

Simple pediatric nutritional risk score to identify children at risk of malnutrition^{1,2}

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ABSTRACT

Background: Although hospitalized children are at risk of malnutrition, routine screening of nutritional status has been hindered by lack of a validated nutritional assessment tool.

Objective: Our aim was to develop a simple pediatric nutritional risk score that could be used at hospital admission to identify patients at risk of acute malnutrition during hospitalization.

Design: Nutritional risk was assessed prospectively in 296 children. Anthropometric measurements, food intake, ability to eat and retain food, medical condition, and symptoms interfering with feeding (pain, dyspnea, and depression) were evaluated within 48 h of admission. Pathology was classified as mild (grade 1), moderate (grade 2), or severe (grade 3). The risk of weight loss was investigated with stepwise logistic regression.

Results: Weight loss during hospitalization occurred in 65% of the children and was >2% of admission weight in 45% of patients. Multivariate analysis indicated that food intake <50%, pain, and grade 2 and 3 pathologic conditions ($P = 0.0001$ for all) were associated with weight losses of >2%. The nutritional risk score ranged from 0 to 5 and was calculated by adding the values for the significant risk factors as follows: 1 for food intake <50%, 1 for pain, 1 for grade 2 pathologic condition, and 3 for grade 3 pathologic condition. A score of 1 or 2 indicated moderate risk and a score ≥ 3 indicated high risk of malnutrition.

Conclusions: This simple score is suitable for routine use to identify patients at risk of malnutrition during hospitalization. Implementation may prevent hospital-acquired malnutrition. *Am J Clin Nutr* 2000;72:64–70.

KEY WORDS Malnutrition, nutritional risk, risk score, pain, hospital-acquired malnutrition, food intake, children, pediatrics, weight loss, nutritional assessment, nutrition screening, malnutrition screening

INTRODUCTION

The nutritional status of children often deteriorates after admission to the hospital. Although the exact prevalence of malnutrition in hospitalized children is extremely difficult to quantify, studies suggest that $\approx 50\%$ of children in acute medical or surgical wards are nutritionally compromised (1, 2). In children, malnutrition can have early and serious consequences, such as slowing of growth and increased susceptibility to various infections. Hospital-

acquired malnutrition is also associated with increased risk of adverse clinical events and longer hospital stays, which incur additional health care costs (3). Despite these findings, this problem remains largely unrecognized by health care workers (4).

Measuring a patient's current nutritional status identifies only patients who are already undernourished, not those at risk of malnutrition (5, 6). To prevent acute hospital-acquired malnutrition and its complications, the risk of nutritional depletion needs to be identified at the time of admission so that appropriate nutritional intervention can be initiated at an early stage (7). Although nutritional risk assessment tools and screening methods have been developed, they are complicated and unsuitable for routine use on a hospital-wide basis. Moreover, none of them were specifically designed for use in a pediatric setting (8). We report on the design and validation of a simple scoring system to screen pediatric patients for risk of nutritional depletion.

SUBJECTS AND METHODS

Subjects

Children who were admitted consecutively to either a medical ward (gastroenterology, cardiology, pulmonology, hematology, or general pediatrics) or a surgical ward (visceral surgery) at Necker-Enfants Malades Hospital were enrolled in the study between March 1 and May 1, 1997. The inclusion criteria were a hospital stay of ≥ 48 h and age > 1 mo. Children with conditions that involve large variations in hydration (severe hepatopathy or nephropathy or cardiac insufficiency) were excluded. Weight and height were measured as part of the routine admission procedure. Weight was measured daily thereafter in the same conditions (nude, after voiding, in the morning before breakfast). A baby scale (Testut, Paris; precision, 5 g) was used for infants weighing < 15 kg and an electronic scale (Seca, Hamburg, Germany; precision, 100 g) was used for children weighing > 15 kg. If the patient was dehydrated on

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admission, weight was reevaluated after complete rehydration when the clinical examination and laboratory test results were normal; this weight was considered to be the reference weight. For all other children, the weight at admission was the reference weight. Each child's weight was assessed by determining the percentage of ideal body weight (PIBW) by using the standards of Sempe et al (8). Nutritional status was classified as follows: within normal range if PIBW was 90–100%, underweight if PIBW was 85–89%, mild undernutrition if PIBW was 80–84%, moderate undernutrition if PIBW was 75–79%, and severe malnutrition if PIBW was <75% (9).

Assessment of nutritional risk factors

A complete assessment of nutritional risk was performed within 48 h of hospital admission; this included interviewing the parents and nursing staff and, when possible, the patient. For each child, the same investigator performed all the assessments and interviews. The following nutritional risk factors were evaluated: food intake, difficulty retaining food (diarrhea and vomiting), pain, and ability to eat. The child's ability to eat was evaluated either in terms of specific criteria, such as dysphagia and assisted feeding, or by noting symptoms that interfered with food intake, such as dyspnea and depression.

Daily diet allowances were appropriate to the pathologic condition of each patient and were prescribed during the routine admission procedure. The parents, nursing staff, and dietitian assessed daily intake of the prescribed diet during the first 48 h of hospitalization. The investigator recorded whether food intake was >50% or <50% of the diet allowance. Ability to eat was categorized as either "able to eat unassisted" or "assistance with feeding required." Difficulty retaining food was measured as the number of episodes of vomiting and diarrhea that occurred each day; the cutoff points were >3 vomiting episodes/d and >5 episodes of loose stools/d.

Pain was assessed by using age-appropriate methods. For the infants, the parents and nursing staff indicated whether they observed any signs of pain, including incessant crying, abnormal movement, and any other behaviors that suggested the infant was in pain. For children aged >6 y, a visual analogue scale with ratings from 0 (no pain) to 100 (worst pain imaginable) was used. The cutoff point was a rating >40 (10). Pathologic condition was classified as mild (grade 1), moderate (grade 2), or severe (grade 3). No validated classification system for pathologic condition was available. We derived our method from classifications by the American Academy of Pediatrics and the American Dietetic Association (5, 11, 12). Grade 1 conditions involved mild stress factors, eg, admission for diagnostic procedures, minor infection not necessarily requiring hospitalization, other episodic illnesses, or minor surgery. Grade 2 conditions involved moderate stress factors, eg, severe but not life-threatening infection, routine surgery, fracture, chronic illness without acute deterioration, or inflammatory bowel disease. Grade 3 conditions involved severe stress factors, eg, AIDS, malignancy, severe sepsis, major surgery, multiple injuries, acute deterioration of chronic disease, and major depression.

Endpoint criterion

The endpoint criterion was a weight loss of >2% of the reference weight. The endpoint weight, which was used to evaluate each child for weight loss during hospitalization, was either weight at discharge (if the child did not lose weight dur-

ing the hospital stay) or the lowest weight measured before discharge (if the child did lose weight). If nutritional support was begun or was changed significantly during hospitalization, the endpoint weight was the last weight obtained before the change occurred. Daily weight loss for each child was calculated by dividing the total amount of weight lost by the number of days in the hospital.

Statistical analysis

Statistical analyses were performed by using the BMDP software package (University of California, Los Angeles) (13). The sample size was determined by referring to the results of a previous study in our hospital that showed that ≥40% of patients lose weight during hospitalization (7). To calculate our sample size, we predicted that ≥20% of patients would reach the endpoint criterion; therefore, 300 patients would be needed and ≥60 patients would be predicted to lose >2% of their reference weight. The association between nutritional risk factors and the endpoint criterion was first assessed by using Fisher's exact test and the Mantel-Haenzel adjustment test. To identify the factors that were significant predictors of weight loss of >2% of reference weight, those factors that were significant predictors in univariate analysis were then analyzed with stepwise logistic regression to select the combination of factors that would best predict this weight-loss endpoint. For each risk factor retained, the final model estimated the partial regression coefficients ($b_0, b_1, b_2, \dots, b_i, b_n$) and the corresponding odds ratios. A linear probability function (F) was established as follows:

$$F = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n \quad (1)$$

where the factors b_i were the coefficients obtained in the logistic regression model. To calculate the theoretic probability of losing >2% of the reference weight for each combination of risk factors, we used the following equation:

$$\text{Probability} = \text{exponential}(F) / [1 + \text{exponential}(F)] \quad (2)$$

Because this method was too complicated for use in routine clinical practice, we designed a nutritional risk score that represented the probability of losing >2% of reference weight for all the risk factors combined; our approach was designed on the basis of a method for measuring disease risk (14). Each probability value was rounded to the nearest whole number and divided by 2 to simplify the calculations. The score was then calculated by adding the numbers for the corresponding risk factors. Each value of the score was linked to the probability of losing >2% of the reference weight so that we could define a classification rule on the basis of the degree of nutritional risk. A linear trend test of the risk of losing >2% of the reference weight with each incremental increase in the score was used to validate the reliability and accuracy of the scoring system.

RESULTS

Characteristics of the patients at study entry

A total of 296 patients were included in the analysis. Baseline characteristics are shown in **Table 1**. The median age was 15 mo. Seventy-nine children (26%) presented with undernutrition (PIBW <85%) and 96 patients (33%) had a severe, life-threatening disease (grade 3 pathologic condition). Fifty-five children received intravenous fluids.



TABLE 1
Baseline characteristics of the patients at study entry

Variable	Patients <i>n</i> [%]
Age (mo)	
1–3	48 [16]
3–12	85 [29]
12–72	87 [30]
≥72	76 [25]
Sex	
Male	171 [57]
Female	125 [43]
Percentage ideal body weight (%) ¹	
≥100	120 [41]
90–99	65 [22]
85–89	32 [11]
80–84	21 [7]
75–79	16 [5]
<75	42 [14]
Diagnosis	
Grade 1: mild stress factor	67 [22]
Detection of health problem	21
Bronchiolitis	24
Gastroenteritis	14
Minor surgery	6
Other minor infection	2
Grade 2: moderate stress factor	125 [42]
Current surgery	34
Chronic cardiopathy	22
Chronic enteropathy	30
Severe infection	11
Cystic fibrosis	6
Sickle cell disease	5
Other	17
Grade 3: severe stress factor	96 [33]
Cardiac surgery	14
Deterioration of chronic disease	28
Major visceral surgery	32
Hemopathy	12
Severe depression	3
Severe sepsis	4
Other	3
Unknown	8 [3]

¹Weight at admission/ideal body weight for age.

Nutritional outcome

Nutritional outcome is summarized in **Table 2**. Of the 191 children who lost weight, 85 (44.5%) lost 2–5% and 49 (25.6%) lost >5% of their reference weight. Mean daily weight loss ranged from 0.4% in the patients with a total weight loss of <2% to 4.8% in the patients with a total weight loss of >10%. The mean length of hospital stay was 7 d (range: 2–60 d) and 65% of the children were hospitalized for >5 d. The 296 patients in the study were also divided into 2 groups on the basis of whether the endpoint criterion (weight loss of >2% of reference weight) was reached: group 1 consisted of the children with a weight loss of 0–2% (162 patients) and group 2 consisted of those with a weight loss of >2% (134 patients). Included in group 1 were the 105 children (35% of all patients) who did not lose weight during hospitalization.

Nutritional risk factors

Univariate analyses showed that food intake of <50% of the diet allowance, pain, and severity of disease were significant pre-

dictors of weight loss of >2% of reference weight (**Table 3**). Assistance with feeding, dyspnea, depression, vomiting, and diarrhea were not significant predictors. Undernutrition at admission did not increase the risk of nutritional depletion during the hospital stay. Dysphagia was excluded from the analysis because of the small number of subjects ($n = 6$) with this condition. Nevertheless, this factor was taken into account indirectly because all of these patients had food intakes of <50%. Adjustment for age, length of hospital stay, and hospitalization in a medical or surgical ward did not affect the results. Of the 55 children who received intravenous fluids, 40 lost >2% of their reference weight. However, use of intravenous fluids was not included in further analyses because this effect disappeared after adjustment for severity of the pathologic condition.

The stepwise logistic regression analysis showed that the combined association of <50% food intake, pain, grade 2 pathologic condition, and grade 3 pathologic condition was the most predictive of weight loss of >2% during the hospital stay (**Table 4**). The linear probability function with regression coefficients obtained in the logistic regression model was as follows:

$$F = (0.9594 \times \text{food intake} < 50\%) + (0.7789 \times \text{pain}) + (1.004 \times \text{grade 2 disease}) + (3.214 \times \text{grade 3 disease}) - 2.498 \quad (3)$$

Each risk factor was assigned a value of 1 if present or 0 if absent. These values were then introduced into the equation and multiplied by the corresponding coefficients. The following example illustrates the 2-step procedure that was used to calculate the theoretical probability of weight loss of >2% for a patient in pain with a grade 2 pathologic condition who ate <50% of the meals provided:

$$F = (0.9594 \times 1) + (0.7789 \times 1) + (1.004 \times 1) + (3.214 \times 0) - 2.498 = 0.2443 \quad (4)$$

The probability of a weight loss >2% is represented by Equation 2, where exponential(F) = 1.2767. Thus, probability = $1.2767 / (1 + 1.2767) = 0.56$.

Pediatric nutritional risk score

The cumulative score, which reflected the respective weighting of the corresponding coefficients, is shown in Table 4 and

TABLE 2
Total and mean daily weight loss during hospitalization for the 191 patients with weight loss

	Patients	
	<i>n</i>	Daily weight loss ¹ %
Total weight loss (%) ²		
<2	57	0.4 ± 0.06 ³
2–5	85	1.1 ± 0.1
>5–10	43	1.2 ± 2.1
>10	6	4.8 ± 2.3

¹Daily weight loss = weight at admission – endpoint weight/endpoint date – admission date.

²Total weight loss = weight at admission – weight at discharge/weight at admission.

³ $\bar{x} \pm \text{SD}$.

TABLE 3

Significant nutritional risk factors according to univariate analyses in patients with no weight loss or weight loss of <2% (group 1) and patients with weight loss of >2% (group 2)

Variable	Group 1 (n = 162)	Group 2 (n = 134)
Food intake <50% ¹		
No	92	29
Yes	70	105
Pain ¹		
No	132	74
Yes	30	60
Pathology ²		
Grade 1	58	9
Grade 2	81	44
Grade 3	16	80
Unknown	4	4

¹Significant difference between groups, $P < 0.0001$ (Fishers exact test).

²Significant difference between groups, $P < 0.0001$ (linear trend test).

Table 5. A score of 1 was attributed to food intake of <50% (predicted probability according to the model = 0.15), pain (predicted probability = 0.17), and grade 2 pathologic condition (predicted probability = 0.18). A score of 3 was attributed to grade 3 pathologic condition (predicted probability = 0.67). The cumulative score was calculated by adding the values for all the risk factors; the highest possible score was 5 because grade 2 and 3 conditions were mutually exclusive. The discriminating power of the score was shown by the significant increase in the risk of losing >2% of the reference weight each time the value of the score increased (linear trend test; $P = 0.0001$). The theoretic probabilities for each combination of factors and the number of patients who actually lost >2% of their reference weight for each score value are shown in Table 5.

Three classes of risk were identified as follows: patients with a score of 0 were considered at low risk of nutritional depletion; those with a score of 1 or 2, which indicated a predicted risk of ≥ 0.15 , were considered to be at moderate risk; and those with a score of ≥ 3 , which indicated a predicted risk of ≥ 0.56 , were considered to be at high risk. Of the patients who lost >2% of their reference weights, 2% were in the low-risk class, 25% were in the moderate-risk class, and 78% were in the high-risk class. Recommendations for appropriate nutritional support for each risk category are shown in Table 6.

The following examples illustrate the clinical application of the score.

1) A patient with cystic fibrosis and bronchial infection has a grade 3 pathologic condition and therefore has a score of 3. If abdominal pain (1 point) and food intake <50% (1 point) were also present, this patient would be assigned a score of 5.

A score ≥ 3 indicates that the patient is at high risk of malnutrition and must be referred to a nutrition team (a physician specializing in nutrition, a dietitian, and a nurse). Enteral or parenteral nutritional support should be considered.

- 2) A patient with appendicitis has a grade 2 pathologic condition and therefore has a score of 1. This patient is at moderate nutritional risk; he or she should be referred to a dietitian and oral nutritional support should be started. If this patient is also in pain (1 point) and has food intake of <50% (1 point), the nutritional risk score would increase to 3 and the patient would be considered at high nutritional risk.
- 3) A patient with gastroenteritis has a grade 1 pathologic condition and therefore has a score of 0. This patient is at low nutritional risk. If the patient also has abdominal pain (1 point) and food intake <50% (1 point), the score would increase to 2 and the patient would be considered at moderate nutritional risk.

DISCUSSION

This prospective study showed that the factors most predictive of weight loss in children during a hospital stay were poor food intake, pain, and severity of disease; the combination of these factors was the best predictor of whether patients were at risk of nutritional depletion. On the basis of these findings, we developed a pediatric nutritional risk score that is simple and easy to use in a clinical setting for identifying children at risk of nutritional depletion during hospitalization.

Although many studies of nutritional assessment techniques have been reported, controversy remains about which anthropometric measures (weight loss, weight for height, or weight for age) provide the most reliable and accurate data for assessing nutritional status (15). Slowing of normal growth may provide information about the chronology of malnutrition, but only after the effects of primary causes other than malnutrition are excluded. In accordance with guidelines published in 1997 (9), we proposed a method for classifying nutritional status on admission that is based on ideal weight for age. Other assessment techniques, such as skinfold-thickness measurements, midarm muscle circumference, biochemical and immunologic tests, and bioelectrical impedance analysis are rarely used in routine clinical practice because they are complicated and time consuming and are not sensitive enough to detect acute malnutrition (16–25).

Indeed, few studies have proposed screening tools that can identify patients at immediate risk of malnutrition. Wolinsky et al (26, 27) screened elderly patients to identify those at high nutritional risk by using nutritional risk factors similar to those in our study. They designed a nutritional risk index that was subsequently validated in >500 patients by using correlations with anthropometric, laboratory, and clinical markers of nutritional status and also utilization of health services (28). However, unlike our nutritional risk score, their assessment procedure is detailed and time-consuming

TABLE 4

Results of stepwise logistic regression with risk factors for weight loss of >2% of reference weight: implementation for the final score

Variable	Coefficient	Odds ratio (95% CI)	Predicted probability	Score value
Grade 3 pathology	3.214	24.9 (10.2, 60.5)	0.67	3
Grade 2 pathology	1.004	2.73 (1.23, 6.04)	0.18	1
Pain	0.7789	2.18 (1.11, 4.3)	0.17	1
Food intake <50%	0.9594	2.61 (1.35, 5.05)	0.15	1
Constant	-2.498			

TABLE 5

For each value of nutritional risk score, total number of patients with that score, number of patients with weight loss of >2% of reference weight, and predicted risk of weight loss of >2% of reference weight

Score	Total patients <i>n</i>	Patients with	Predicted risk
		weight loss of >2% <i>n</i> [%]	
0	44	1 [2]	0.07
1	69	16 [23]	0.15–0.22
2	52	15 [29]	0.23–0.33
3	58	38 [65]	0.56–0.67
4	34	31 [91]	0.82–0.84
5	39	33 [84]	0.89

and is consequently unsuitable for use in routine clinical practice. Moreover, because their risk index was designed specifically for use in elderly persons, it is not appropriate for use in a pediatric setting. Reilly et al (5) developed a nutrition risk score that takes into account weight loss, body mass index for adults or growth percentiles for children, food intake, and the effect of disease status to identify patients at low, moderate, and high risk of nutritional depletion. However, only a small number of children were included in the study, the score was validated in only 20 patients, and the endpoint criterion was a comparison with the nutritional risk index designed by Wolinsky et al (26, 27) rather than a comparison with objective criteria.

In our study, nutritional risk factors were selected by using multivariate analysis in a large pediatric population. The endpoint criterion was established prospectively. Although the score coefficients were the rounded probabilities from the stepwise regression analysis, these values reflected the weighting of each nutritional risk factor because they were derived from the probability of weight loss of >2% of reference weight when the corresponding risk factor was present. Each value of the score was then linked to a probability of nutritional depletion so that the presence of each additional risk factor indicated greater nutritional risk and increased the value of the score. This was confirmed by the greater number of patients with weight loss for each incremental increase in the score value. For example, 2% of the patients with a score of 0 lost >2% of their reference weight compared with 84% of the patients with a score of 5. Furthermore, the similarity between the risk factors observed in this study and the risk factors identified in

the stepwise logistic regression model confirmed the validity of this method.

However, some points need to be discussed. Patients with severe hepatopathy, nephropathy, and cardiac insufficiency were excluded because the changes in hydration status induced by these conditions would have prevented us from measuring weight loss due to malnutrition alone, which was the central question addressed in this study. However, even though they were not included in the study, these patients can be evaluated with the nutritional risk score to identify those at risk of acute nutritional depletion during hospitalization.

A weight loss of >2% of the reference weight was chosen as the endpoint criterion because the amount of weight lost over a relatively short period has great prognostic significance for malnutrition. Studies in adult patients showed that a weight loss of >10% during the 3 mo preceding surgery (eg, 0.8% in 1 wk) correlated with postoperative morbidity (29). Our prospective estimation of the critical threshold for weekly weight loss was based on the finding by Merritt and Blackburn (30) that a 5% weight loss in 1 mo was the critical threshold for an adverse clinical outcome. This corresponds, by extrapolation, to a daily weight loss of 0.17% or a weight loss of 1.25% over a 7-d period, which was the mean length of hospital stay in this study. Our findings indirectly support the validity of this threshold in that the patients in our study with a weight loss of >2% had a daily weight loss of $\geq 1\%$, which is 6 times higher than the critical threshold reported above.

One unexpected finding was that diarrhea, vomiting, and dyspnea did not increase the risk of weight loss. Patients with these conditions may have either received nutritional advice on admission or experienced transient episodes that did not lead to sustained weight loss. Dysphagia per se was not included as a risk factor in the score, but because dysphagia reduced food intake, it was taken into account by the food-intake risk factor. All the dysphagic patients lost >2% of their reference weight. Undernutrition at admission (PIBW <85%) was not a risk factor for weight loss during hospitalization, because all of the children in this category had a grade 2 or 3 pathologic condition and thus were classified as being at high nutritional risk on admission. This relation can be explained by the fact that malnutrition in developed countries is usually correlated with either acute deterioration of a chronic disease (6, 8, 12) or an acute episode of a severe disease (31–33). However, in the unlikely event that a patient is <75% of ideal body weight on admission with no other risk factors, the patient should be monitored closely for further weight loss.


TABLE 6

Pediatric nutritional risk score and recommendations for nutritional intervention

Pathology	Risk factors [coefficients]		Score	Nutritional risk	Nutritional intervention
	Food intake <50% [1]	Pain [1]			
Mild (grade 1) [0]	None	None	0	Low	None
Mild (grade 1) [0]	One	One	1	Moderate	Assess food intake and weight daily
Mild (grade 1) [0]	Both	Both	2	Moderate	Refer to a dietitian
Moderate (grade 2) [1]	None	None	1	Moderate	Start oral nutritional support
Moderate (grade 2) [1]	One	One	2	Moderate	
Moderate (grade 2) [1]	Both	Both	3	High	Measure ingested food precisely
Severe (grade 3) [3]	None	None	3	High	Refer to a nutrition team
Severe (grade 3) [3]	One	One	4	High	Consider enteral or parenteral nutritional support
Severe (grade 3) [3]	Both	Both	5	High	

The nursing or medical staff can easily complete our nutritional risk score in routine practice for all types of patients. The main purpose of our tool is to detect patients at risk of malnutrition who need to be targeted for early nutritional support, but the score should also increase nursing staff awareness of nutritional risk and the importance of adequate nutrition for patient outcome. This is particularly true for moderately ill patients. Although the nutritional risk of patients with severe disease is usually obvious and is typically assessed regularly (31–33), nutritional assessment is more difficult, and often neglected, in patients with less severe conditions (12). With our score, when patients who had grade 2 conditions also had pain and poor food intake, they were upgraded from the moderate- to the high-risk class. This addresses the potentiation of disease-induced nutritional risk by other risk factors. Because food intake and pain are rarely considered in these patients, underestimation of these risk factors may explain the common deterioration of nutritional status during hospital stay (34). Use of our score can identify these patients at risk of acute weight loss who would not usually be considered for nutrition assessment at admission or nutrition monitoring during their hospital stay.

Because each risk category corresponds to a grade of malnutrition, it is easily linked to appropriate action. We recommend that patients at moderate risk be referred to a dietitian and that those at high risk be followed by a nutrition team. We also recommend that patients be assessed any time their medical condition changes. However, it must be emphasized that this screening procedure in no way substitutes for accurate assessment of longitudinal growth data, which remains the only means of detecting and evaluating the chronicity and chronology of undernutrition. The purpose of this tool is to identify patients at risk of nutritional depletion before malnutrition occurs.

We conclude that this pediatric nutritional risk score identifies children at risk of nutritional depletion. This score is currently being used as part of the routine admission procedure in our hospital. We hope that it will prevent morbidity associated with nutritional depletion and thereby reduce the length of hospital stay. This multidisciplinary approach to the prevention of undernutrition may maximize the benefits that patients derive from the health care provided. 

REFERENCES

- Moy RJD, Smallman S, Booth IW. Malnutrition in a UK children hospital. *J Hum Nutr Diet* 1990;3:93–100.
- Hendrikse WH, Reilly JJ, Weaver LT. Malnutrition in a children's hospital. *Clin Nutr* 1997;16:13–8.
- Reilly JJ, Hull SF, Albert N, Waller A, Bringardener S. Economic impact of malnutrition: a model system for hospitalized patients. *JPEN J Parenter Enteral Nutr* 1988;12:372–6.
- Coats KG, Morgan SL, Bartolucci AA, Weinsier RL. Hospital associated malnutrition: a reevaluation 12 years later. *J Am Diet Assoc* 1993;93:27–33.
- Reilly HM, Martineau JK, Moran A, Kennedy H. Nutritional screening. Evaluation and implementation of a simple Nutrition Risk Score. *Clin Nutr* 1995;14:269–73.
- White JV. Risk factors for poor nutritional status. *Prim Care* 1994; 21:19–31.
- Poisson-Salomon AS, Colomb V, Sermet I, Ricour C. Prise en charge du risque nutritionnel. Vers une amélioration des pratiques. (Preventing nutritional risk: towards improving practices.) *Nutr Clin Metab* 1997;11:161–8 (in French).
- Sempe M, Pedron G, Roy-Pernot MP. *Auxologie: méthodes et séquences.* (Auxologia: methods and sequences.) Paris: Theraplix, 1979 (in French).
- Klein S, Kinney J, Jeejeebhoy K, et al. Nutrition support in clinical practice: review of published data and recommendations for future research directions. Summary of a conference sponsored by the National Institutes of Health, American Society for Parenteral and Enteral Nutrition, and American Society for Clinical Nutrition. *Am J Clin Nutr* 1997;66:683–706.
- Aradine CR, Beyer JE, Tompkins JM. Children's pain perception before and after analgesia. A study of instrument construct validity and related issues. *J Pediatr Nurs* 1988;3:11–23.
- American Academy of Pediatrics. Report on the future role of the pediatrician in the delivery of health care. *Pediatrics* 1991;87:401–9.
- Taylor Baer M, Bradford Harris A. Pediatric nutrition assessment: identifying children at risk. *J Am Diet Assoc* 1997;97(suppl): S107–15.
- Dixon WJ, ed. *BMDP statistical software manual.* Berkeley: University of California Press, 1990.
- Coste J, Fermanian J, Venot A. Methodological and statistical problems in the construction of composite measurement scales: a survey of six medical and epidemiological journals. *Stat Med* 1995; 14:331–45.
- Wright JA, Ashenburg CA, Whitaker RC. Comparison of methods to categorize undernutrition in children. *J Pediatr* 1994;124:944–6.
- Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr* 1987;11:8–13.
- Hirsch S, De Obaldia N, Petermann M, et al. Subjective global assessment of nutritional status: further validation. *Nutrition* 1991; 7:35–7.
- Buzby GP, Mullen JL, Matthews DC, Hobbs CL, Rosato EF. Prognostic nutritional index in gastrointestinal surgery. *Am J Surg* 1980;139:160–7.
- Guigoz Y, Vellas BJ, Garry PT. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;54(suppl):559–65.
- Harvey KB, Moldawer LL, Bistrian BR, Blackburn GL. Biological measures for the formulation of a hospital prognostic index. *Am J Clin Nutr* 1981;34:2013–22.
- Rainey-MacDonald CG, Holliday RL, Wells GA, Donner AP. Validity of a two-variable nutritional index for use in selecting patients for nutritional support. *JPEN J Parenter Enteral Nutr* 1983;7:15–20.
- Elmore MF, Wagner DR, Knoll DM, Eizember L, Oswald MA, Glowinski EA. Developing an effective adult nutrition screening tool for a community hospital. *J Am Diet Assoc* 1994;94:113–8.
- Ingenbleek Y, Carpentier YA. A prognostic inflammatory and nutritional index in scoring critically ill patients. *Int J Vitam Nutr Res* 1985;55:91–101.
- Dempsey DT, Mullen JL. Prognostic value of nutritional indices. *JPEN J Parenter Enteral Nutr* 1987;11:109S–14S.
- Hootkooper L, Lohman T, Going S, Hall M. Validity of bioelectric impedance for body composition assessment in children. *J Appl Physiol* 1989;66:814–21.
- Wolinsky FD, Prendergast JM, Coe RM, Chavez MN. Preliminary validation of a nutritional risk index. *Am J Prev Med* 1985;1:53–9.
- Wolinsky FD, Coe RM, McIntosh A, Kubena J, Prendergast J, Chavez N. Progress in the development of a nutritional risk index. *J Nutr* 1990;120:1549–53.
- Posner BM, Jette AM, Smith KW, Miller DR. Nutrition and health risks in the elderly: the Nutrition Screening Initiative. *Am J Public Health* 1993;83:972–8.
- Windsor JA, Hill GL. Weight loss with physiological impairment. A basic indicator of surgical risk. *Ann Surg* 1988;207:290–6.
- Merritt RJ, Blackburn GL. Nutritional assessment and metabolic response to illness of the hospitalized child. In: Suskind RM, ed. *Textbook of pediatric nutrition.* New York: Raven Press, 1981:285–307.

31. Mullen JL, Gertner MH, Buzby GP, Goodhart GL, Rosato EF. Implications of malnutrition in the surgical patient. *Arch Surg* 1979; 114:121–5.
32. Suttman U, Ockenga J, Selberg O. Incidence and prognosis of malnutrition and wasting in human immunodeficiency virus-infected outpatients. *J AIDS* 1995;8:239–46.
33. Merrick HW, Long CL, Grecos GP, Dennis RS, Blakemore WS. Energy requirements for cancer patients and the effect of total parenteral nutrition. *JPEN J Parenter Enteral Nutr* 1988;12: 8–14.
34. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. *BMJ* 1994;308:945–8.

