Received: 5 May 2019 | Revised: 10 July 2019 | Accepted: 10 August 2019

DOI: 10.1002/pbc.27980

Pediatric Blood & Cancer

SIOP INTERNATIONAL SOCIETY OF PAEDIATRIC ONCOLOGY

aspho The American Society of Pediatric Hematology/Oncology

WILEY

RESEARCH ARTICLE

Validation of an algorithmic nutritional approach in children undergoing chemotherapy for cancer

Sidharth Totadri[1] | **Amita Trehan**[1] | **Diviyaa Mahajan**[1] | **Karina Viani**[2] | **Ronald Barr**[3] | **Elena J. Ladas**[4]

[1]Pediatric Hematology-Oncology unit, Department of Pediatrics, Advanced Pediatrics Center, Postgraduate Institute of Medical Education and Research, Chandigarh, India

[2]ITACI—Hematology-Oncology Department of Instituto da Criança do Hospital das Clínicas, School of Medicine, University of São Paulo, São Paulo, Brazil

[3]Departments of Pediatrics, Pathology and Medicine, McMaster Children's Hospital, Hamilton, Ontario, Canada

[4]Division of Pediatric Hematology/Oncology/Stem Cell Transplant, Columbia University Medical Center, New York City, New York

Correspondence
Amita Trehan, Pediatric Hematology-Oncology unit, Department of Pediatrics, Advanced Pediatrics Center, Postgraduate Institute of Medical Education and Research, Chandigarh, India, Pin code 160012.
Email: trehan.amita@pgimer.edu.in

Abstract

Background: Undernutrition impacts clinical outcome adversely in children with cancer. This study aimed to validate a nutritional algorithm with specific application to the low- and middle-income country (LMIC) setting.

Procedure: Fifty children with a new diagnosis of cancer were enrolled in this randomized interventional study. Weight, height/length, and mid-upper-arm circumference (MUAC) were measured at baseline. The study arm was administered nutritional care as per the algorithm and the control arm received the institutional standard of care. Weight was monitored regularly and MUAC was repeated after 3 months. Children were classified based on weight for height if <2 years of age or body mass index if ≥2 years, as normal, wasted, and severely wasted. The algorithmic approach comprised administration of oral supplements, nasogastric feeds, and/or parenteral nutrition based on objective assessment of the nutritional status.

Results: Fifty patients were analyzed (study: 25, control: 25). Four in the study arm (16%) and six in the control arm (24%) had wasting at baseline. MUAC was <5th percentile in 15 (60%) and 13 (52%) patients in the study and control arms, respectively. At the end of 3 months, the median increment in weight was 0.8 kg (interquartile range [IQR]: −0.02; 2.00) and 0.0 kg (IQR: −0.70; 1.25) in the study and control arms, respectively ($P = .153$). The median increment in MUAC was 1.20 cm (IQR: 0.10; 2.30) and 0.00 cm (IQR: −0.50; 1.10) in the study and control arms, respectively ($P = .020$).

Conclusions: The application of an algorithm designed for use in LMICs resulted in significant improvement in nutritional status, as measured by MUAC.

KEYWORDS

developing country, mid-arm circumference, pediatric oncology, survival gap, undernutrition

1 | INTRODUCTION

Nutrition is an indispensable aspect of supportive care in children with cancer. Undernutrition translates into higher morbidity and mortality and an impaired quality of life in patients with cancer.[1–6] In low- and middle-income countries (LMICs), undernutrition is prevalent in the general population. Thirty-eight percent and 21% of Indian children under the age of 5 years are stunted and wasted, respectively.[7] Optimizing nutritional therapy is a vital step towards closing the survival gap that exists between children with cancer in high-income countries and those in LMICs.[8] The Nutrition Working Group of the International Society of Pediatric Oncology (SIOP), committee on Pediatric Oncology in Developing Countries (PODC), described a resource-adapted framework for assessment of nutritional status and delivery of nutritional care.[9] A review of the literature on nutrition intervention algorithms in pediatric oncology revealed that there is a paucity of standard algorithms, particularly in LMICs.[9] Additionally, the algorithms identified were complicated and had not been validated

Abbreviations: BMI, body mass index; IQR, interquartile range; LMICs, low- and middle-income countries; MUAC, mid-upper-arm circumference; NG, nasogastric; PGIMER, Postgraduate Institute of Medical Education and Research; PODC, Pediatric Oncology in Developing Countries; WFH, weight for height; WHO, World Health Organization.

in a precise manner.[9] A pilot study demonstrated the feasibility of applying an algorithm tailored to the needs of children with cancer in the following LMICs: Brazil, South Africa, and India.[9] As the next step to establishing a standard and objective approach to undernutrition in children with cancer, our study aimed to validate the SIOP-PODC nutritional algorithm in a single LMIC center.

The objective of the study was to compare a modifiable nutritional algorithm to an institutional standard of care, in advancing nutritional interventions and improving nutritional status. To the authors' knowledge, this is the first study to evaluate systematically the use of a nutritional algorithm among children with cancer undergoing care in an LMIC center.

2 | METHODS

2.1 | Study design and patients

An open-label, randomized, parallel-group pilot study was conducted from July 2017 to December 2017. Fifty children diagnosed with cancer and satisfying the selection criteria were enrolled in the study. The study was approved by the institutional ethics committee of the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh. Informed consent was obtained from the parents or guardians, and assent was obtained from children older than 7 years of age.

The inclusion criteria were as follows: children aged < 12 years with a newly diagnosed malignancy and undergoing treatment in the pediatric oncology unit at PGIMER. Patients who did not consent, were receiving palliative care, or were diagnosed with a malignancy not requiring chemotherapy were not eligible for participation.

2.2 | Randomization

Enrolled patients were randomized to one of the two arms using a computer-generated table of random numbers, which were in sealed envelopes for allocation. The primary investigators (S.T. and A.T.) evaluated all the study arm patients objectively, as per the SIOP-PODC nutritional algorithm. The patients in the control arm were seen by the other doctors in the unit. Patients randomized to the study arm were administered a standard nutritional algorithm. Patients randomized to the control arm were managed with the existing institutional standard. Excluding nutrition, the patients in the study and control arms did not differ with respect to any aspect of therapy and supportive care.

2.3 | Nutritional assessment and follow-up

Patients enrolled in the study were followed prospectively for a period of 3 months. Baseline assessment of nutritional status was performed using the following parameters: weight (kilograms) using an electronic weighing scale, height/length (centimeters) using a stadiometer/infantometer, and mid-upper-arm circumference (MUAC, centimeters) using a nonelastic measuring tape. Body mass index (BMI) was calculated based on the formula BMI = weight (kg)/height squared (m^2). Children were categorized based on the World Health Organization's (WHO) weight for height (WFH) *z* scores in those <2 years and BMI *z* scores in those ≥2 years.[10] Children were classified based on WFH or BMI *z* scores as eutrophic ($+2 > z > -2$), wasted ($z = -2$ to -3), severely wasted ($z < -3$), and overweight/obese ($z > +2$). MUAC centiles were based on the percentiles published by Frisancho.[11]

2.4 | Outcome measures

During the subsequent 3 months, patients were followed at approximately 2-week intervals. The modes of nutrition included oral, nasogastric (NG) tube, or parenteral. Weight and height/length were recorded at each visit. MUAC was recorded after 3 months. Significant treatment-related morbidities, which included febrile neutropenia, transfusion requirement, and mucositis of WHO grade 2 or higher, were recorded during the study period. The weight increment was calculated by subtracting the baseline weight from the weight at the end of the study. The MUAC increment was calculated by subtracting the baseline MUAC from the MUAC at the end of the study.

2.5 | Nutritional algorithm

The patients in the study group were assigned to a SIOP-PODC nutritional algorithm based on their baseline nutritional assessment, as described below.

1. Children with severe wasting (Figure S1)—NG feeding was initiated. If enteral tolerance was limited in a child at presentation, and it was unlikely that the child would tolerate enteral nutrition for a subsequent duration of more than a week, total parenteral nutrition was considered.
2. Children with wasting and children with MUAC <5th centile for age irrespective of being eutrophic/overweight/obese (Figure S2)—A trial of oral supplements was administered for 2 weeks, which was continued for 2 more weeks if there was adequate weight gain. NG feeding was initiated if there was poor weight gain at the end of 2 or 4 weeks of administration of oral supplements.
3. Children who were eutrophic/overweight/obese and had MUAC >5th centile for age (Figure S3)—No active intervention was indicated at presentation. If weight loss of >10% occurred during the study period, accompanied by consumption of <50% of the required calorie intake and a likelihood of diminished intake due to therapy, they were managed with the same algorithm as that used for children with wasting.

For the control group, there was no algorithmic approach. Participants were assessed routinely by the treating physicians and the dietitian as per the institutional standard, wherein the doctor evaluating the child assesses the anthropometry and dietary intake intermittently. The decision for referral of patients in the control group to the dietitian and nutritional intervention was made individually, on a patient-by-patient basis. A dedicated dietitian (D.M.) was

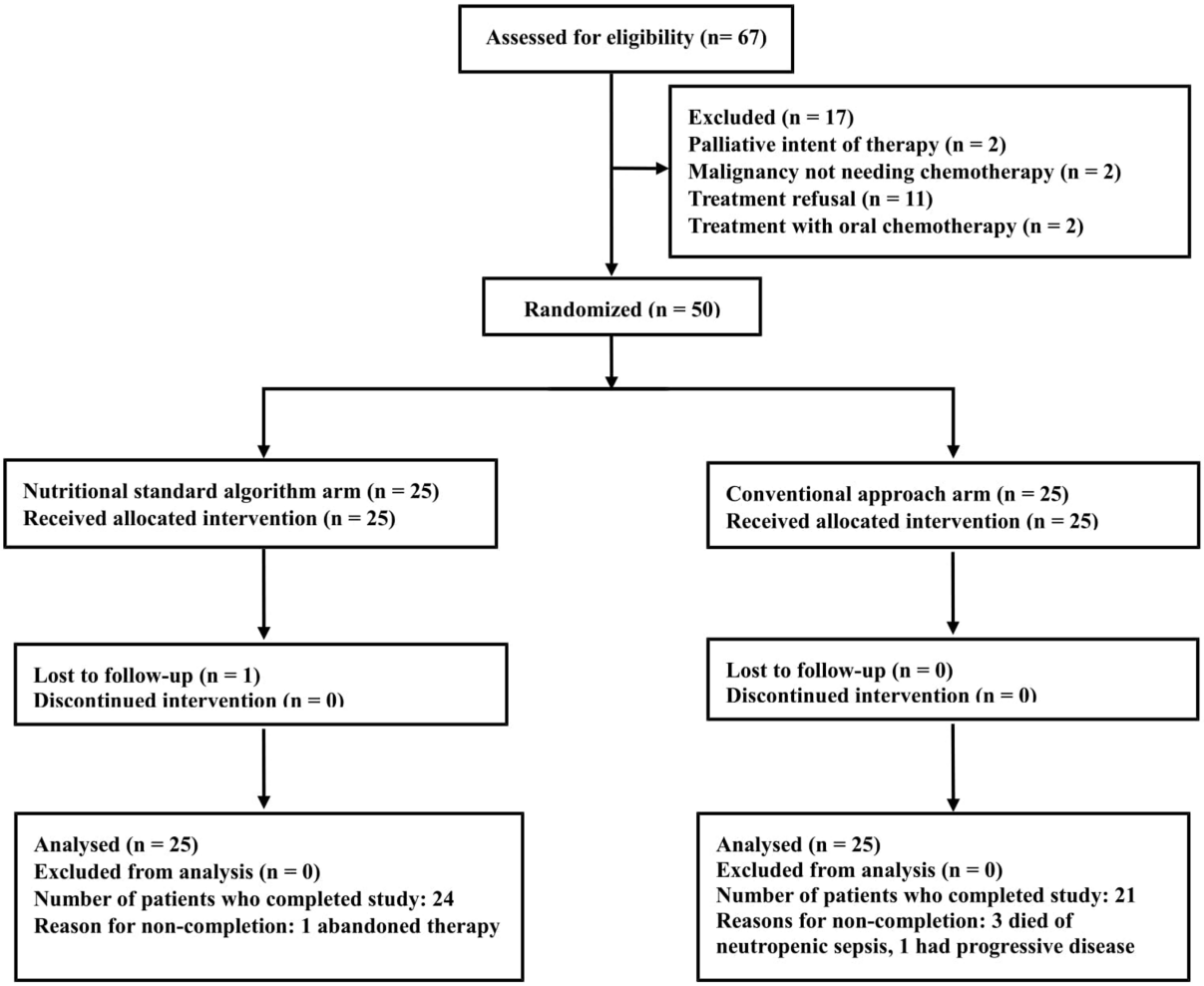

FIGURE 1 CONSORT diagram; intent-to-treat analysis was performed

involved in the administration of nutritional interventions, such as oral supplements, NG tube feeds, and parenteral nutrition, for both groups.

For patients who required nutritional supplementation, the dietitian used the 24-h dietary recall method and age-appropriate calorie and protein requirements to calculate the calorie and protein deficits.[12,13] Readily available local foods were advised as part of a daily diet chart. In addition, commercially available oral supplements were advised in suitable quantities to correct the calculated deficits. The commonly used supplements included B-Protin (British Biologicals)—116 Kcal and 12 g protein per 30 g—and Pediasure (Abbott)—462 Kcal and 14.1 g protein per 100 g. Patients in the study and control groups received the same supplements.

2.6 | Statistical analysis

The data were entered in SPSS (version 20.0, 2011; SPSS, Inc., Chicago, IL). Baseline variables were analyzed by descriptive statistics. Comparison of proportions was performed with chi-squared and Fisher's exact tests. Comparison of medians between the two groups at baseline and 3 months was performed with the Mann-Whitney U test. We imputed the missing values using the "last observation carried forward" method and then carried out an intention-to-treat analysis.

3 | RESULTS

3.1 | Baseline characteristics

Between July 1, 2017 and December 31, 2017, 67 patients were screened for the eligibility criteria, and 17 were excluded due to not meeting eligibility requirements (Figure 1, CONSORT diagram). A total of 50 patients—25 patients in the study arm and 25 in the control arm—were analyzed. The median age of the patients was 4.5 years (range: 0.8-12). The male to female ratio was 2:1. The common diagnoses were acute lymphoblastic leukemia (N = 30; 60% of patients), followed by Wilms' tumor (N = 6; 12%) and acute myeloid leukemia (N = 5; 10% of patients). Seven (14%) patients were wasted and three (6%) were severely wasted. MUAC less than the 5th centile was observed in 28 (56%) patients at baseline. One patient in the study arm abandoned therapy. One patient in the control arm had progressive disease necessitating palliative care. Three patients in the control arm succumbed to neutropenic sepsis prior to completion of the study. Two of the three patients who died were wasted, with all three having an MUAC less than the 5th centile. The baseline characteristics were comparable in the two arms (Table 1). There was no child who was overweight or obese.

TABLE 1 Baseline characteristics of patients enrolled in the two arms

Characteristics	Study arm	Control arm	*P*
No. of patients	25	25	
Median age (years)	4.5 (1-12)	4.1 (0.8-11.8)	.621
Females, n (%)	8 (32)	9 (36)	.765
Diagnosis, n (%)			.366
Acute lymphoblastic leukemia	15 (60)	15 (60)	
Acute myeloid leukemia	2 (8)	3 (12)	
Wilms' tumor	1 (4)	5 (20)	
Germ cell tumor	2 (8)	0 (0)	
Non-Hodgkin lymphoma	2 (8)	1 (4)	
Hodgkin lymphoma	2 (8)	1 (4)	
Ewing sarcoma	1 (4)	0 (0)	
Radiotherapy, n (%)	0	2 (8)	.490
Wasting, n (%)	4 (16)	6 (24)	.480
MUAC <5th centile, n (%)	15 (60)	13 (52)	.569

Abbreviation: MUAC, mid-upper-arm circumference.

3.2 | Nutritional assessment

Participants allocated to the study arm (one abandoned therapy) experienced a median weight increment of 0.80 kg (interquartile range [IQR]: −0.02; 2.00). There were four children who were wasted at baseline, one being severely wasted. Two (50%) achieved a normal WFH/BMI *z* score at the end of the study period. One of the four wasted patients experienced further weight loss of >10% and failed to regain weight by the end of the study, and the status quo remained unchanged for the severely wasted child. All 20 patients in the study arm who were eutrophic at baseline remained eutrophic at the end of the study. Six of them experienced weight loss of >10% initially but regained their baseline weight by the end of the study period.

The median MUAC increment was 1.20 cm (IQR: 0.10; 2.30). Of the 15 patients with an MUAC <5th centile, eight (53%) achieved an MUAC of >5th centile by the end of the study period while the remaining seven (47%) patients continued to have an MUAC <5th centile. The remaining patients with a normal baseline MUAC had a normal MUAC at the end of the study period. MUAC and weight were not reassessed in the child who abandoned therapy after 3 weeks.

Among the control group, the median weight increment was 0.00 kg (IQR: −0.70; 1.25). Of the six patients who were wasted, two died before completion of the study period and two (33%) achieved a normal WFH/BMI *z* score at the end of the study period. Two remained wasted, with one losing >10% weight. Of the 19 eutrophic patients, three were found to be wasted at the end of the study period compared to none in the study arm. Four had an initial loss of weight of greater than 10% from the baseline, with one returning to baseline during the study period. One of the eutrophic patients succumbed during the study period.

The median MUAC increment was 0.00 cm (IQR: −0.50; 1.10). Of 10 patients who had a baseline MUAC <5th centile, two (20%) patients achieved an MUAC of >5th centile by the end of the study period. Of the remaining 11 patients who had normal baseline MUAC, two were found to have an MUAC <5th centile at the end of the study period. MUAC and weight could not be reassessed in three patients who succumbed to neutropenic sepsis and one patient who had progressive disease.

The median weight increment was greater, though not statistically significantly, in the study arm ($P = .153$). The median MUAC increment was significantly greater in the study arm ($P = .020$).

Children with ALL receive glucocorticoids as part of the induction chemotherapy, which may have confounded the effect of nutritional interventions in the study. The proportion of patients with ALL was equal in the study and control groups (Table 1). Children with ALL did not differ from children with other malignancies with respect to the median MUAC increment (0.85 cm [IQR: −0.05; 1.92] vs 0.3 cm [IQR: 0.0; 1.92], $P = .196$) and median weight increment (0.45 kg [IQR: −0.30; 2.05] vs 0.1 kg [IQR: −0.55; 1.00], $P = .875$) at the end of the study.

3.3 | Nutritional interventions

Eighteen (72%) patients in the study arm were assessed and managed by the dietitian, versus eleven (44%) in the control arm ($P = .045$). All 15 patients with an MUAC <5th centile in the study arm were assessed by the dietitian in comparison to three (23%) of the 13 patients with an MUAC <5th centile in the control arm ($P < .001$). Of the four patients who were underweight in each arm, all those in the study arm and one of four (25%) patients in the control arm were referred for nutritional assessment.

Patients in the study arm were more likely to receive oral supplements ($P = .011$). The frequency of NG tube insertion did not differ in the two arms ($P = .368$). As per the algorithm, one child was severely wasted, requiring NG tube insertion at baseline; however, it was deferred for 2 weeks due to parental apprehension. None of the patients warranted parenteral nutrition as per the algorithm. Of the patients that received intervention, the median number of days to any nutritional intervention ($P = .311$), NG tube insertion ($P = .147$), and initiation of oral supplementation ($P = .141$) did not differ between the two arms. However, the number of children receiving nutritional intervention was greater in the study arm. Table 2 provides a comparison of the administration of nutritional interventions in the two arms.

3.4 | Treatment-related toxicities and survival

Occurrence of mucositis of grade ≥2 did not differ between the arms ($P = .351$). Patients in the study and control arms did not differ with respect to the median number of red cell transfusions ($P = .735$), number of episodes of febrile neutropenia ($P = .891$), and duration of episodes of febrile neutropenia ($P = .852$). The median number of platelet transfusions was greater in the control arm ($P = .020$). Treatment-related morbidity and mortality in both arms are described in Table 3.

TABLE 2 Comparison of nutritional interventions administered in the two arms

Parameter	Measurement	Study arm, n = 25	Control arm, n = 25	*P*
Dietitian visits	Number (%)	18 (72)	11 (44)	.045
Administration of nutritional supplements	Number (%)	18 (72)	9 (36)	.011
Nasogastric tube insertion	Number (%)	9 (36)	7 (28)	.368
Time (days) to any nutritional intervention	Median (range)	11 (1-80)	18 (1-51)	.585
Time (days) to nasogastric tube insertion	Median (range)	8 (1-53)	26 (14-51)	.147
Time (days) to initiating oral supplements	Median (range)	11 (1-80)	26 (13-51)	.141

TABLE 3 Treatment-related morbidity and mortality in the study and control arms

Parameter	Study arm (n = 25)	Control arm (n = 25)	*P*
Treatment mortality, n (%)	0	3 (14)	.117
Mucositis of grade ≥2, n (%)	5 (20)	3 (12)	.351
Median number of packed red cell transfusions, n (IQR)	2 (1-3)	2 (1-3)	.735
Median number of platelet transfusions, n (IQR)	0 (0-1.5)	3 (0-5.5)	.020
Median number of episodes of febrile neutropenia, n (IQR)	1 (0-2)	1 (1-1)	.891
Median duration of episodes of febrile neutropenia, n (IQR)	8 (1-10)	5 (2.5-12)	.852

4 | DISCUSSION

Improving the nutritional status is imperative to further improving outcomes for children with cancer in LMICs. To this end, we present the results of a simple algorithm to direct and improve the delivery of nutritional therapy among children with cancer. A systematic review, including 46 studies, identified a high prevalence of undernutrition among children with cancer with an adverse association with survival in most studies.[14] A Central American study of close to 3000 children with cancer at diagnosis demonstrated higher abandonment rates and inferior event-free survival in those who were nutritionally depleted,[5] a finding that has been replicated at our center. We found that for children with ALL, weight <5th centile for age was an independent predictor of mortality.[4] Yet, there is marked heterogeneity in the practices of identification and management of malnutrition in children with cancer around the globe.[15,16] Our results are a step forward in closing this gap in clinical care.

Comprehensive nutritional assessment, including dietary assessment, anthropometry, physical examination, laboratory investigation, and imaging, is arduous the world over, more so in resource-limited settings.[8] Weight, height, and MUAC are simple and not labor-intensive or time-consuming anthropometric measures—characteristics critical for implementation in an LMIC setting.[8] The SIOP PODC algorithm uses these parameters to identify children needing nutritional intervention. Relying on weight indices as standalone measures of nutritional status can lead to underdiagnosis of malnutrition.[17] Children have been described to have abdominal tumors weighing >10% of their body weight.[18] MUAC has been validated as an accurate measure of nutritional status in children with cancer.[19] Our study demonstrated that <20% patients were wasted as per WFH/BMI *z* scores. However, greater than 50% of the children were undernourished based on MUAC centiles.

The oral route is preferred in the first-line management of undernutrition. The study demonstrated that an algorithmic approach was effective in prompting nutritional intervention for all patients with undernutrition. Remarkably, less than one-third of patients with low MUAC and one-fourth of wasted patients received any nutritional intervention in the control group. This emphasizes the need for a uniform, protocolized approach for nutritional monitoring and intervention in children with cancer.

A significant increase in MUAC was demonstrated in the study arm but not in the control arm. The increase in weight, though greater in the study arm, did not differ significantly between the arms. One of the reasons for this disparity is that a greater proportion of patients had a suboptimal MUAC at baseline (56%), in comparison to merely 20% of patients who were wasted based on weight-based anthropometry. Assessment of nutritional status based on weight is deceptive and can be affected by tumor mass, edema, ascites, and the weight-gaining effects of steroid therapy in children with leukemias/lymphomas.[20] Therefore, the MUAC increment in our study is more relevant clinically than the insignificant weight gain. Further, all children with appropriate WFH/BMI and MUAC at baseline maintained their eutrophic status at the end of the study in the study arm. In contrast, a proportion of children who were eutrophic at diagnosis were found to be underweight or have MUAC <5th centile at the end of the study in the control arm.

The patients in the control group did not differ significantly from those in the study group with respect to the time taken to initiate nutritional interventions. Although similar, the algorithm identified a greater number of patients requiring nutritional intervention and resulted in more thorough follow-up, evidenced by an increased number of nutritionally replete participants, when compared to those in the control group.

Our study did not find significant differences between the groups in terms of treatment-related morbidity such as febrile neutropenia

or mucositis, although we were not statistically powered to evaluate treatment-related toxicities. Of interest was the observation that three patients died of neutropenic sepsis in the control group while none died in the study arm during the study period. All three had evidence of undernutrition. This is an area important for further inquiry and underscores that an algorithmic approach that facilitates monitoring and early intervention may be able to effectively prevent undernutrition during therapy, thereby reducing treatment-related toxicities.

The study was limited by its small size and a short follow-up at a single institution. The study was aimed at evaluating the nutritional algorithm and not the management of patients. However, it is one of the first studies to validate the SIOP-PODC nutritional algorithm in an LMIC center. It supports the benefits of using an algorithmic approach to identify children with or at risk of undernutrition during therapy for cancer, and initiating a prompt and appropriate nutritional intervention. Further studies to determine whether a nutritional algorithm-based approach towards the prevention and early treatment of undernutrition in children with cancer can improve nutritional outcomes, reduce treatment-related toxicities, and improve survival are the need of the hour.

CONFLICT OF INTEREST

The authors have no conflict of interest to report.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Sidharth Totadri https://orcid.org/0000-0002-0076-994X
Amita Trehan https://orcid.org/0000-0001-9071-7651
Ronald Barr https://orcid.org/0000-0002-5711-7440
Elena J. Ladas https://orcid.org/0000-0001-5077-5582

REFERENCES

1. PDQ Supportive and Palliative Care Editorial Board. Nutrition in Cancer Care (PDQ®): Health Professional Version. In: PDQ Cancer Information Summaries. Bethesda, MD: National Cancer Institute (US); 2002. http://www.ncbi.nlm.nih.gov/books/NBK65854/. Accessed February 20, 2017.
2. Pribnow AK, Ortiz R, Báez LF, Mendieta L, Luna-Fineman S. Effects of malnutrition on treatment-related morbidity and survival of children with cancer in Nicaragua. *Pediatr Blood Cancer*. 2017;64:e26590.
3. Brinksma A, Sanderman R, Roodbol PF, et al. Malnutrition is associated with worse health-related quality of life in children with cancer. *Support Care Cancer*. 2015;23:3043-3052.
4. Trehan A, Bansal D, Varma N, Vora A. Improving outcome of acute lymphoblastic leukemia with a simplified protocol: report from a tertiary care center in north India. *Pediatr Blood Cancer*. 2017;64:e26281.
5. Sala A, Rossi E, Antillon F, et al. Nutritional status at diagnosis is related to clinical outcomes in children and adolescents with cancer: a perspective from Central America. *Eur J Cancer*. 2012;48:243-252.
6. Orgel E, Sposto R, Malvar J, et al. Impact on survival and toxicity by duration of weight extremes during treatment for pediatric acute lymphoblastic leukemia: a report from the Children's Oncology Group. *J Clin Oncol*. 2014;32:1331-1337.
7. National Family Health Survey. Key findings from NFHS-4. http://rchiips.org/NFHS/factsheet_NFHS-4.shtml. Accessed September 16, 2016.
8. Ladas EJ, Arora B, Howard SC, Rogers PC, Mosby TT, Barr RD. A framework for adapted nutritional therapy for children with cancer in low- and middle-income countries: a report from the SIOP PODC Nutrition Working Group. *Pediatr Blood Cancer*. 2016;63:1339-1348.
9. Fleming CA, Viani K, Murphy AJ, et al. The development, testing, and preliminary feasibility of an adaptable pediatric oncology nutrition algorithm for low-middle income countries. *Indian J Cancer*. 2015;52:225-228.
10. WHO. The WHO child growth standards. http://www.who.int/childgrowth/standards/en/. Accessed December 12, 2018.
11. Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. *Am J Clin Nutr*. 1981;34:2540-2545.
12. National Institute of Nutrition. Dietary guidelines for Indians—a manual. http://ninindia.org/DietaryGuidelinesforNINwebsite.pdf. Accessed December 12, 2018
13. WHO. Human energy requirements. Report of a joint FAO/WHO/UNU expert consultation, Rome, Italy, 17-24 October 2001. https://www.who.int/nutrition/publications/nutrientrequirements/9251052123/en/. Accessed December 12, 2018.
14. Iniesta RR, Paciarotti I, Brougham MFH, McKenzie JM, Wilson DC. Effects of pediatric cancer and its treatment on nutritional status: a systematic review. *Nutr Rev*. 2015;73:276-295.
15. Schoeman J, Ladas EJ, Rogers PC, Aryal S, Kruger M. Unmet needs in nutritional care in African paediatric oncology units. *J Trop Pediatr*. 2018. https://doi.org/10.1093/tropej/fmy068.
16. Ladas EJ, Sacks N, Brophy P, Rogers PC. Standards of nutritional care in pediatric oncology: results from a nationwide survey on the standards of practice in pediatric oncology. A Children's Oncology Group study. *Pediatr Blood Cancer*. 2006;46:339-344.
17. Bauer J, Jürgens H, Frühwald MC. Important aspects of nutrition in children with cancer. *Adv Nutr*. 2011;2:67-77.
18. Sala A, Antillon F, Pencharz P, Barr R, AHOPCA Consortium. Nutritional status in children with cancer: a report from the AHOPCA workshop held in Guatemala City, August 31-September 5. *Pediatr Blood Cancer*. 2004;45:230-236.
19. Barr R, Collins L, Nayiager T, et al. Nutritional status at diagnosis in children with cancer. 2. An assessment by arm anthropometry. *J Pediatr Hematol Oncol*. 2011;33:e101-e104.
20. Schoeman J. Nutritional assessment and intervention in a pediatric oncology unit. *Indian J Cancer*. 2015;52:186-190.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Totadri S, Trehan A, Mahajan D, Viani K, Barr R, Ladas EJ. Validation of an algorithmic nutritional approach in children undergoing chemotherapy for cancer. *Pediatr Blood Cancer*. 2019;e27980. https://doi.org/10.1002/pbc.27980