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Review

Nutritional screening tools for hospitalized children: Methodological considerations

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SUMMARY

Children who are admitted to the hospital are at a risk of developing undernutrition, especially children with an underlying disease. High percentages of both acute and chronic undernutrition have been reported in various Western countries for many years. Several nutritional screening tools have been developed for hospitalized children in the last years. This review gives an overview of the nutritional screening tools that are currently available with a focus on their aims, clinical use and validity.

1. Introduction

Several studies in recent years have shown that the percentage of children admitted to the hospital with acute and/or chronic undernutrition remains considerable, despite advances in nutritional therapies and medical interventions.[1–6] In specific diagnostic categories the prevalence of undernutrition is even much higher.[7] There is no accepted gold standard for the assessment of the nutritional status of a child. For the purpose of this review we use the criteria of the WHO to express acute and chronic undernutrition.[8]

Most studies have reported the prevalence of undernutrition upon admission to hospital but there are a considerable number of children who will develop undernutrition during their hospital stay. Remarkably, only a few studies have been published about this issue and they all show that in 20–50% of children the nutritional status deteriorates during admission.[9–13]

The importance of the early identification of nutritional risk and appropriate nutritional management thereafter is highlighted already for many years[14] and numerous nutritional screening tools have been developed for adults and children. Over 70 screening tools for adults and children are reported in the literature.[15] The question is, however, how does one choose an appropriate nutritional screening tool from such a large number available? One has to realize that all these screening tools have been designed with different goals, applications and processes. Furthermore, there is the debate about the usefulness of a screening tool. The usefulness of recommended screening tools is usually based on the aspects of predictive validity (the extent to which a screening tool predicts certain outcomes, such as mortality or body composition), concurrent validity (the extent to which screening tools agree with each other), reproducibility (reliability; agreement between users of a given tool) and practicality.

Currently, there is no consensus on the ideal screening tool to determine on admission those children who are at risk for developing undernutrition during hospital stay and will benefit from nutritional support. Such a screening tool looking at the risk is basically different from measuring the actual nutritional status with weight and height of the child.

The aim of this review is to give an overview of the currently available nutritional screening tools for children admitted to the hospital, and to discuss their aims, clinical use and validity.

2. How to design a screening tool?

It was stated by the ESPEN in 2003[16] that screening tools are designed to detect protein and energy undernutrition and/or to predict whether undernutrition is likely to develop or worsen under the present and future conditions of the patient. Accordingly, screening tools should embody the following four main principles:

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Table 1
Patient characteristics of the screening tools.

Tools	Studied group	Age	Nr of children	High risk group
NRS[17]	Medical	0–17 yr	26	–
PNRS[13]	Medical & Surgical	>1 mnth-18 yr	296	↑Risk >2% weight loss
STAMP[18,19]	Medical & Surgical	2–17 yr	110	–
SGNA[20]	Surgical	>1 mnth-18 yr	175	↑LOS, ↑Infections, ↓SD BMI
PYMS[21,22]	Medical & Surgical except cardiology, renal, orthopedic, critical care	1–16 yr	247	↓SD W/H
$STRONG_{kids}$[10]	Medical & Surgical	>1 mnth-18 yr	423	↑LOS ↓SD W/H

NRS = Nutrition Risk Score; PNRS = Pediatric Nutritional Risk Score; STAMP = Screening Tool for the Assessment of Malnutrition in Paediatrics; SGNA = Subjective Global Nutritional Assessment; PYMS = Paediatric Yorkhill Malnutrition Score; $STRONG_{kids}$ = Screening Tool for Risk Of Impaired Nutritional Status and Growth.

1. How is the actual condition now? This item concerns the actual body composition of the patient. Height and weight can be measured to allow calculation of SD-scores or BMI.
2. Is the condition stable? This item embodies recent weight loss that can be obtained from the patient's history, or even better, from previous measurements in medical records.
3. Will the condition worsen? This question may be answered by asking whether food intake has been decreased up to the time of screening and if so by approximately how much and for how long.
4. Will the disease process accelerate nutritional deterioration? This item covers the underlying disease process which may increase nutritional requirements due to the stress metabolism associated with the severity of the underlying disease (e.g. major surgery, sepsis, and multi trauma), causing nutritional status to worsen more rapidly or to develop a poor nutritional status rapidly from fairly normal states.

It was stated that variables 1–3 should be included in all screening tools, whereas the fourth variable is relevant mainly in the hospital setting. In screening tools, each variable should be given a score, thereby quantifying the degree of risk and allowing a direct link to a defined course of action. Below, these four main principles will be evaluated for each available pediatric screening tool.

3. Screening tools for children admitted to the hospital and their aims

Currently there are 6 screening tools available for children admitted to the hospital;

1. Nutrition Risk Score (NRS)[17]
2. Pediatric Nutritional Risk Score (PNRS)[13]
3. Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP)[18,19]
4. Subjective Global Nutritional Assessment (SGNA)[20]
5. Pediatric Yorkhill Malnutrition Score (PYMS)[21,22]
6. Screening Tool for Risk Of impaired Nutritional Status and Growth ($STRONG_{kids}$).[10]

Table 1 shows the characteristics of each tool and the relationship between risk categories and outcome.

Table 2
Aim of different screening tools.

Tools	Identify nutritional status	Identify need for nutritional intervention	Predict clinical outcome without nutritional intervention
NRS[17]		X	
PNRS[13]		X	X
STAMP[18,19]	X	X	
SGNA[20]	X	X	
PYMS[21,22]	X	X	X
$STRONG_{kids}$[10]		X	X

NRS = Nutrition Risk Score; PNRS = Pediatric Nutritional Risk Score; STAMP = Screening Tool for the Assessment of Malnutrition in Paediatrics; SGNA = Subjective Global Nutritional Assessment; PYMS = Paediatric Yorkhill Malnutrition Score; $STRONG_{kids}$ = Screening Tool for Risk Of Impaired Nutritional Status and Growth.

By using the PRNS tool,[13] screening can be completed after 48 h whereas in the other five tool screening can be done and completed directly on admission. The $STRONG_{kids}$, STAMP and PYMS tools[10,18,19,21,22] were originally also designed as a screening tool to be used weekly in the patients with a prolonged hospital stay.

Table 2 summarizes the goals of each screening tool. All tools were designed to identify the need for nutritional intervention, three tools were designed to identify the nutritional status of the child and in three tools clinical outcome was predicted without predefined nutritional intervention.

4. Evaluation of screening tools according to ESPEN principles

Table 3 shows an overview of the content of each of the six screening tools in relation to the four main items of a screening tool according to ESPEN.

The PYMS, the SGNA, the NRS and the $STRONG_{kids}$ incorporate all these 4 items in their tool.[10,17,20–22] Whereas the PYMS and NRS use anthropometric measurements to define the actual nutritional status, the SGNA and the $STRONG_{kids}$ rely on a subjective clinical assessment. The SGNA and PNRS have included additional items (gastro-intestinal motility, parental height and functional capacity for SGNA and pain for PRNS).

5. Evaluation of the screening tools

The usefulness of the screening tools was evaluated for each screening tool using a number of different methods (Table 4).

Table 3
Comparison of screening tools according to 4 main principles of a screening tool (ESPEN).[15]

Tools	Current nutritional status	Weight loss	Reduced intake	Disease severity	Other items
NRS[17]	X	X	X	X	
PNRS[13]			X	X	Pain assessment
STAMP[18,19]	X		X	X	
SGNA[20]	X	X	X	X	GI symptoms, functional capacity, parental height
PYMS[21,22]	X	X	X	X	
$STRONG_{kids}$[10]	X	X	X	X	

NRS = Nutrition Risk Score; PNRS = Pediatric Nutritional Risk Score; STAMP = Screening Tool for the Assessment of Malnutrition in Paediatrics; SGNA = Subjective Global Nutritional Assessment; PYMS = Paediatric Yorkhill Malnutrition Score; $STRONG_{kids}$ = Screening Tool for Risk Of Impaired Nutritional Status and Growth.

Table 4
Evaluation of the screening tools.

Tools	Reproducibility	Sensitivity	Type of validity	Outcome parameter validity
NRS[17]	Dietitians vs nursing staff; agreement 74%	–	Criterion	Nutritional action plans Dietetic referral
PNRS[13]	–	–	Predictive	Risk of losing weight during hospitalization
STAMP[18,19]	Full dietetic assessment vs STAMP, kappa 0.54	72%	Criterion	Full dietetic assessment
SGNA[20]	Third assessor, kappa 0.28	–	Predictive Criterion	Number complications surgery Objective nutritional assessment
PYMS[21,22]	Dietitians vs nursing staff, kappa 0.53	59%	Criterion Concurrent Discriminant	Full dietetic assessment Other screening tools Lean and fat index
$STRONG_{kids}$[10]	–	–	Predictive	Length of hospital stay

NRS = Nutrition Risk Score; PNRS = Pediatric Nutritional Risk Score; STAMP = Screening Tool for the Assessment of Malnutrition in Paediatrics; SGNA = Subjective Global Nutritional Assessment; PYMS = Paediatric Yorkhill Malnutrition Score; $STRONG_{kids}$ = Screening Tool for Risk Of Impaired Nutritional Status and Growth.

Reproducibility (reliability) was tested in the NRS, SGNA, STAMP and PYMS tools and showed fair agreement in all the tested tools.[17–22] In the NRS all moderate and high risk patients were detected by the nurses. The inter-rater agreement for the PYMS completed by the two dieticians compared with the nursing staff concurred for 86% of patients when low and medium-risk categories were grouped together.

Sensitivity, specificity and positive predictive values were calculated in the STAMP tool and PYMS tool.[18,21,22] Full dietetic assessment was used as the golden standard to judge this. For the STAMP tool a sensitivity of 72%, a specificity of 90% and a positive predictive value of 55% was detected. For the nurse-rated PYMS tool these values were 59, 92 and 47% respectively. The sensitivity of the NRS tool[17] was tested against the validated Nutritional Risk Index (correlation coefficient of 0.68) and the dietitian's clinical impression ($r = 0.83$) of the patient's risk of nutritional depletion.

Validity was described in a different way for the different tools (see Table 4). Measures of predictive validity (prediction of outcomes) and criterion validity (sensitivity, specificity) were mostly used. The PYMS study also investigated the concurrent validity (comparison between tools e.g. STAMP and SGNA) and discriminant validity (ability of risk score to discriminate fat and lean mass) of their tool.

6. Scoring system of screening tools

All six screening tools use a scoring system to divide the nutritional risk into 3 groups, low, moderate and high risk of malnutrition. Each item of the tools bears a certain amount of points (ranging between 0 and 2) and the total number of points (total score) reflects the degree of the nutritional risk of the patient. The allocation of points however, within each tool, and consequently the maximum total scores and cut-off points for classification of risk groups are different. Therefore, using these various scoring systems there are substantial differences in the percentage of patients in each risk group. In the original studies, the percentage of patients considered at high risk were 45%, 9%, 15%, 14% and 18% for PRNS, $STRONG_{kids}$, SGNA, PYMS and STAMP respectively.[10,13,18–22] Moderate risk was found in 41%, 53% and 36% for the PRNS, $STRONG_{kids}$ and SGNA respectively.

7. Nutritional advice in relation to risk category

Most nutritional screening tools give some form of nutritional advice and suggestions for follow-up screening according to the risk category. For the high risk groups, PNRS, STAMP, PYMS and $STRONG_{kids}$[10,13,18,19,21,22] recommend assessment by a dietician or by a nutritional team and/or an individualized nutritional plan. These advices are comparable to the recommendations given in the adult screening tools for high nutritional risk groups, e.g. Malnutrition Universal Screening Tool (MUST) and Short Nutritional Assessment Questionnaire (SNAQ).[23,24]

8. Applicability

8.1. Ease and speed of administration

In the original description of the tools, it was only mentioned for the PRNS tool that it took 48 h to complete the items of the tool. The other tools had considered in their criteria ease and speed of use. Concerning the speed, Ling et al. performed a cross-sectional study in which two trained investigators applied STAMP and $STRONG_{kids}$ in 43 children. The STAMP tool took 10–15 min to apply whereas the $STRONG_{kids}$ took 5 min. The reason for this is due to the addition of anthropometric measurements in the STAMP tool.

8.2. Assessors

The PYMS and STAMP screening tools were developed for use by nurses.[18,19,21,22] The $STRONG_{kids}$ tool[10] was developed and tested in a study in which two of the four items were obtained from the parents and two items were scored by junior physicians or pediatricians. In current clinical practice, however, $STRONG_{kids}$ is widely used by nurses as well as dieticians.

8.3. Feasibility

The feasibility of the tool was only described in the original manuscript of the $STRONG_{kids}$ tool.[10] The tool could be applied in 98% of the children investigated. In the study concerning the STAMP tool, 30 of the participating 170 children (17.6%) had incomplete data i.e. lack of measurements of weight and/or height, which are necessary for calculating the STAMP risk score.[19]

9. Comparison of use of screening tools

In four studies an attempt was made to compare one ore more tools in the same patient population. Ling et al. compared STAMP with $STRONG_{kids}$ in a group of 43 children and concluded that $STRONG_{kids}$ was superior to STAMP in terms of risk classification because STAMP over-diagnosed the number of children with nutritional risk.[25]

Wiskin et al. compared the STAMP, PRNS, SGNA and $STRONG_{kids}$ tools in 46 children with inflammatory bowel disease attending outpatient clinics and those requiring an inpatient stay. Results of the tools were compared with WHO anthropometric criteria for malnutrition. There was no agreement between the different risk categories based on the tools and the degree of malnutrition based

on anthropometric data. The authors conclude that the relevance of nutrition screening tools for children with chronic disease is unclear and there is the potential to under recognize nutritional impairment in children with IBD.[26]

Gerasimidis et al. compared the PYMS, STAMP and SGNA tools when performed by dieticians and compared with a full dietetic assessment.[21] The PYMS showed similar sensitivity as the STAMP, but a higher predictive value. The SGNA had higher specificity than the PYMS but much lower sensitivity. The authors concluded that the PYMS appeared to be effective at identifying children at risk of malnutrition and should produce fewer false-positive cases than the STAMP screening tool. Interestingly the authors also stated that comparison with the SGNA gave different results because the SGNA is an assessment method, rather than a screening tool, which aims to identify children with established malnutrition.

A study performed by Moeni et al. in 150 Iranian children in a tertiary hospital compared the use of $STRONG_{kids}$, PYMS and STAMP and also actual nutritional status was assessed. The $STRONG_{kids}$ tool correlated more strongly with the antropometric measurements than the other tools and risk stratification based on $STRONG_{kids}$ was strongly related to length of hospital stay.[27]

10. Discussion

Currently there are six screening tools available to screen the nutritional risk of children admitted to the hospital. Three tools, the SGNA,[20] the PYMS[21] and the $STRONG_{kids}$[10] were based on existing guidelines[16,28] and one tool, the NRS,[17] was compared with the adult Nutritional Risk Index (NRI).[29] Two tools, PRNS and STAMP, were developed after multivariate analysis of a structured questionnaire that identified those factors who were significant predictors of nutrition risk.

As stated by Elia et al. it is important to consider that screening tools are developed for diverse purposes, for use by people with different backgrounds and for application in one or more settings and for one or more disease groups.[15] The aim of all six pediatric nutritional screening tools is to identify children at risk of malnutrition on admission to the hospital and the need for nutritional intervention during hospitalization. However there were some differences concerning the use of these tools. The STAMP, PYMS, NRS and SGNA also aimed to assess nutritional status on admission, whereas the $STRONG_{kids}$ and PRNS aimed to raise awareness of those children at nutritional risk on admission. Furthermore, the PNRS, SGNA and $STRONG_{kids}$[10] aimed to predict clinical outcome without nutritional intervention. We feel it is highly important to distinguish between those tools designed to evaluate the risk of becoming malnourished during hospital stay from the tools designed to evaluate actual nutritional status or malnutrition on admission. Importantly, those patients who are not acutely and/or chronically malnourished who are classified as high risk on admission, necessitate further analysis and nutritional intervention.

There is a lot of debate among professionals on how to validate screening tools. Due to the fact that there is no universally accepted definition for malnutrition, it is impossible to validate a tool with a gold standard. Evaluation of a screening tool may embody several items like reproducibility, applicability and validity. Concerning the six pediatric tools reproducibility was tested in four tools; in the STAMP and SGNA tool reproducibility was tested between dietitians and in the NRS and PYMS tool between nurses and dietitians. The most controversial issue in validating a nutritional screening tool is if it can predict current nutritional status. PYMS and STAMP validated their tool with a full dietetic assessment which was considered to be the golden standard. However, it is questionable if this is the gold standard, especially as not all countries have dieticians and their role may vary depending on the country. Worldwide, anthropometric measurements are used for assessing nutritional status. According to the definition of the WHO a SD score <-2 for weight for height (WFH) and height for age (HFA) are used for acute and chronic malnutrition respectively.[8] Applying this definition for malnutrition the $STRONG_{kids}$ and SGNA found significant differences for mean SD scores and/or the number of children with malnutrition in the different risk categories. STAMP, PYMS and NRS use actual measurements of weight and height as part of their tool, therefore it is not reliable to make a discrimination of SD scores within the risk groups.

Due to the fact that there is no universally accepted definition for malnutrition and because the aims of tools differ, it is almost impossible to judge the inferiority or superiority of one tool over the other. In the four studies that looked at the use of various screening tools in one population, different findings were obtained depending on the population or disease.

For general clinical practice, however, the ideal screening instrument will be one that can quickly and reliably triage the nutritional status of children, so as to identify the high-risk groups who need more detailed assessment and intervention.[30] In our experience, the $STRONG_{kids}$ tool is very practical and easier to use compared to the other screening tools because it is quick and can be carried out by every health care professional directly on admission.[10] The $STRONG_{kids}$ relies on 4 simple items and it is not necessary to perform anthropometric measurements which are time consuming and also necessitates interpretation of the growth charts. This tool therefore allows you to first determine the risk of becoming undernourished and thereafter one can determine those that need a full dietetic assessment. Ling et al. showed in a cross-sectional study the applicability of the STAMP tool versus the $STRONG_{kids}$ by two trained investigators. STAMP took approximately ten minutes longer than $STRONG_{kids}$ (15 vs 5 min).[25]

Furthermore, a tool that predicts outcome during admission is probably the most valuable tool because nutritional intervention may influence outcome such as length of stay or risk of complications and will demonstrate that earlier intervention is cost-effective. In other words, the predictive validity of the tool might be more interesting than the criterion validity (e.g. the sensitivity and specificity of the tool on admission). Three tools used a model of predictive validity and outcome parameters were weight loss during hospitalization (PRNS), the number of complications after surgery (SGNA) and length of hospital stay (SGNA and $STRONG_{kids}$). It is necessary however, to perform future studies who will elucidate if nutritional intervention in children at high risk really influences these outcome parameters.

In our opinion, nutritional risk screening should be part of the primary care of all children admitted to the hospital. Whatever nutritional screening risk is used, it will help to raise the awareness of the clinician about the nutritional status of the child. In addition, in all children weight and height measurements and calculation and interpretation of standard deviation scores using appropriate growth charts should also be performed routinely. This will give information about the current nutritional status of the child.

We want to emphasize that nutritional screening and risk determination not only starts on hospital admission but should be followed with regular follow-up assessments during admission, including (where possible) weight measurements and nutritional risk. The $STRONG_{kids}$, STAMP and PYMS were originally also designed as a screening tool to be used repeatedly in the patients with a prolonged stay in the hospital. Their usefulness for this purpose should be investigated.

11. Recommendations for clinical practice

- Incorporate screening of nutritional risk as part of the admission procedure for each hospitalized child
- When choosing a nutritional screening tool, consider the different purposes and applications of the tool in relation to what you want to achieve in your practice.
- $STRONG_{kids}$ seems to be the most practical, easy and reliable tool for assessment of nutritional risk
- PYMS seems to be the most practical tool when incorporating both the determination of nutritional risk and actual nutritional status
- Have the screening tools performed during the admission procedure by nurses or any other health professional and follow the advice according to the risk category.
- Perform a follow-up assessment of nutritional risk at least weekly during hospital admission in all children
- At discharge, consider dietetic follow-up after admission for those children in the high risk group

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KJ and JH both drafted the manuscript and read and approved the final manuscript.

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