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Original Article

Dutch national survey to test the STRONG$_{kids}$ nutritional risk screening tool in hospitalized children☆

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SUMMARY

Background & aims: Children admitted to the hospital are at risk of developing malnutrition. The aim of the present study was to investigate the feasibility and value of a new nutritional risk screening tool, called STRONG$_{kids}$, in a nationwide study.

Methods: A Prospective observational multi-centre study was performed in 44 Dutch hospitals (7 academic and 37 general), over three consecutive days during the month of November 2007.The STRONG$_{kids}$ screening tool consisted of 4 items: (1) subjective clinical assessment, (2) high risk disease, (3) nutritional intake, (4) weight loss. Measurements of weight and length were performed. SD-scores <-2 for weight-for-height and height-for-age were considered to indicate acute and chronic malnutrition respectively.

Results: A total of 424 children were included. Median age was 3.5 years and median hospital stay was 2 days. Sixty-two percent of the children were classified "at risk" of developing malnutrition by the STRONG$_{kids}$ tool. Children at risk had significantly lower SD-scores for weight-for-height, a higher prevalence of acute malnutrition and a longer hospital stay compared to children with no nutritional risk.

Conclusions: The nutritional risk screening tool STRONG$_{kids}$ was successfully applied to 98% of the children. Using this tool, a significant relationship was found between having a "high risk" score, a negative SD-score in weight-for-height and a prolonged hospital stay.

1. Introduction

Children who are admitted to the hospital are at a high risk of developing malnutrition, especially children with an underlying disease.[1,2] High percentages of both acute and chronic malnutrition have been reported in different countries.[1]

In a tertiary hospital in France, Sermet-Gaudelus et al. (2000) found 62% of children had lost weight during their hospital stay.[3] It is widely known that poor nutritional status has negative consequences for the child, underlining the importance to careful monitor. In two recent studies it was shown that both acute and chronic malnutrition affect the cognitive development of school-aged children.[4,5] Furthermore, poor weight gain in children with congenital heart defects, in the first months after surgery, was strongly related to later mortality.[6]

To prevent malnutrition, and especially hospital-acquired malnutrition along with its complications, early identification of nutritional depletion is essential, ideally on admission to the hospital. Such an approach provides the physician with the opportunity to apply appropriate nutritional interventions, in the hope of preventing complications. Currently, there is no consensus to the best method of assessing nutritional risk of children admitted to the hospital.

Three groups have attempted to develop such a nutritional risk screening tool for children. Sermet-Gaudelus et al.[3] developed the 'pediatric nutritional risk score' and Secker and Jeejeebhoy[7] the 'subjective global nutritional assessment' (SGNA) tool. Both these tools identify children at risk of malnutrition during hospitalization. However, we have found these tools to be complicated and time-consuming and consequently their uptake has been limited. Recently, McCarthy et al.[8] developed the 'STAMP' tool, a combination of measurements of weight and height and two additional questions on disease risk and intake. We found this tool also

Non-standard abbreviations: SD scores, standard deviation scores; WFH, weight-for-height; HFA, height-for-age; STRONG$_{kids}$, Screening Tool Risk on Nutritional status and Growth.

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complex to use and more of a nutritional assessment than a nutritional risk tool. There are no reports published using either of these scoring systems. We therefore attempted to develop an easy to apply nutritional risk screening tool, called $STRONG_{kids}$, in an effort to overcome some of the issues with previous tools. Our tool consists of four areas (1) subjective global assessment (2) high risk disease (3) nutritional intake and losses (4) weight loss or poor weight increase. The aim of our study was to investigate the feasibility and value of this new nutritional risk screening tool on children admitted to hospitals in the Netherlands over three consecutive days.

2. Materials and methods

2.1. Subjects

Every Dutch hospital ($n = 101$) containing a pediatric ward was invited to participate (by letter), on a voluntary basis. This included 93 general and 8 academic hospitals. Our three screening days took place from November 26th through November 28th 2007. Our inclusion criteria were, age>1 month, admission to a pediatric ward (intensive are patients excluded) and an expected stay of at least one day. The institutional review board of Erasmus Medical Centre approved the study protocol, and waived the need for informed consent from each parent, because of the standard nature of the measurements in this protocol. Parents or caregivers were informed by a letter approved by the institutional review board and could refrain from participation without consequences.

All children had their age, sex, diagnosis and length of hospital stay recorded. Race was classified as Caucasian or non-Caucasian. Children were classified as surgical or non-surgical, and suffering from an underlying disease or not. The reasons for admission were classified as respiratory, trauma, infectious, surgical, oncological, gastro-intestinal, cardiac, neurological and others.

2.2. Assessment of nutritional status and nutritional risk factors

The research protocol consisted of the following items.

2.2.1. Item A: nutritional risk screening tool $STRONG_{kids}$ (Screening Tool for Risk on Nutritional status and Growth)

On admission a questionnaire to score the risk for malnutrition was performed. This nutritional risk screening questionnaire consisted of 4 items and each item was allocated a score of 1–2 points with a maximum total score of 5 points;

(1) Subjective clinical assessment (1 point).
Is the patient in a poor nutritional status judged by subjective clinical assessment (diminished subcutaneous fat and/or muscle mass and/or hollow face)?
(2) High risk disease (2 points).
Is there an underlying illness with a risk of malnutrition or expected major surgery (Table 1)?
(3) Nutritional intake and losses (1 point).
Are one of the following items present?
Excessive diarrhoea (≥5 per day) and/or vomiting (>3 times/day) the last few days?
Reduced food intake during the last few days before admission (not including fasting for an elective procedure or surgery)?
Pre-existing dietetically advised nutritional intervention?
Inability to consume adequate intake because of pain?
(4) Weight loss or poor weight gain? (1 point)
Is there weight loss or no weight gain (infants <1 year) during the last few weeks/months?

The first 2 items were assessed by a pediatrician and the second 2 items were discussed with the parents or caregivers. Questions answered with 'unclear' were classified as 'no'.

2.2.2. Item B: Anthropometric measurements

On admission, and also at discharge, weight measurements were taken. Supine length or standing height was assessed on admission only. All measurements were carried out in a standardized way, using standard equipment (digital scales, stadiometer) which was explained to the participating hospitals beforehand.[9] The measurements were performed by the nursing staff or attending physicians. All anthropometric data was compared with published standards based on a Dutch reference population and translated into standard deviation scores (SD scores).[10] This resulted in SD scores for weight-for-height (WFH) and height-for-age (HFA). A SD score of <-2 for WFH was used to indicate acute malnutrition, and an SD score of <-2 for HFA was used to indicate chronic malnutrition.[11] Overall malnutrition rate was defined as the presence of acute and/or chronic malnutrition.

2.2.3. Statistical analysis

Descriptive analyses were used to describe the study population and the feasibility of performing the risk assessment and the measurements. Chi^2-tests were used to compare percentages between groups. Comparison of continuous data between groups was carried out using the *T*-test, Mann–Whitney test or Kruskall Wallis test.

The malnutrition risk score (scale 0–5) was compared with the actual nutritional status on admission expressed as WFH SD-score.

Multiple regression analysis of various clinical measures such as the length of stay (LOS) was carried out. LOS was converted logarithmically in this analysis to reduce the influence of outlying observations. We considered p (two-sided) <0.05 to be significant.

3. Results

The overall hospital response rate was 52% (52 hospitals, 7 academic and 45 general). Of this four of the 45 general hospitals did not include any patients and 4 failed to return their case record forms. Finally 44 hospitals participated (7 academic and 37 general). A total of 424 children met the inclusion criteria (172 from

Table 1
Overview of the item 'high risk disease' of the screening tool.

High risk disease
Anorexia nervosa
Burns
Bronchopulmonary dysplasia (maximum age 2 years)
Celiac disease
Cystic fibrosis
Dysmaturity/prematurity (corrected age 6 months)
Cardiac disease, chronic
Infectious disease (AIDS)
Inflammatory bowel disease
Cancer
Liver disease, chronic
Kidney disease, chronic
Pancreatitis
Short bowel syndrome
Muscle disease
Metabolic disease
Trauma
Mental handicap/retardation
Expected major surgery
Not specified (classified by doctor)

the academic and 252 from the general hospitals). Baseline characteristics are shown in Table 2. The median age was 3.5 years (range 31 days–17.7 years) and the median length of hospital stay was 2 days (range 1–44 days). Twenty-four percent of the children were admitted for>4 days. Surgery was the reason for admission for 23% of the children. Overall 29% of the admitted children suffered from an underlying disease with a significant difference between the academic and general hospital population (51% vs. 15% respectively, $p < 0.001$).

3.1. Anthropometric measurements

Weight and height measurements on admission were available in 99% and 92% of children respectively (height measurements were not available in 8% of the children because of logistic reasons, i.e. they were too sick to measure or had severe psychomotor or neuromuscular disorders). The mean SD-score for WFH (−0.22 SD) and HFA (−0.15 SD) was significantly below zero ($p = 0.04$ and $p = 0.035$, respectively). The percentage of children with acute malnutrition was 11% (95% CI: 8–15%) and with chronic malnutrition was 9% (95% CI: 6–12%). Overall the prevalence of malnutrition on admission was 19% (95% CI: 15–23%).

3.2. Nutritional risk screening tool $STRONG_{kids}$

The nutritional risk screening tool $STRONG_{kids}$ was used to assess risk in 98% of the children. The four items of the questionnaire, i.e. 'subjective clinical assessment', 'high risk disease', 'nutritional losses' and 'weight loss or poor weight gain' scored with presence "yes" in 10%, 28%, 48% and 15% respectively. In the group of children in which the 'subjective clinical assessment' item was scored positively, 49% were found to have a SD-score <−2 for WFH of HFA. There was a significant difference in scoring between academic and general hospitals for 'high risk disease' (46% and 15% respectively, $p < 0.001$) and 'nutritional losses' (36% and 57% respectively, $p < 0.001$).

3.3. Malnutrition risk score

Fig. 1 depicts that when the risk scores increase the WFH SD-scores decrease. It shows that risk scores from 1 to 3 have similar mean SD-scores for WFH (difference $p = 0.84$). These scores were therefore combined under the category *moderate risk*. Furthermore, the risk scores 4 and 5 have comparable mean SD-scores for WFH (difference $p = 0.60$), so these scores were combined under the category *high risk*. Mean SD-scores are significantly different between risk categories.

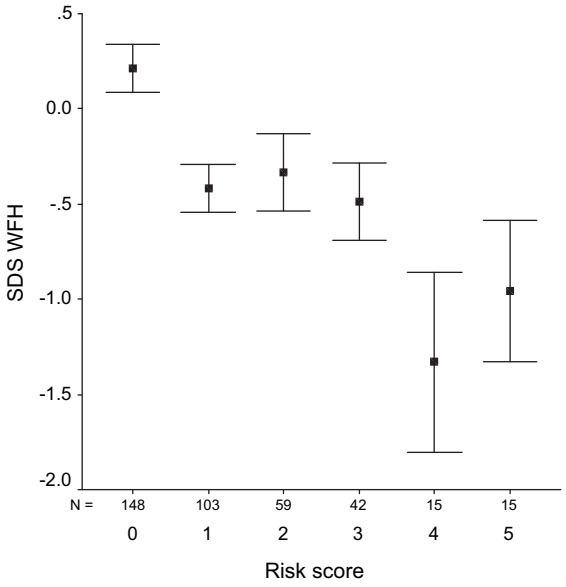

Fig. 1. Relationship between nutritional risk scores ($STRONG_{kids}$) and mean SD-scores for WFH. All values expressed as mean ± SEM. SDS WFH = SD-score for weight-for-height. With increasing risk scores the SD-scores for WFH decreased ($r_s = -0.25$, $p < 0.001$). Risk scores 1 through 3 have similar mean WFH SD-scores (difference $p = 0.84$) and were combined into the category *moderate risk*. Risk scores 4 and 5 have comparable mean WFH SD-scores (difference $p = 0.60$) and were combined into the category *high risk*. Mean SD-scores are significantly different among the 3 risk categories ($p < 0.05$ for all comparisons).

3.4. Risk categories

Overall, 38% of the children were categorized as low risk, 54% as moderate risk and 8% as high risk. The distribution of risk categories between academic and general hospitals were significantly different, i.e. in the academic hospitals 15% of the children were classified as high risk whereas this was only 5% in the general hospitals ($p = 0.014$ for low vs. high risk and $p < 0.001$ for moderate vs. high risk).

Differences in several characteristics and outcome variables between the different risk categories are shown in Table 3. There was an increase in the percentage of children with acute malnutrition on admission from the low risk, to moderate risk and to high risk groups, 5%, 14% and 27% respectively ($p = 0.004$ for low vs.

Table 2
Patient characteristics and diagnoses ($n = 424$) according to type of hospital.

Patient characteristics	Total $n = 424$	Academic $n = 172$	General $n = 252$
Sex, m:v (%)	63:37	62:38	64:36
Age (yr), Median (range)	3.5 (31 d–17.7 years)	5.7[a] (39 d–17.7 years)	2.2 (31 d–17.6 years)
Length of hospital stay (days), Median (range)	2 (1–44)	2 (1–33)	2 (1–44)
Underlying disease (%)	29	51[b]	15
Diagnostic groups (%)			
Infectious	32	9	47
Surgical	23	37	13
Gastro-intestinal	16	17	15
Respiratory	6	5	7
Cardiac	4	9	1
Trauma	4	1	6
Oncologic	4	9	0
Neurological	3	5	2
Other	8	8	9

[a] significant difference compared to general hospitals ($p = 0.001$).
[b] significant difference compared to general hospitals ($p < 0.001$).

Table 3
Differences between risk groups.

	Low risk ($n = 160$)	Moderate risk ($n = 223$)	High risk ($n = 34$)
SD weight-for-height (mean)[a,b,c]	0.21	−0.40	−1.15
SD height-for-age (mean)[b,c]	−0.11	−0.04	−1.05
Acute malnutrition[a,b]	5%	14%	27%
Chronic malnutrition[b,c]	8%	6%	28%
Malnutrition[b,c]	12%	19%	47%
Academic[b,c]	44%	35%	68%
Underlying disease[a,b,c]	5%	36%	97%
Surgical[a,b]	43%	12%	3%
Age (median, years)[a,c]	4.3	2.3	8.7
Length of stay (median, days)[a,b]	2 (2.5)[d]	3 (4.6)[d]	3 (6.0)[d]

[a] Significant difference between low risk and moderate risk group.
[b] Significant difference between low risk and high risk group.
[c] Significant difference between moderate risk and high risk group.
[d] Mean length of stay is shown between parentheses.

moderate risk, $p < 0.001$ for low vs. high risk, and $p = 0.1$ for moderate vs. high risk). Furthermore, the prevalence of overall malnutrition in the high risk group (47%) was significantly higher when compared to the percentage of malnutrition in the moderate (19%) and low (12%) risk groups (both $p < 0.001$).

The percentage of children with underlying disease was significantly different among the 3 risk categories (5%, 36% and 97% of the children in the low, moderate and high risk groups respectively). In 95% of the children who scored "yes" for the item 'high risk disease' an underlying disease was present. The gender distribution was similar in the 3 risk groups.

3.5. Length of hospital stay

The length of hospital stay (LOS) of children with a low risk score was significantly shorter compared to children with a moderate or high risk score, median 2 vs. 3 days respectively ($p < 0.001$). Univariate analysis revealed that an increase in the nutritional risk category, younger age, presence of an underlying disease, non-surgical reason of admission and non-Caucasian ethnicity were all significantly related to a longer LOS. After adjusting for all these clinical risk factors, multivariate analysis demonstrated that the difference in LOS between nutritional lower vs. higher risk categories remained significant ($p = 0.017$).

3.6. Discharge data

Of the 103 children who were admitted to hospital for>4 days the median length of stay was 8 days (range 5–44). Data for both weight and height at discharge were available for 62 of the 103 children (60%). Within this group 65% of the children lost no weight or gained weight, and 35% lost weight. Only 3% had a weight loss more than 5% during this admission. Children in the high risk group had a significantly greater increase in WFH SD-score between admission and discharge compared with the moderate and low risk groups (+0.36 SD, +0.00 SD, and +0.004 SD respectively, $p < 0.001$).

4. Discussion

This is the first study in which a nutritional risk screening tool, called $STRONG_{kids}$, was used in a nationwide setting. The $STRONG_{kids}$ tool is a comprehensive summary of commonly asked questions concerning nutritional issues, combined with a clinical view of the child's status. It is performed on admission to the hospital and it will help to raise the clinician's awareness of nutritional risks. In this study almost half of all Dutch hospitals (both academic and general) participated and the $STRONG_{kids}$ was used in 98% of the children admitted to these hospitals. The prevalence of malnutrition based on the weight and length measurements was 19%, whilst $STRONG_{kids}$ predicted that 54% of the children were at moderate risk and 8% were at high risk of developing malnutrition. Children at moderate or high nutritional risk had significantly lower SD scores for weight-for-height, a higher prevalence of acute malnutrition (WFH <−2 SD) and a longer hospital stay compared to children with low nutritional risk.

Compared with previously described nutritional risk screening methods such as Sermet-Gaudelus et al. (France) and Secker and Jeejeebhoy (Canada), it appears that $STRONG_{kids}$ is more practical and simple.[3,7] We feel that its simplicity and practicality have been demonstrated in that it can be carried out directly on admission, can be carried out by one assessor and the nutritional risk is immediately determinable. This makes the tool less time consuming. Contrarily the tool of Sermet-Gaudelus et al. requires a period of 48 h after admission in order to complete the nutritional risk score. This time is needed because nutritional intake is recorded during the first 48 h after admission. The subjective global nutritional assessment in the study of Secker and Jeejeebhoy is also rather complex because a number of additional questions concerning the history of the child have to be completed. Although both of these methods have advantages it is well known that a time-consuming screening tool is less likely to be taken up by health care providers. Furthermore with these methods skilled staff was necessary whereas for $STRONG_{kids}$ written instructions alone enabled the participating paediatricians to complete the questionnaires appropriately in 98% of the cases.

Using both previously described screening tools three risk groups were defined and outcome parameters correlated with the risk classification. In the first study[3] a higher risk was associated with more weight loss during admission whereas in the second study[7] a higher risk score was related to a longer hospital stay and a higher infection rate. With the recently described STAMP tool, (which combines 2 questions along with weight and height measurements) three risk groups were also defined but so far these have not been related to outcome parameters.[8] Furthermore the use of weight and height measurements is suggestive of an assessment rather than a nutritional risk screening tool.

In our study, we were able to classify three risk groups from the overall risk score based on anthropometric differences. We showed that children in the moderate and high risk groups had significantly lower median SD-scores for WFH on admission. The differences we found in SD-scores for WFH between the risk groups were comparable with those found in the study of Secker and Jeejeebhoy.

In contrast to the French study,[3] we observed no relationship between risk score and weight loss during hospital admission. In our group of children with a length of stay of >4 days, those with the highest risk score showed the greatest weight gain. Overall in only 3% of the children a weight loss >5% was measured during admission. An explanation for this difference might be the fact that in our study only a quarter of the children were admitted for >4 days whereas in the study of Sermet-Gaudelus et al. all patients were followed. Furthermore, the children in the French study stayed longer in the hospital and were of a younger age.

In our study nearly all children in the highest risk group had an underlying disease. Most of the children with an underlying disease were admitted to an academic hospital, which explains the higher percentage of children with a high nutritional risk in these hospitals compared to the general hospitals. Previous studies have also demonstrated a high prevalence of malnutrition in children with an underlying disease.[2,12–15] This suggests that for this specific group of children extra attention should always be given to their nutritional status on admission and interventions should be planned.

We feel that the strength of this study relates to a couple of facts; 1. is that we were able to perform a nationwide study, performed on a voluntary basis; 2. this screening tool $STRONG_{kids}$ was successfully carried out in 98% of the children included; and 3. that both academic and general hospitals participated, thus indicating that a representative group of children was included.

A weakness of this study is the fact that the screening tool was performed by many different observers, possibly influencing the results. However we had provided the same written instruction to all participating pediatricians on the screening tool prior. There was also a debate about the value of the item 'subjective clinical assessment'. So far only one study in children compared clinical examination with anthropometry.[16] In this study, in a group of 44 children agreement was found between the anthropometry and the nutritional classification [in 64% of the observations].[16] Furthermore, in the study of Secker and Jeejeebhoy part of the screening

tool included a nutrition-related physical examination, looking at specific signs of fat and muscle wasting, as well as edema. In our study we did not include an objective assessment but all observations were carried out by skilled pediatricians which might give more reliable results. We included the subjective clinical assessment item because we felt that a nutritional risk screening tool should contain an item that incorporates the clinical condition of the child. Alternatively a measurement such as arm circumference or skinfold thickness could be added to the tool. However this then moves the tool from a risk assessment to a nutritional assessment, which we feel is the next step after screening for risk. This is a commonly confused aspect in practice where assessment is mixed with risk, whilst the purpose of our study was to screen nutritional risk only and not to assess the status of the child.

Another limitation of our study is the lack of measuring the consistency of the items, i.e. the interrater variability. This should be performed in future studies. Our study was not designed as a validation study and therefore nothing can be concluded about the sensitivity or specificity of the $STRONG_{kids}$ tool. We believe, however, that the question remains as to what method should be used to validate a nutritional risk screening tool. Future studies should consider length of hospital stay and items concerning morbidity (i.e. complication rate, secondary infections, antibiotic use and time between hospital admission as well as time to complete recovery at home) as outcome parameters. These items might be more reliable than weight loss during admission (as many children do not lose weight) or nutritional status upon admission. In order to thoroughly investigate these relationships a much larger study population is needed. However, we would encourage the use of $STRONG_{kids}$ as a practical awareness tool until further studies are performed in this area.

In conclusion, we believe that the nutritional risk screening tool $STRONG_{kids}$ will help raise clinician's awareness of the importance of nutritional status in children. It directs the clinician to consider important issues related to nutritional risk including the clinical appearance of the child, the disease risk, nutritional losses, inadequate intake and weight trajectory. Furthermore, the use of this screening tool can ensure early identification of those children at nutritional risk and therefore ensure nutritional interventions that may contribute to overall improvements in our patients care.

Concerning the therapeutic consequences of the $STRONG_{kids}$ screening tool, we propose a nutritional follow-up according to the risk category, which is displayed in Table 4. Children classified in the "moderate risk" group should receive a critical look at their nutritional intake and follow-up weight measurements are indicated at least twice per week with a re-evaluation of their risk after one week. For all children in the "high risk" category, a consultation with a dietician is warranted immediately after admission in order to make an adequate and individualized nutritional plan.

Table 4
Nutritional risk score and recommendations for nutritional intervention.

Score	Risk for malnutrition and need for intervention	
	Risk	Intervention and follow-up
4–5 Points	High risk	Consult doctor and dietician for full diagnosis and individual nutritional advice and follow-up. Start prescribing sip feeds until further diagnosis.
1–3 Points	Medium risk	Consult doctor for full diagnosis; consider nutritional intervention with dietician. Check weight twice a week and evaluate the nutritional risk after one week.
0 Points	Low risk	No intervention necessary. Check weight regularly conform hospital policy and evaluate the nutritional risk after one week.

Conflict of interest

No conflicts of Interests declared by all authors.

Statement of authorship

JH and KJ proposed the study, and participated in its design and coordination as well as drafted the manuscript. HZ carried out the studies and helped to analyze the data and helped to draft the manuscript. WH performed the statistical analysis and interpretation of data together with JH and helped to draft the manuscript. All authors read and approved the final manuscript.

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The participating students were N Kruijer, P Kramer, C Alingh, A Kerver, S vd Oord, H Zwart, and W Roest.

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