessment tools to diagnose malnutrition were developed.

Malnutrition of hospitalized patients is more likely to be attributed to the inflammatory response and consequent metabolic hypertrophy and catabolism rather than inadequate nutrient intake. Therefore, the malnutrition diagnostic criteria developed by the Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition recommend considering the etiology such as degree and duration of the inflammatory response due to acute and chronic diseases [19]. Six indicators (meal intake change, weight loss, body fat loss, muscle loss, body water accumulation, and grip strength) are assessed, and malnutrition is diagnosed if two or more of these indicators meet the criteria.

In 2016, the Global Leadership Initiative on Malnutrition (GLIM), consisting of related societies around the world, established criteria for diagnosing malnutrition. The degree of malnutrition (moderate or severe) is evaluated based on unintentional weight loss, low BMI, and muscle mass loss, and whether the cause is decreased food intake, inflammation, or disease is determined [20].

The tools developed for diagnosing malnutrition include the Subject Global Assessment (SGA) and Mini-Nutritional Assessment (MNA). The SGA was developed to assess the risk of complications in patients with gastrointestinal surgery. It consists of questions about recent changes in weight, meal intake, digestive symptoms, and systemic function, as well as parameters assessed by observation, such as subcutaneous fat, muscle loss, edema, and ascites. A blood test is not required and the nutritional status is assessed in three stages by subjective judgments of 7 items. Well-nourished, mildly malnourished or suspected of malnutrition, and severely malnourished status are classified as grades of A, B, and C, respectively [21]. The MNA is a tool developed to assess malnutrition in elderly individuals in long-term care institutions. It includes 6 questions on physical measurements and subjects' systemic condition, 8 questions on diet, and 3 questions on self-evaluation of health [22]. A score of 24 or higher out of a total of 30 points is considered as indicating good nutritional status, a score of 17 to 23.5 indicates a risk of malnutrition, and a score of fewer than 17 points indicates malnutrition. The sensitivity and specificity were reported to be as high as 96% and 98%, respectively.

NUTRITIONAL SCREENING

Nutritional screening is performed to select patients for nutritional interventions through a comprehensive and in-depth nutritional assessment. It is distinct from a nutritional

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assessment. Nutritional screening indicators or tools should be able to select patients at risk of malnutrition reliably, rapidly, simply, and efficiently. Multiple nutritional screening tools have been developed for adult patients. The Nutrition Risk Screening 2002 (NRS-2002) was developed to predict the risk of complications by assessing the risk of malnutrition in patients hospitalized for acute treatment [23]. No nutritional screening tool has been verified only among patients with neurological disorders, but the application of nutritional screening tools developed for elderly hospitalized patients can be considered for patients with stroke, dementia, and Parkinson's disease.

Mini Nutritional Assessment-Short Form (MNA-SF)

The MNA-SF (version 1) consists of 6 items extracted from the MNA, and version 2 allows BMI to be replaced by the calf circumference if the subject's height and weight cannot be measured. Using the full MNA results as the gold standard, the MNA-SF version 1 and version 2 showed high sensitivity and specificity [24]. However, this result may have been due to the fact that the MNA-SF contains only 6 items, in which context the finding that the MNA-SF can replace the MNA, which consists of 17 items, can be interpreted as confirming its validity. A study that compared the MNA-SF with the SGA found that its sensitivity was high, but its specificity was low [25]. The efficacy of this tool should be verified through an in-depth nutritional assessment by a dietitian or an evaluation of its sensitivity and specificity for malnutrition according to the nutritional diagnostic criteria of the American Society for Parenteral and Enteral Nutrition or the GLIM diagnostic criteria.

Malnutrition Universal Screening Tool (MUST)

The MUST, a nutritional screening tool developed by the British Association for Parenteral and Enteral Nutrition for hospitalized adult patients, classified patients as being at low, medium, or high risk for malnutrition based on 3 factors: 1) BMI, 2) unintended weight loss in 3–6 months, and 3) acute illness with no nutritional intake for over 5 days. Patients at high risk for malnutrition should be referred to a nutritional specialist. Its sensitivity and specificity were also reported to be high with reference to the SGA and MNA [25], and it is appropriate as a nutritional screening tool for hospitalized elderly patients. It can be used in the acute phase of stroke according to the guideline for clinical nutrition in neurology developed by the European Society for Parenteral and Enteral Nutrition [26].

Geriatric Nutrition Risk Index (GNRI) and Controlling Nutrition Status (CONUT)

The GNRI, which was developed as a nutrition screening tool for hospitalized elderly patients, selects high-risk patients for malnutrition based on the plasma albumin concentration and the ratio of the current body weight to the ideal body weight [27]. The GNRI was reported to be correlated with morbidity, mortality, and length of hospital stay. The CONUT includes albumin, total lymphocyte count, and cholesterol [28] as factors to calculate a malnutrition risk score. A study determined that the CONUT could be used in elderly patients by validating it using patients' medical progress, the MNA, and the SGA. Although biomedical tests such as albumin, total lymphocyte count, and cholesterol are performed in most hospitalized patients, and the test results are indicators that can be easily and quickly calculated through the hospital's electronic medical records without requiring an interview with the patient [24], these findings may be affected by physical stress or the patient's immune condition rather than nutritional status [24]. Therefore, the CONUT can be considered as a nutritional screening tool to identify patients at risk of malnutrition who need an overall nutritional assessment to determine whether a nutritional intervention should be provided, but it has a limited ability to be used to diagnose malnutrition.

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CALCULATION OF NUTRITIONAL REQUIREMENTS

In the nutritional assessment process, nutritional requirements appropriate for the patient's condition are calculated, and the collected data are compared to these requirements to set the goal for the patient's nutritional supply. Although indirect calorimetry is the optimal method of measuring energy consumption, yielding values that can be used to estimate energy requirements, this method is difficult to apply in real-world conditions, and estimation formulas are mainly used. An individual's energy requirement is the sum of the basal metabolic rate, physical activity, and the specific dynamic action requirement of food. The basal metabolic rate is defined as the amount of calories required to sustain life, including respiration and cardiac function, and generally accounts for about 60%–80% of daily energy consumption. In a normal person, the energy required for physical activity accounts for 15%–20% of the total energy, and the energy for the specific dynamic action of food accounts for 10%. Various formulas have been developed to calculate energy requirements. Although energy requirements increase immediately after traumatic brain injury or stroke, the metabolic rate decreases to the pre-injury level at some point during rehabilitation. Energy consumption even decreases in paralyzed patients with limited activity, and this decrease is exacerbated as muscle loss progresses. In a study measuring energy consumption using indirect calorimetry for 3 months immediately after stroke, the energy requirements were about 1.1 to 1.15 times the basal metabolic rate calculated by the Harris-Benedict formula [29]. Patients with dysphagia, especially those on an oral diet, are at high risk of insufficient energy intake and malnutrition due to insufficient food and beverage consumption. However, in some patients including those who are stably supplied with tube feeding, there is also a risk of overweight and obesity due to excessive energy intake. Therefore, it is necessary to regularly monitor and assess the amount of nutrition in order to ensure that an adequate level of nutrition is provided. A simple way to calculate energy requirements is to multiply a coefficient per kilogram of body weight. For elderly individuals with chronic diseases and very little activity, 20–25 kcal/kg is considered to be a realistic recommendation [30].

The recommended protein intake for Korean adults is 0.91 g/kg, and 1.0–1.5 g/kg is recommended depending on the degree of protein demand since the protein requirement increases in response to trauma or metabolic stress. The protein requirement is preferably adjusted according to the nitrogen balance. Since the nitrogen balance is not only affected by protein intake, calories and protein intake should be increased together in patients with a negative nitrogen balance. Patients with renal failure or liver disease should follow the recommended protein intake for their specific disease according to its severity and treatment. For patients with bedsores, the energy and protein intake should be increased for wound healing.

Nutritional requirements determined using formulas are estimates; therefore, they can serve as a guideline for starting nutrition supply, but they should not be used rigidly. Changes in weight and body composition, blood test results, and the patient's systemic condition should be evaluated regularly, and the nutrition supply should be adjusted accordingly.

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CONCLUSION

Patients with neurological disorders are prone to malnutrition due to factors such as dysphagia, movement disorders, cognitive impairment, and depression. Malnutrition negatively affects patients' clinical course and increases medical costs. The nutritional assessment of patients with neurological disorders should include an overall evaluation of their nutrition intake, anthropometric measurement, biochemical tests, medical diagnoses, and clinical condition. During rehabilitation after the acute phase, it is important for patients to maintain adequate weight. This can be achieved by comprehensive and in-depth nutrition assessment with appropriate consideration of changes in body composition and adequate nutrition intervention.

Although nutritional screening tools to identify patients at risk of malnutrition have been developed, as well as criteria and tools for diagnosing malnutrition, no tools have been verified through prospective large-scale studies on patients with neurological disorders. When applying nutritional screening tools and tools for diagnosing malnutrition, it is necessary to understand the purpose, background, strengths, and limitations of each tool. Biochemical indicators such as albumin, cholesterol, and the total lymphocyte count can be affected more strongly by physical stress than by nutritional status. Hence, clinicians should be cautious regarding the diagnosis of malnutrition using criteria that include these results as the main assessment indicators.

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