Malnutrition and medical nutrition therapy in hospitalized children: a case study of using national malnutrition screening tools in northeastern Iran

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Abstract
Background: Nationwide studies have focused only on prevalence of malnutrition in hospitalized children, while medical nutrition therapies and assessing nutritional interventions is neglected.
Methods: This research was conducted in tertiary level children hospitals in the NorthEastern region of Iran for 1 year from 2016 to 2017. Five questions were included in the initial assessment form and, if there was even one positive response, nutritional interventions were prescribed for the patients.
Results: A total of 65 children aged $\geq$ 5 years and hospitalized for $\geq$ two days were included. 24.6% of patients had 2 >BMI Z-score>-2 at time of admission. At the beginning of the study, weight loss more than 10%, and appetite loss or decreased food intake was observed in 10.8% and 20% of the study population, respectively. Median BMI percentile of patients with nutritional intervention was 8.9 (0.1-98.7) at the beginning of the study and 12.7 (0.1-98.4) at discharge time which shows a significant difference (P=0.01).
Conclusion: Medical nutrition therapy employed in this study prevented deterioration of nutritional status of children during hospitalization and was effective in stabilizing indices of nutritional status.
Keywords: Body mass index, hospitalized children, malnutrition.

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Introduction

The daily metabolism of children depends on receiving substrates such as food and vitamins[1]. While, inadequate intake of essential nutrients strongly affects children's growth[2], sick children especially who need to be hospitalized are likely to be affected by nutritional impairment[3]. The effect of malnutrition on the child cannot be limited only to the individual growth, it has been mentioned by various studies that there is an association between deterioration of the nutritional status upon admission or

during hospitalization with increased mortality, morbidity, prolonged length of hospital stay, and increased rates of complications such as infections[1]. The primary type of malnutrition that occurs due to inadequate food intake is most often seen in developing countries, and the second type occurs in developed countries that is associated with chronic diseases[4].

According to scientific resources, the prevalence of malnutrition, particularly acute and/or chronic undernutrition among children admitted to the hospital remains considerable[5]. It has been stated that about 70-80% of children with malnutrition enter and leave the hospital, while their problem is not identified and treated[6].

Hence, early identification of nutritional risk by screening nutritional status can be an important part of patients' standard care[7]. By early detection of children at risk for developing malnutrition, intervention and treatment can be started when is more effective and less expensive[8]. In spite of this fact, there is limited information on the malnourished children at time of admission, during hospitalization and at discharge time[9], because, nutritional screening tools were designed to address adult patients and it is not too late that pediatric tools have been developed[7]. There are some known guidelines for nutrition screening developed by European Society for Clinical Nutrition and Metabolism (ESPEN), American Society for Parenteral and Enteral Nutrition (ASPEN), and European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN)[1].

Some of most famous tools to perform nutritional risk screening in children are Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP), Screening Tool for Risk On Nutritional status and Growth (Strongkids), and Pediatric Yorkhill Malnutrition Score (PYMS) that are developed by European countries, have not yet been completely examined in developing countries[3]. Moreover, there is not much information about application of nutritional screening tools in clinical practice and there is no consensus on which tools to use[8,10]. A clinical nutritional assessment tool may be consisted of questions related to detailed medical and dietary history of the patient, measurements of body size and composition and laboratory data[1]. Depending on the criteria used to define malnutrition, various reports are available on the prevalence of malnutrition in different areas[11]. Weight-

for-Height score is the most frequently used criterion for acute malnutrition and body mass index (BMI) is also used to describe malnutrition[12].

Despite the numerous studies globally published on the prevalence of malnutrition in children, evaluating the nutritional status of inpatient children is often neglected[13]. One of the most important reasons for this is the lack of identification of patients with or at risk of malnutrition in hospitals and as a result, lack of nutritional support in a timely and appropriate manner[14-16]. This problem has three main reasons: not routinely assess the nutritional status of children at the time of admission, inadequate number of pediatric clinical nutritionists and the complexity of using the usual methods for checking the nutritional status of children due to individual differences in the growth and maturity of children[17,18].

The aim of this study was investigating nutritional status of inpatient children and evaluating effectiveness of medical nutrition therapy in children requiring nutritional support using nationally developed screening tools and anthropometric indices.

Methods
Children admitted to three tertiary university hospitals, Qaem, Imam Reza, and Dr. Sheykh, located in Mashhad, Iran, were enrolled in this cross-sectional interventional study between 20 March 2016 and 20 March 2017. Inclusion criteria were age between 5 and 18 year(s) and duration of hospitalization of at least 48 hours. Children admitted to units other than the pediatric wards or admitted to pediatric intensive care unit (PICU) and neonatal intensive care unit (NICU) and those with a specific diet like ketogenic diet were excluded.

Nutritional status assessment forms
In this study, children were evaluated at both admission and discharge times using primary and secondary forms. The form used to evaluate nutritional status of children at the time of admission is shown in appendix. This form was comprised of demographic information, anthropometrics, and 5 questions to determine the status of malnutrition. Patients at the time of discharge were also evaluated in terms of weight and BMI z-score. Positive response to each of the questions determining current nutritional status, weight loss, reduced intake and severe disease in the initial form filled for each patient indicated

that the patient needs to receive medical nutrition therapy. Hence, professional nutrition assessment form was completed by dietitian (appendix).

Medical nutrition therapy

In medical nutrition therapy performed in this study at first, using guidelines of ESPEN and considering sex and age of patient, the patient's daily requirement to calorie intake, carbohydrate, fat, and protein was calculated by nutritionist. In the next step, the nutritionist documented medical nutrition therapies in the patient's records, which included the determination of the efficient feeding route (oral, enteral or parenteral), then the diet was verified by pediatric expert. Patient was provided with an appropriate oral, enteral (the standard hospital gavage solution composed of 0.45 Kcal/ml calories, 0.075 g/ml protein, 0.17 g/ml carbohydrates and 0.0417 g/ml fat) or parenteral diet, dietary supplements in the form of syrup, pill, fortified calorie-dense powder or capsule if required. Moreover, patients' nurse was trained regarding enteral or parenteral diet and dietary supplements ordered for the patient and patient's attendant was trained regarding oral diet ordered for the patient.

After professional nutritional evaluating in the relevant format, in next visits of patients, nutritional status follow-up form was filled (appendix). The patient was followed-up according to this form in terms of changes in nutritional indices during hospitalization.

Finally, to evaluate nutritional status at time of discharge, the end part of follow up form having 5 questions was filled by responsible resident and criterion for judging the status was BMI Z-score less than -2 and greater than 2.

Ethical considerations

The study was approved by the Ethical Committee of Mashhad University of Medical Sciences. Parents or legal attendants of the children were assured about the confidentiality of patient information and informed consent was obtained from them.

Statistical analysis

Statistical analysis was performed using SPSS version 23. To study and compare quantitative variables between the two groups, the distribution of each variable was first studied using the Kolmogorov-Smirnov test. With respect to the normal distribution of weight, BMI, and BMI z-score at admission and discharge, parametric paired t-test was used. While BMI percentiles at admission and discharge had not normal distribution and were assessed using non-parametric Wilcoxon test.

Results

In this study, 65 patients were enrolled, of which 28 (43.1%) were female and 37 (56.9%) were male. The mean age of the subjects was 112.4±35.84 months. The lowest age of participants was 60 months and the highest was 192 months. The mean height of the participants was 130.27±18.43 cm. 92 cm and 174 cm were respectively the smallest and the highest registered height of the patients. The average length of hospital stay was 7.09±5.7 days. The minimum length of hospital stay was 2 days and the maximum was 27 days. Based on the initial assessment checklist, the prevalence of acute malnutrition was 56.9% and 37 patients needed nutritional intervention. BMI Z-score of 24.6% (n=16) of patients was a sign of malnutrition. Moreover, 10.8% (n=7) of patients in the months leading up to the study had a weight loss of more than 10%, 20% (n=13) had anorexia or decreased food intake, and 44.6% (n=29) had malignancy or chronic illness or were candidates for major surgery, all of which were indicative of malnutrition.

Table 1. Demographic information and anthropometric indicators of patients who received nutrition therapy

Samples	AGE (Month)	GENDER	Pre-WEIGHT (kg)	Post-WEIGHT (kg)	HEIGHT (CM)	Pre-BMI (kg.m²)	Post-BMI (kg.m²)
1	75	M	25	24.5	110	20.7	20.2
2	84	M	20	20.2	112	15.9	16.1
3	120	F	34	34	142	16.9	16.9
4	156	F	55	55	135	30.2	30.2
5	150	M	35	35.5	151	15.4	15.6
6	108	M	21	22.5	125	13.4	14.4
7	110	F	17	18.5	125	10.9	11.8
8	144	M	42	42	140	21.4	21.4
9	171	M	28	28.5	132	16.1	16.4
10	164	F	34	35	152	14.7	15.1
11	144	M	32	32.3	150	14.2	14.4
12	76	M	16	17.5	103	15.1	16.5
13	144	M	31	31	150	13.8	13.8
14	122	M	25	25.5	140	12.8	13
15	69	F	16	16	114	12.3	12.3
16	87	M	20	21.2	132	11.5	12.2
17	156	M	58	58.5	174	19.2	19.3
18	72	M	16	17	107	14	14.8
19	137	F	34.5	35.5	150	15.3	15.8
20	67	M	17	17.3	106	15.1	15.4
21	144	M	28	24	146	13.1	11.3
22	138	M	37	37.5	145	17.6	17.8
23	135	F	38	38	144	18.3	18.3
24	110	M	29	29	129	17.4	17.4
25	132	F	38	38	140	19.4	19.4
26	175	M	71	71	164	26.4	26.4
27	60	M	12	13.5	94	13.6	15.3
28	99	F	26	26	111	21.1	21.1
29	120	F	22.5	22.5	130	13.3	13.3
30	96	F	27	27	124	17.6	17.6
31	70	F	20	20	120	13.9	13.9
32	73	F	13	13	98	13.5	13.5
33	84	M	18	18	118	12.9	12.9
34	72	M	9.8	9.8	92	11.6	11.6
35	120	M	18	18	116	13.4	13.4
36	192	M	58	54	163	21.8	20.3
37	92	M	17	17	116	12.6	12.6

Data on demographic information and anthropometric indices of patients undergoing nutritional treatment are presented in Table 1.

Table 2 provides the same information for patients who did not need a nutritional intervention. Based on paired t-test, there was no significant difference in terms of the weight of patients receiving nutritional therapy between the time of admission and discharge (P= 0.474). The difference was not also significant in the other group of patients (P= 0.060). In the patients with medical nutritional therapy, mean BMI at time of admission and discharge was 16.11±4.17 and 16.26±4.05, respectively (P=0.164). In the other group, mean BMI at time of admission and discharge was 16.06±2.59 and 16.08±2.59, respectively (P=0.103). Comparison of BMI between the time of admission and discharge based on the nutritional assessment forms indicates that there was no significant difference in this regard in both groups of study.

Table 2. Demographic information and anthropometric indicators of patients who did not receive nutrition therapy

Samples	AGE (Month)	GENDER	Pre-WEIGHT (kg)	Post-WEIGHT (kg)	HEIGHT (CM)	Pre-BMI (kg.m²)	Post-BMI (kg.m²)
1	103	F	23	23	130	13.6	13.6
2	72	M	18	18	115	13.6	13.6
3	132	F	28	28	135	15.4	15.4
4	108	M	35	35	129	21	21
5	96	M	25	25	130	14.8	14.8
6	121	F	34	34.3	152	14.7	14.8
7	150	F	52	52.3	155	21.6	21.8
8	78	F	20	20.5	119	14.1	14.5
9	86	F	17	17	107	14.8	14.8
10	121	M	25	25	140	12.8	12.8
11	120	M	25	25	119	17.7	17.7
12	186	M	50	50	155	20.8	20.8
13	70	F	17	17	115	12.9	12.9
14	132	F	31	31.2	147	14.3	14.4
15	162	F	44	44	150	19.6	19.6
16	156	F	38	38.2	154	16	16.1
17	120	F	30	30	135	16.5	16.5
18	66	M	20	20	112	15.9	15.9
19	96	F	25	25	120	17.4	17.4
20	120	M	34	34	135	18.7	18.7
21	62	M	15	14.8	103	14.1	14
22	102	M	34	34	147	15.7	15.7
23	84	M	22	22	118	15.8	15.8
24	63	F	18	18	118	12.9	12.9
25	72	M	20	20.1	116	14.9	14.9
26	102	F	28	28	144	13.5	13.5
27	186	M	33.5	33.5	140	17.1	17.1
28	72	F	32	32	128	19.5	19.5

Based on the information obtained from the initial form of nutritional status assessment, BMI Z-score of 13 (20%) patients on admission was less than -2 and 3 (4.6%) patients had a BMI Z-score greater than 2. Based on the final form of nutritional status assessment, at time of discharge, 10 (15.4%) patients had BMI Z-score<-2 and BMI Z-score was higher than 2 in 3 (4.6%) patients. BMI Z-scores of patients at the beginning and end of the study in the intervention group are shown in Figure 1.
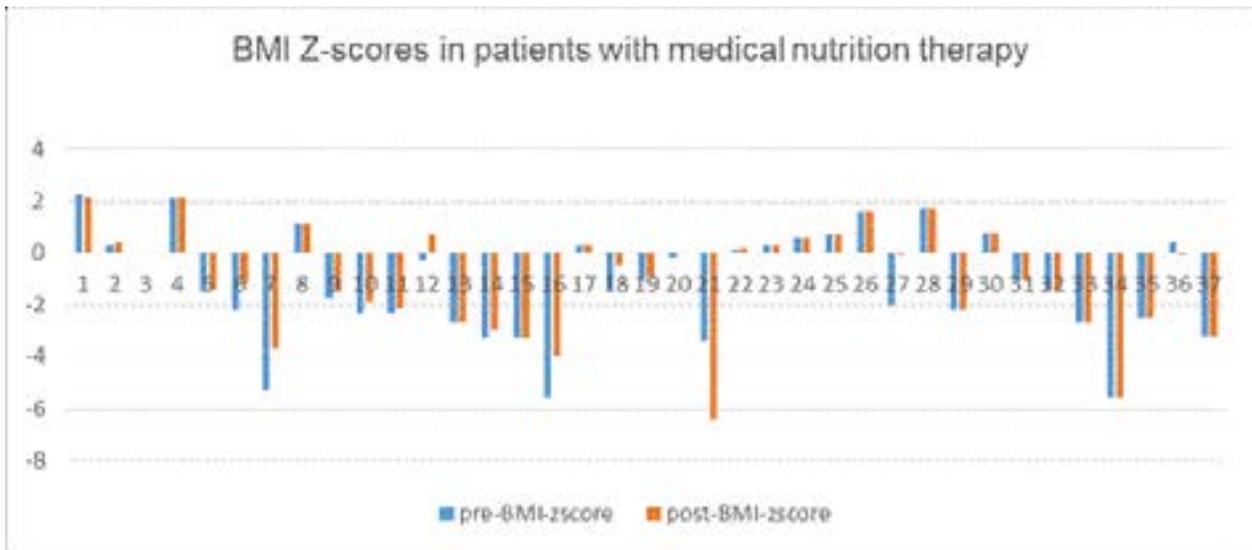
Fig.1. Comparison of BMI Z-scores of patients between the beginning and the end of the study in presence of medical nutrition therapy

Figure 2 shows similar information for patients who did not need nutritional treatment. Accordingly, in patients receiving nutritional support, mean BMI Z-score at time of admission and discharge was -1.22±2.06 and -1.05±2.05, respectively (P=0.182). While, mean BMI Z-score at time of admission and discharge in the other group was -0.58±1.26 and -0.56±1.26, respectively (P=0.234). Hence, there was no significant difference between initial and final BMI Z-scores in both groups.
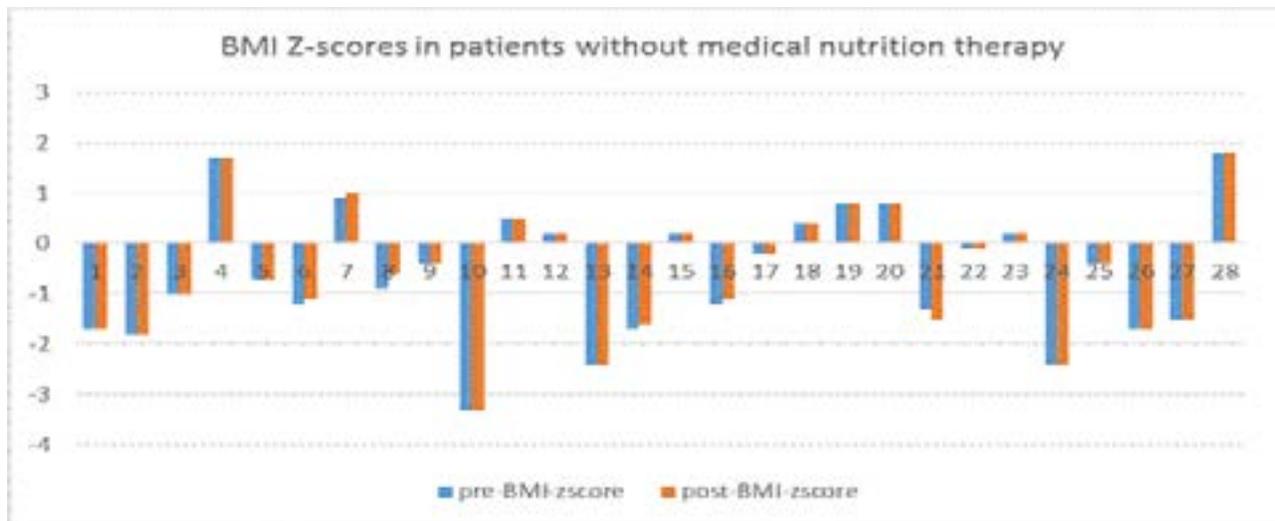
Fig.2. Comparison of BMI Z-scores of patients between the beginning and the end of the study without medical nutrition therapy

Using Wilcoxon test, the median BMI percentile of patients who were selected for nutritional intervention was 8.9 (0.1-98.7) at the beginning of the study and eventually reached 12.7 (0.1-98.4) at discharge time which shows a significant difference (P=0.01). But the difference of median BMI percentile between admission and discharge times was not considerable in the group of patients who did not receive additional nutritional support (P=0.249).

Discussion

In this study, the initial form of nutrition status assessment designed internally was used to screen hospitalized children with malnutrition. The validity and reliability of this screening tool was confirmed earlier by another study conducted at Taleghani Hospital of Tehran. The sensitivity of this tool which was defined as the percentage of people with malnutrition based on a dietitian's diagnosis had been obtained as 83.7%. The specificity of this form that was defined as the percentage of people with good nutritional status based on a dietitian's diagnosis had been reported 84.6%[19].

In this study, the mean duration of hospital stay was 7.09±5.7 days. In the study conducted by Moeeni et al.[3] length of hospital stay was directly affected by nutritional status and well-nourished patients of their study stayed on average 37% shorter than malnourished children and 33% of children with severe under-nutrition were hospitalized longer than 4 days. Although it has been stated that high nutritional risk status is associated with greater weight loss[20], but no remarkable change in weight of patients occurred in this study.

24.6% of the patients of current study had 2<BMI Z-scores<-2, which is consistent with the findings of the study carried out in Italy by Campanozzi et al.[21] which used same criterion and 21.9% of patients had BMI Z-scores below the normal range distribution or above the upper limit. In the study of Moeeni et al.[22] in New Zealand using STRONGkids nutritional risk screening tool, 24.7% of hospitalized children were malnourished. In total, using all criteria defined in the assessment form no.1, 56.9% of the patients of current study were diagnosed with malnutrition at time of admission. Tienboon[23] that studied nutrition problems of hospitalized children in Thailand, found that 50–60% of patients at ages 1–15 years were undernourished. These values are strongly higher than rates of malnutrition in developed countries. In the study of Joosten et al.[9] in Netherlands, 19% of children were malnourished at admission. Malnutrition of admitted children was also reported to be 24.1% in Germany[24], 24.5% in Boston, USA[25], and 7% in Glasgow, UK26. The differences of malnutrition rates among countries can be related to the various dietary patterns, measures selected to define malnutrition and approaches adopted to nutritional management[2].

Some methodological limitations need clarification. We could not comprise all the potentially confounding factors. Next, the sample size was a limitation of this study that we cannot examine the sex-specific effects of variables.

Conclusion

This study showed that more than half of the hospitalized children suffered from malnutrition at time of admission. The nutritional status of children supported by medical nutrition therapies at the time of discharge, was similar to those of children who had not received additional nutritional support. Hence, medical nutrition therapy carried out in this research was effective in preventing from deterioration of nutritional status in malnourished children.

Conflict of interest
None.

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