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Research Article

Nutritional Risk Screening in Hospitalized Children: Validation of a Tool Developed in a Highly Complex Hospital in the City of Buenos Aires

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Received: August 17, 2020; **Published:** November 07, 2020

Abstract

Introduction: Children requiring hospitalization are at higher risk for malnutrition. Nutritional screening allows identifying malnutrition or the risk of developing it. The Food and Nutrition Area of the Dr. J. P. Garrahan Hospital developed the "Pediatric Nutrition Screening Tool" (HTNP) considering the lack of consensus on a gold standard and to adjust criteria for assisted population. The objective of this research was to validate it for children in intermediate/moderate care.

Methods: Prospective, descriptive and cross-sectional study. Between August 2016 and April 2018, children aged 1 to 18 years, who met the inclusion criteria, were included. The HTNP and the subjective global nutritional assessment tool (SGNA) -as a comparison test- were applied. The HTNP has three criteria: Pathology and cause of hospitalization - Weight loss - Deterioration of the attitude towards food. Nutritional risk is defined if two criteria are met.

It was analyzed: sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), feasibility and reproducibility.

Results: 745 children were evaluated (50.1% female, median age: 7.2 years). Nutritional risk was detected in 50.7% (n: 378) of children with HTNP and in 48.7% (n: 363) with SGNA. The HTNP presented: Sensitivity 87.3% (95% CI 83.8 - 90.9), Specificity 84.0% (95% CI 80.2 - 87.8), PPV 83.9% (95% CI: 80.0 - 87.7) and NPV 87.5% (95% CI: 83.9 - 91.0).

The kappa coefficient of 0.91 (0.74 - 1.0) and 0.78 (0.5 - 1.0), respectively, was obtained from the reproducibility analysis with two independent evaluators (n: 42). Its implementation took an average of three and a half minutes (1 - 5 minutes).

Conclusion: HTNP is a simple, reproducible, practical and feasible instrument to implement to identify patients at nutritional risk.

Keywords: *Nutritional Risk; Screening; Pediatrics; Hospitalized Child*

Introduction

Nutritional deterioration is a relevant problem in hospitalized pediatric patients, especially those with chronic diseases. The data on its prevalence vary depending on the criteria used for its analysis, the characteristics of the assisted population, as well as the pathological conditions that led to hospitalization. Research data in different countries such as the United States, France, Germany, the Netherlands and other Latin American countries have reported a prevalence of malnutrition of 5% in developed countries and up to 50% in developing countries [1,2]. In our country, studies carried out in 2004, 2005 and 2011 at the Prof. Dr. JP Garrahan Pediatric Hospital agree with this variability, by showing that between 34% and 42% of hospitalized children had some form of alteration of nutritional status or growth [3-5].

The early identification of the risk of nutritional deterioration in hospitalized children is a key action to prevent or lessen the consequences of malnutrition, among which are a greater risk of infections, delayed healing, loss of muscle mass, longer duration of hospital stay and higher healthcare costs [6].

The definition of hospital malnutrition involves a degree of complexity related to the parameters considered as well as the time of its evaluation. The definition of nutritional status upon admission, which is generally based on anthropometric methods, is different from that established with the evaluation of the patient, which allows for the inclusion of subjective criteria as well as the consideration of other risk factors [7].

According to the Guidelines of the European Society for Clinical Nutrition and Metabolism (ESPEN, 2002), the nutritional screening tools are intended to detect energy-protein depletion and/or predict whether there is a risk of developing malnutrition, or that the condition current get worse. As requirements, these tools must be simple, fast, sustainable over time and reproducible by the members of the health team [8,9].

In the last 15 years, several nutritional screening tools have been developed for hospitalized pediatric patients with the aim of identifying malnutrition on admission, which differ in the data collected, in the time and complexity of their implementation, and in the standard of comparison used [10-14].

The Subjective Global Nutritional Assessment for Children (in Spanish: Valoración Nutricional Global Subjetiva-VNGS-) is a validated tool in pediatric patients, which aims to identify patients at risk of presenting infectious complications and longer hospitalization times. This has been prepared considering seven clinical characteristics and the physical examination with a nutritional focus and uses anthropometric data of weight and height. Taking into account the time required for its implementation and the significant amount of data that must be collected, it can be considered as a tool to systematize an exhaustive assessment of nutritional deterioration, but not a screening tool. This tool was validated by Carniel., *et al*. in 2015, in a group of pediatric patients hospitalized in Brazil, obtaining an association between the results of the tool with the time of hospital stay and readmission [15,16].

Due to the fact that the nutritional screening tools developed in other countries differ in the population they attend, the data they record, the time and complexity for their implementation, there is no universality of criteria to define which is the most appropriate tool for the detection of nutritional risk and not if there is only one way to detect it. Thus, recent reviews propose to establish a routine tool for the time of hospital admission that is consistent with the data and resources available from each institution, considering the characteristics of the assisted population [17-20].

In response to the need to systematize the identification of nutritional risk in patients hospitalized in our institution, The Food Area Department developed the Pediatric Nutritional Screening Tool (HTNP) [21].

Objective of the Study

The objective of this work was the validation of the tool developed using the Subjective Global Nutritional Assessment (VNGS) as a comparison standard, as well as the analysis of its feasibility and reproducibility, in children and adolescents from 1 to 18 years of age admitted to wards intermediate/moderate care.

Materials and Methods

A descriptive and cross-sectional study was carried out, integrating the stage of evaluation of the performance of the HTNP between August 2016 and April 2017 as well as its implementation and evaluation of feasibility and reproducibility between August 2017 and April 2018.

Children and adolescents between 1 and 18 years old admitted to selected intermediate and moderate care wards (CIM), who met the inclusion criteria and whose families agreed to participate in the study, were consecutively recruited. In all cases, the application sequence was the same and began with the application of HTNP and then VNGS. Anthropometric data required by the screening tool and the comparison tool were collected.

The cases whose weights did not represent the real value (edema, casts, dehydrated patients) and the readmissions to the ward for those who had already been assessed were excluded.

Pediatric nutrition screening tool (HTNP)

Consider three aspects:

1. Base pathology and reason for hospitalization: Identification of the presence of any of the pathologies that condition nutritional risk (Annex Nº1).
2. Weight loss prior to admission: The current weight of the child and its relationship with the usual referred weight, the time elapsed and whether there has been a significant weight loss according to standardized cut-off points are taken into consideration.
3. Eating attitude: The decrease or not of the intake is registered, with the guide of a directed question and a dichotomous answer (yes-no).

Nutritional risk is defined when the patient meets at least two of the above criteria.

The VNGS translated into Spanish was used as a reference for a complete nutritional assessment. This tool considers seven clinical aspects with a nutritional focus and three characteristics of the physical examination with a nutritional focus to identify signs of inadequate energy/protein intake. Based on the presence or absence of clinical, dietary and physical characteristics associated with malnutrition, an

overall rating of "normal or well nourished", "moderately malnourished" or "severely malnourished" is assigned which was recategorized for statistical analysis. Those with moderate or severe malnutrition according to the VNGS were classified with nutritional risk and those who obtained a result of well-nourished without nutritional risk.

Anthropometric data: Weight and height measurements were made by the researcher, trained in these techniques, 24 hours after admission to the CIM or 48 hours on the weekend. The techniques described in the Guides for the Evaluation of Growth of the Argentine Society of Pediatrics were followed [22].

Reproducibility of HTNP: It was evaluated, in a subgroup of the sample, by applying HTNP by two professionals with different levels of clinical experience.

Feasibility of HTNP: It was analyzed in a subgroup of the sample, considering the admissions to each ward and the feasibility of implementing HTNP in relation to the requirements of the standard of comparison used. In turn, the time required to apply the tool was also recorded.

Statistical method: The sample size was calculated for a proportion according to the prevalence data of global malnutrition [23], data from our institution and the results of the evaluation of the performance of the tool [3-21]. With a power of 80% and considering a safety margin, a sample was calculated from 492 patients.

A description of the characteristics of the population studied was made using frequency tables and summary and dispersion measures.

The analysis of sensitivity, specificity and predictive values of the screening tool, compared to an imperfect reference test (VNGS) was performed using contingency tables, with a 95% confidence interval.

For the reproducibility analysis, the agreement was estimated with the Kappa test for dichotomous variables.

To collect, record and analyze the information, the REDCap database (Research Electronic Data Capture) and the statistical software R Studio were used.

Results

Characterization of the children participating in the study

The final sample for validation of the tool was made up of 745 children. 50.1% were female. Everyone age groups were represented, with a lower proportion of children between 13 and 18 years. The characterization data are shown in table 1.

Nutritional risk detection

The HTNP tool identified 50.7% (n: 378) of the children with nutritional risk and the VNGS did so in 48.7% (n = 363) of the children (unifying the moderate and severe malnutrition categories).

Regarding the individualized analysis of the aspects considered by HTNP: 59.3% (n = 442) of the children presented a base pathology with nutritional risk, 38.4% (n = 286) presented a decrease in weight prior to admission and 53.9% (n = 402) presented a decrease in food intake.

Characterization variable		Distribution
Sex	Female	50.1% (n = 373)
	Male	49.9% (n = 372)
Age in years: median and range		7.2 (1 - 18)
Age category	1 - 3 Years	22.9% (n = 172)
	3 - 8 Years	30.9% (n = 230)
	8 - 13 Years	27.8% (n = 206)
	13 - 18 Years	18.4% (n = 137)

Table 1: *Characteristics of the children participating in the study (n = 745).*

Reproducibility of the HTNP

From the analysis of a pilot test of the implementation, it was evidenced the need to elaborate an instructions for the application of the HTNP, with the aim of clarifying concepts and unifying the approach modality. The results of the reproducibility analysis in a subgroup of 42 children are shown in table 2, observing values of considerable agreement between the evaluators (Kappa coefficient 0.91 and 0.78).

HTNP tool	Evaluador 2 (n=22)		Evaluador 3 (n=20)	
	Kappa coefficient	Range	Kappa coefficient	Range
Appearance: Pathology risk	0.90	(0.72 - 1.00)	0.89	(0.67 - 1.00)
Aspect: Weight Loss Risk	1.00	(1.00 - 1.00)	0.89	(0.67 - 1.00)
Appearance: Risk from decreased intake	0.79	(0.51 - 1.00)	0.69	(0.38 - 1.00)
HTNP Result	0.91	(0.74 - 1.00)	0.78	(0.5 - 1.00)

Table 2: *Reproducibility results of the HTNP obtained after the implementation of the instructions for the application (n = 42).*

Feasibility: In the period in which this analysis was carried out, there were 215 admissions of which HTNP could have been applied to 57.2% (n = 123) of the children. The chosen comparison test (VNGS) requirements limited inclusion to 40.9% (n = 88) of income.

Regarding the time required to apply the tool, an average result of three and a half minutes was obtained (minimum: 1 and maximum: 5 minutes).

Sensitivity and specificity

The VNGS is composed of numerous items, one of which requires prior size to assess longitudinal growth. In 277 cases this data could not be obtained. With the aim of evaluating whether the missing data had any impact on the performance of the tool, the sensitivity, specificity and predictive values of HTNP were analyzed considering two scenarios: the total sample, including the patients in whom it was missing. VNGS height (n = 745) and the group in which only patients with complete VNGS (n = 468) were considered. As can be seen in table 3, the results obtained were similar, and it can be considered that this missing data did not affect the results. In both scenarios the sensitivity, specificity, and predictive values exceeded 80%.

Total sample HTNP results (n = 745)			
Sensitivity % (IC: 95%)	Positive predictive value % (IC: 95%)	Specificity % (IC: 95%)	Negative predictive value % (IC: 95%)
87.33 (83.77 - 90.89)	83.86 (80.02 - 87.70)	84.03 (80.23 - 87.84)	87.47 (83.94 - 90.99)
Sample HTNP results with full VNGS (n = 468)			
Sensitivity % (IC: 95%)	Positive predictive value % (IC: 95%)	Specificity % (IC: 95%)	Negative predictive value % (IC: 95%)
85.29 (80.58 - 90.00)	83.54 (78.67 - 88.41)	82.61 (77.49 - 87.72)	84.44 (79.49 - 89.40)

Table 3: *Results of sensitivity, specificity, positive predictive value and negative predictive value of the proposed nutritional screening tool (HTNP).*

Sensitivity, specificity and predictive values analysis was performed according to groups of pathologies and according to age categories. For the grouping by pathologies, the International Classification of Diseases of the World Health Organization (ICD-10) was used as a reference, used to record the underlying disease of hospitalized patients. Table 4 shows the seven groups formed and the values obtained in each group. The tool showed a sensitivity greater than 95% for the group of neoplastic pathologies and a specificity greater than 92% for the group of diseases of the respiratory system and other diagnoses, this being the most comprehensive category.

Table 5 shows the results according to age categories, observing the greater sensitivity of the tool in the group of 3 to 8 years and the greater specificity in the younger group, of 1 to 3 years.

Age	n	Sensitivity % (IC: 95%)	Positive predictive value % (IC: 95%)	Specificity % (IC: 95%)	Negative predictive value % (IC: 95%)
1 - 3 Years	171	84.85 (77.28 - 92.42)	92.31 (86.28 - 98.33)	90.28 (82.74 - 97.82)	81.25 (72.07 - 90.43)
3 - 8 Years	230	90.00 (84.22 - 95.78)	84.38 (77.69 - 91.06)	81.82 (74.16 - 89.48)	88.24 (81.49 - 94.98)
8 - 13 Years	207	84.71 (76.47 - 92.95)	81.82 (73.19 - 90.44)	86.89 (80.49 - 93.29)	89.08 (83.05 - 95.10)
13 - 18 Years	137	89.83 (81.27 - 98.39)	74.65 (63.82 - 85.47)	76.92 (66.93 - 86.91)	90.91 (83.22 - 98.60)

Table 5: *Results of sensitivity, specificity and predictive values according to age categories (n = 745).*

Days of hospitalization

The median days of hospitalization in the sample was 4 days (1 - 123), when analyzed according to the presence of nutritional risk due to HTNP (n = 378) or not (n = 367), this was 5 days (1 - 123) versus 3 days (1 - 71), respectively.

The mean difference analysis yielded a significant difference in the days of hospitalization according to the presence of nutritional risk upon admission to CIM or not (9.58 and 5.52 respectively, P: 0.000).

Discussion

Nutritional screening tools have been recommended by various international organizations related to nutrition as a simple and quick method to detect nutritional risk. International accreditation bodies such as the Joint Commission International, in their standards base the need to carry out a screening (screening) at the beginning of hospitalization to assess the nutritional status, functional needs and any other special needs that patients may have, and refer them for in-depth evaluation and treatment when necessary (AOP 1.4) [24].

According to ESPEN, its components should include the current condition, stability, expected progression of the condition and the influence of the disease on nutritional status.

In relation to these requirements, the HTNP considers weight loss and time, as well as the decrease in intake, integrating the current condition; Regarding the influence of the disease, the pathologies that condition nutritional risk are defined and identified, taking into account the influence of pathological processes in a greater risk of deterioration of the nutritional state6. This aspect is also part of other screening tools [9,11-13].

In relation to the decrease in intake, this is a prognostic factor in the nutritional deterioration of hospitalized pediatric patients and has been considered in most of the nutritional screening tools developed. In our study, it was observed that 53.8% (n: 402) answered affirmatively to this question, in agreement with what was observed by Huysentruyt K., *et al*. when applying the Pediatric Nutrition Screening Tool (PNST), which registered more than 50% of the patients with this condition [10,19].

On the other hand, with respect to the weight loss criterion, in our study, 38.4% (n = 286) of the children presented a significant decrease in weight with respect to their usual weight. This, added to the pathological process and the effects of hospitalization, has consequences such as a clinical evolution with a higher risk of complications, prolonging the time of hospital stay and increasing healthcare costs [1,11,25,26].

The assessment of height as an anthropometric data, although it has many benefits for the analysis of the child's growth and has been included in some screening tools such as the Screening Tool for Assessment of Malnutrition in Paediatrics (STAMP) and Pediatric Yorkhill Malnutrition Score (PYMS), implies obtaining data that is usually not available in all children at admission, and may not be feasible to perform in a percentage of patients that cannot be measured at the beginning of their hospitalization. In a previous study at our institution, it was shown that, even with trained personnel, 28.3% of the children could not be evaluated in the first hours of hospital admission [5,11,12].

The comparison instrument implemented to validate the tool, the VNGS, has been used as a reference for the complete nutritional assessment; having been chosen to validate other nutritional screening tools. White., *et al*. used the VNGS and anthropometric measurements to assess the validity of the PNST tool; Gerasimidis., *et al*. compared the performance of the PYMS tool with other tools, including the VNGS as part of the evaluation process; Wonoputri., *et al*. analyzed the performance of three nutritional screening tools with anthropometric measurements and with the VNGS as a complete evaluation standard [12,27].

When analyzing reproducibility, only PYMS and STAMP have taken this measurement into account. For PYMS, the results of the questionnaires carried out by nursing personnel and nutrition graduates were compared with 86% agreement [12], reaching the conclusion that in order to be applied by nurses it requires additional training, since they have less knowledge about nutrition. Regarding STAMP, the

results obtained by two nutritionist physicians were compared, achieving an agreement with a kappa coefficient of 0.85 [11]. In the HTNP, the reproducibility analysis of the tool yielded values of considerable agreement between the evaluators when it was implemented by nutritionists with different levels of experience. A pilot sample made it possible to identify the need to carry out an application instruction and with it, to unify interpretations, thus achieving an adequate concordance among professionals.

The feasibility analysis allowed obtaining information regarding its possibility of implementation in a large part of the income, which is extremely important in a screening tool, as well as its short time required. Of the available screening tools, only the Screening Tool for Risk on Nutritional Status and Growth (STRONGkids) analyzed the feasibility of implementation [13], but this tool uses clinical impression data that require experience in the evaluation.

Likewise, in many of these tools, the results are linked to a specific course of action, which is of particular interest to our future interventions for appropriate actions [8,26,28].

Regarding the prevalence of nutritional risk, it is highly variable among the different tools developed. This variability is related, in part, to the criteria and classifications used. The HTNP considers a dichotomous cut-off point (risk-no risk), while other tools categorize risk as low-moderate-severe, such as PNST and STRONGKids. Our HTNP tool identified 50.7% (n = 378) patients with nutritional risk, a value very similar to that observed when applying the VNGS when the categories of moderate and severe malnutrition were unified. This prevalence of nutritional risk detected is consistent with the characteristics of patients admitted to the hospital who have a high medical complexity and undergo one or more simultaneous pathological processes. Likewise, the study carried out by Mazza., *et al*. in 2004 in our institution, it reflects that 19.6% of the children were under follow-up for chronic pathologies and 45.2% were admitted for exacerbated chronic pathologies [3].

The tools that had sensitivity and specificity analysis are STAMP, PYMS, STRONG Kids and PNST, with wide variability in the values obtained [29,30].

Although for this research those inpatient wards were selected in which patients with a wide variety of conditions were admitted, because the field work was carried out by a single researcher, not all of the CIMs were included and they may not have been seen represented all pathological conditions. Another aspect to consider is inherent to the institution in which this tool has been validated, due to the complexity of the patients it receives; Its implementation in hospital institutions with different degrees of complexity is a necessary process to expand its usefulness of application in different areas and achieve greater representativeness.

The results obtained from the HTNP show adequate sensitivity and specificity values, as well as predictive values, required for a screening tool and which were maintained when performing the sub-analysis according to pathologies and age groups. The criteria used make it feasible, simple and practical to implement, as well as sustainable over time, allowing not only to detect the nutritional risk upon admission of the patient for timely dietary action, but also to reduce the variability in the clinical practice of the intervening professionals.

Conclusion

The results obtained from the validation process of the HTNP tool are consistent with those required for a screening tool. Being this, feasible to implement, reproducible, practical, sensitive and specific. Future studies should evaluate the usefulness of HTNP in different contexts: in terms of socioeconomic and cultural characteristics, as well as in terms of the different complexities of institutions.

Acknowledgement

To Carolina Cernadas for her methodological advice and her constant motivation towards continuous improvement in reflective thinking about why and why we investigate.

To Jorgelina Taveira for her editorial advice.

To the Associate Directorate of Teaching and Research and the Garrahan Foundation, thanks to whom this research was able to be carried out.

To the Growth and Development Service of the hospital for facilitating training in anthropometric techniques for the development of this research.

To the CIMs who collaborate in the development of activities in each of the rooms..

Annex

Annex Nº 1: Pathologies that condition nutritional risk

- Oncological.
- Acquired Immunodeficiency Virus.
- Burned.
- Sepsis-Serious infection.
- Cyanotic or non-cyanotic congenital heart disease.
- Bronchopulmonary dysplasia.
- Complications that make it difficult to swallow: impaired swallowing, difficulty swallowing, mucositis, etc.)
- Eating disorder of the anorexia/bulimia type.
- Bowel pathologies such as short bowel, active inflammatory bowel disease, recently diagnosed celiac disease or with gastrointestinal involvement, incoercible and/or chronic diarrhea.
- Chronic liver diseases: extra-hepatic biliary atresia, hereditary syndromic or non-syndromic intrahepatic cholestasis, fulminant hepatitis.
- Cystic fibrosis.
- Pathology of renal origin such as chronic renal failure, acute renal failure, nephrotic syndrome.
- Food Allergy.
- Congenital metabolism disease: mitochondrial and peroxisomal diseases, carbohydrate metabolism defects, hyperphenylalaninemia, tyrosinemia, homocystinuria, leukocytosis, organic aciduria, among others.
- Neurological disease with seizures or increased muscle tone.

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Volume 9 Issue 12 December 2020
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