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Review Article

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Nutritional Screening Tools among Hospitalized Children: from Past and to Present

Yeoun Joo Lee

Department of Pediatrics, Pusan National University Children's Hospital, Yangsan, Korea

Increased awareness of the importance of nutrition among hospitalized children has increased the use of nutrition screening tool (NST). However, it is not well known the NST for hospitalized children. Therefore, the purpose of this study is to understand the past and present state of adult and child NST and discuss the pros and cons of each NST.

Key Words: Nutrition, Screening, Malnutrition, Child

INTRODUCTION

Nutrition management is essential for the outcomes of patients receiving advanced medical care. Nutritional support prevents complications from infections and shortens the length of hospital stay [1,2]. A recent study about medical cost related to malnourished hospitalized patients has proven that a comprehensive nutrition-focused quality improvement program reduced the per-patient healthcare cost [3].

Although there is a growing interest in preventing malnutrition in hospitalized patients, the recent study has also shown that the prevalence rate of malnutrition among hospitalized children ranged from 7.5% to 17% in Europe [4,5]. In a study in Korea, the prevalence of malnutrition among hospitalized children and adults were 12.5% and 22%, respectively [6,7].

To systematically manage the nutrition of hospitalized patients, the European Society for Parenteral and Enteral Nutrition (ESPEN) and American Society for Parenteral and Enteral Nutrition (ASPEN) recommended the use of the guidelines on nutritional screening to identify hospitalized patients who are at risk for malnutrition [8,9]. The guidelines suggested the identification of patients at risk for malnutrition and provision of interventions and treatments to these patients with the help from a multidisciplinary team of doctors, dietitians, nurses, and pharmacists [10]. Furthermore, the Joint Commission in the United States proposed the nutritional screening of all patients within 24 hours after admission.

The use of appropriate nutrition screening tools (NSTs) is important. Overly complex NSTs are difficult to access, whereas the simplicity but poorly vali-

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Corresponding author: Yeoun Joo Lee, Department of Pediatrics, Pusan National University Children's Hospital, 20 Geumo-ro, Mulgeum-eup, Yangsan 50612, Korea. Tel: +82-55-360-2180, Fax: +82-55-360-2181, E-mail: moonmissing@gmail.com

dated still has limit. NSTs should be practical, reliable, valid, and evidence based [11]. This study aimed at validating the characteristics, application, and validation results of the available NSTs that are used for hospitalized children.

NSTs FOR HOSPITALIZED ADULTS

A variety of NSTs that can be used to screen hospitalized adult patients were developed. The main concept for nutrition screening had started from improving surgical outcomes. The prognostic nutritional index [12] and prognostic inflammatory and nutritional index [13] published in the 1980s were used as the primary index to screen for nutrition based on triceps skin fold, skin sensitivity, and albumin, prealbumin, or transferrin level. With the emphasis of the importance of nutritional screening, NSTs have been developed to improve its accessibility and validity. In the 1990s, several NSTs were developed such as the nutritional risk index (NRI) [14], Birmingham nutrition risk score [15], nutrition risk classification (NRC) [16], and malnutrition screening tool (MST) [17]. They had changed their focus on history taking and physical examination findings. Appetite, dietary intake, weight loss, or body mass index was used as an index of NSTs.

Since 2000, representative screening tools, such as simple screening tool [18], malnutrition universal screening tool (MUST) [11], nutritional risk screening (NRS) 2002 [19], short nutritional assessment questionnaire (SNAQ) [20], and recent Canadian nutrition screening tool [21], have been developed and are still used. The presence of acute disease and severity of the diagnosis along with anthropometric measurements and dietary factors are considered important in the use of MUST and NRS 2002, which are among the NSTs developed since the 2000s. Subjective global assessment (SGA) [22] and mini nutritional assessment (MNA) [23] are convenient assessment tools not only assessing but also screening of the nutritional status. SGA is a method of nutritional assessment based on medical history (weight and diet changes, primary diagnosis, and stress level) and physical symptoms (presence of subcutaneous fat, muscle wasting, ankle edema, ascites, functional capacity, and gastrointestinal symptoms).

A validation study on the individual screening tool, medical environment, and population and age groups has been published in a variety of countries. Moreover, several researches compared each screening tool that was used in a limited setting [24-27].

Aside from the universal NSTs, NST for a specific disease has also been developed, considering the specific nature of the disease. Several NSTs were developed for specific diseases, such as cirrhosis [28], cancers [29], and cerebral palsy [30], and critically-ill patient groups [31].

SCREENING TOOLS FOR HOSPITALIZED CHILDREN

Studies on NSTs for children are limited compared to those of adults. Secker and Jeejeebhoy [32] have used the SGA for hospitalized children who underwent major thoracic or abdominal surgery. A correlation was observed between malnourished children and a higher risk of developing nutrition-associated complications and prolonged hospitalizations. A Brazilian study that used SGA for children with acute illness had found an association between the SGA score and anthropometric measurement. However, no association was observed between the SGA score and length of hospital stay [33].

In 2000, Sermet-Gaudelus et al. [34] have published the pediatric nutritional risk score (PNRS) by developing a unique equation with the study endpoint at $>2\%$ weight loss during the first week of admission. The factors for PNRS are food intake $<50\%$, pain, and the presence of pathologic conditions. Each component can be assigned a score from 1 to 5. Unlike other NSTs, PNRS did not use anthropometric data.

In the UK, the screening tool for the assessment of malnutrition in paediatrics (STAMP) [35] was established in 2004 and evaluated in 2007. To evaluate the quick and easy-to-use NSTs for hospitalized children, three factors were considered: diagnosis, nutri-

tional intake, as well as weight and height. After evaluating these factors, the sum was classified into low, medium, and high risk, and the TAMP also suggested that a care plan in the last step.

In a large tertiary children's hospital in the UK, the pediatric Yorkhill malnutrition score (PYMS) [36] was developed for nutritional screening, and the PYMS used four factors for the screening: body mass index, history of recent weight loss, changes in nutritional intake, and the predicted effect of the current medical condition on nutritional status. PYMS used anthropometric data for two of the four factors by placing weight on the anthropometric data, and subjective data were also used for the effect of the current medical condition.

In 2009, the Dutch Society published the national survey results to test their own NST for the screening tool for risk on nutritional status and growth ($STRONG_{kids}$) [37]. They also focused on developing $STRONG_{kids}$ to improve its applicability. They used four factors for the subjective assessment, high-risk disease, nutritional intake/losses and weight loss/poor weight gain, and a score of 0 to 2 was provided. Like PYMS, $STRONG_{kids}$ also recommended a nutritional intervention for each risk.

Recently, the pediatric digital scaled malnutrition risk screening tool (PeDiSMART) [38] was introduced for hospitalized children by using computer-based information systems in Greece. One of the significant advantages of PeDiSMART is its high reproducibility. Moreover, it can help professionals save time. The factors are weight-for-age z score, nutritional intake level, overall disease impact, and disease symptoms affecting intake. Weight loss might be significantly associated with nutrition support during hospitalization in the PeDiSMART malnutrition risk group after adjusting anthropometric data.

Pediatric nutrition screening tool (PNST) [39] consists of four simple questions that a child's caregiver can answer with Yes or No. Among the four questions about recent weight loss, poor weight gain over the last few months, poor oral intake within the last few weeks, and obvious weight loss or gain based on the PNST, two affirmative responses can identify patients who are at risk. Moreover, a correlation between nutrition risk identified using the PNST and pediatric SGA was observed. PNST also correlated with nutritional status using z-score. PNST may be the easiest NST that can be used. However, interrater reliability or reproducibility data are limited.

Except for PNST, most of the NSTs established the nutritional risk based on three categories: low (mild or grade 1), medium (moderate or grade 2), and severe (grade 3). All the NSTs used to monitor intake evaluate at least one factor for nutritional screening. Although PNRS did not focus on anthropometric data, all the other NSTs focused on weight and height or recent weight loss. NSTs for hospitalized children are summarized in Table 1 [34-39].

VALIDATION STUDY ABOUT NSTs FOR HOSPITALIZED CHILDREN

A limited number of studies about NSTs for hospitalized children compared with those for adults are available. There are studies that compared several representative NSTs [40-46]. Although some studies considered that the PNRS is the most suitable for clinical practice since the results of high sensitivity and specificity in PNRS compared with SGA [40,43]. However, in New Zealand, a study has shown that $STRONG_{kids}$ was the most reliable NST in their clinical setting [45]. Moreover, there are other reports that have reported that the $STRONG_{kids}$ was the most suitable for clinical use [42,46]. Even in studies about acute burn injuries, it is difficult to conclude that one NST is superior than the other [47]. A study that used PeDiSMART has shown a correlation among PYMS, $STRONG_{kids}$, and STAMP. In addition, the area under the curve for weight loss/nutrition support and the length of hospital stay ($>$7 days) was superior to that of the other three indicators [38]. However, newly developed NSTs, such as PeDiSMART and PNST, have not been fully validated.

Table 1. Nutrition Screening Tools Made for Hospitalized Children and Representative Validation Study of Each NST

Name of NST	Country	Number of subjects	Factors used in the NST					Score
			Number of factors	Anthropometry	Appetite or food intake	Diagnosis or pathologic conditions	Others	
PNRS [34]	France	296	3		Food intake <50%	Pathologic condition	Pain	1 to 5
STAMP [35]	UK	122 (developing) 238 (evaluation)	3	Weight and height	Nutritional intake	Diagnosis		0 to 9
PYMS [36]	UK	247	4	Body mass index, history of recent weight loss	Changes in nutritional intake	Predicted effect of the current medical condition on the nutritional status		0 to 7
$STRONG_{kids}$ [37]	Netherlands	424	4	Weight loss or poor weight increase	Nutritional intake and losses	High risk disease	Subjective global assessment	0 to 5
PeDiSMART (computer software) [38]	Greece	500	4	Weight-for-age z score	Nutrition intake level, symptoms affecting intake	Overall disease impact		0 to 18
PNST [39]	Australia	295	4	Recent weight loss, poor weight gains over the last few months, obviously underweight/ significantly overweight	Eating/feeding less in the last few weeks			0 to 4

NST: nutrition screening tool, PNRS: pediatric nutritional risk score, STAMP: screening tool for the assessment of malnutrition in paediatrics, PYMS: pediatric Yorkhill malnutrition score, $STRONG_{kids}$: screening tool for risk on nutritional status and growth, PeDiSMART: pediatric digital scaled malnutrition risk screening tool, PNST: pediatric nutrition screening tool.

DISEASE-SPECIFIC SCREENING TOOLS

A study on paradigm shift was also conducted for the evaluation and treatment of children with disease-specific malnutrition [48]. Since malnutrition is a serious health problem in children with cancer, malnutrition in these children has been a topic of interest. The nutrition screening tool for childhood cancer (SCAN) was developed in Australia and had an excellent accuracy in term of pediatric SGA [49]. It is difficult to identify poor nutritional status with a simple method, and researchers attempted to assess and treat poor nutrition in pediatric patients with cancer [50,51]. Although this tool is not only for hospitalized children, a NST for children with cystic fibrosis is also available [52].

CAN THE NST OBTAIN SIMILAR RESULTS REGARDLESS OF PERFORMER?

Nutritional screening after hospitalization is usually performed by nurses. However, nutritional assessment in hospitalized children is usually conducted by a clinical dietitian. Several screening tools that can be used by nurses during the developmental stage have been developed [11,36]. In addition, a validation study is usually performed by research dietitians [36]. Good reproducibility without obtaining different results depending on the performers is

one of the important factors of a good screening tool. A study about the validity and reliability of nutritional screening in adults by two independence nurses within 24 hours of admission was conducted. The article reported that even within the same occupation, inter-observer agreement showed 78.3%, though 100% agreement in detecting severely malnourished patients [53]. To overcome these differences in the performer's distinction, PeDiSMART attempted to increase its reproducibility by using a computer software [38]. Whether NST can reproduce similar results regardless of the performer must be highly considered.

CONCLUSION

To date, the performance accuracy of NSTs for children and adults are still being developed. Previous studies do not show that any screening tool is superior than the other. Screening tools that tailored for each hospital and diagnosis and those with excellent reproducibility regardless of performers must be developed. However, in actual settings, this cannot be easily performed. Therefore, health care professionals in hospitals must identify and use screening tools that are the most appropriate and suitable for their hospital setting.

Moreover, the sensitivity and specificity of the tools must be re-evaluated compared with the actual outcomes in hospital settings. Most importantly, patients who are at risk for malnutrition should be treated, and malnutrition must be prevented in these patients [54].

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