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Nutritional assessment and status of hospitalized infants

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Abstract

Background: Malnutrition during infancy has long-term adverse consequences for both physical and psychological development. Early detection of malnutrition among hospitalized infants is essential to provide optimal nutrition support. The primary aim of this study was to investigate the nutritional status of hospitalized infants using two methods; the Subjective Global Nutritional Assessment (SGNA) and anthropometric measurement. We also investigated diagnostic category associated with nutritional status, the mean anthropometric Z-scores, and explored the association between malnutrition and nutrition focused variables.

Methods: Nutritional status of 110 hospitalized infants aged 31 days to 12 months from a tertiary pediatric hospital was investigated using the SGNA and anthropometric measurements converted to Z-scores.

Results: Utilizing the SGNA, 78 (70.9%) infants were classified as having normal nutritional status, 30 (27.3%) were moderately malnourished and 2 (1.8%) were severely malnourished. The proportion of infants with acute malnutrition (weight-for-length Z-score <-2) was 16.4%, and chronic malnutrition (length-for-age Z-score <-2) was 3.6%. The mean anthropometric Z-scores of infants were significantly lower in infants identified as moderately and severely malnourished using the SGNA. Decrease in serial weight (OR 44.4; 95% CI: 4.3-451.5), having prolonged gastrointestinal symptoms (OR 18.8; 95% CI: 1.5-234.7), and reduced nutrition related functional capacity (OR 27.6; 95% CI 2.5-301.7) were associated with malnutrition after adjusting for gender, age, and length of hospital stay.

Conclusions: Regardless of the method applied, cases of malnutrition amongst hospitalized infants were identified. The SGNA is a comprehensive approach to identifying malnutrition in hospitalized infants.

Keywords

Subjective Global Nutritional Assessment

Nutritional assessment

Anthropometry

Infants

Nutritional status

What is known

- Malnutrition is a serious concern among hospitalized pediatric patients
- Timely and appropriate nutritional support is important

What is new

- Subjective Global Nutritional Assessment (SGNA) is a useful nutritional assessment tool to assess nutritional status of hospitalized infants
- SGNA nutritional status and anthropometric Z-scores of infants are correlated

Abbreviations

IQR, Interquartile Range

LOS, length of stay

RSV, Respiratory Syncytial Virus

SGNA, subjective global nutritional assessment

Introduction

Nutritional status significantly affects health especially during illness and injury. In hospitalized patients, malnutrition may increase susceptibility to infection and delay the recovery process, and children are particularly prone to malnutrition because of their higher nutrient requirements for growth and development (1). Malnutrition among hospitalized children in both developing and developed countries is well documented (2-8). Several studies have identified that infants (<12 months of age) were the most malnourished group (2, 4, 8, 9). This is a cause for real concern, as infants are particularly vulnerable to the effects of malnutrition. Malnutrition during infancy can impair the development of normal immune systems (10) and early nutrient deficiency can adversely affect long-term cognitive function (11). Organizations such as the European Society for Pediatric Gastroenterology, Hepatology and Nutrition and the International Pediatric Association recommend establishing nutrition support teams to implement nutrition screening to identify and treat malnutrition among pediatric patients (12, 13). Further, malnutrition is an economic burden to healthcare systems and providers by extending hospital stay (8). Therefore, accurate assessment of nutritional status is vital for the efficient clinical management of hospitalized infants and children.

Growth is an important marker of nutritional status in children, and anthropometric measures are used to assess the nutritional status of children. However, using anthropometry alone is difficult to detect those 'at risk' of malnutrition (14). The Subjective Global Nutritional Assessment (SGNA) is a nutritional assessment tool for pediatric patients aged 31 days to 17 years, developed by Secker and Jeejeebhoy (15). The SGNA has been used to evaluate and validate several pediatric nutrition screening tools (16-18). To date, there has not been a study which has specifically focused on using the SGNA in hospitalized infants. The primary aim of the study was therefore to investigate the nutritional status of hospitalized infants using the SGNA and objective anthropometric Z-scores. The secondary aims of the study were to 1) investigate primary diagnostic category associated with nutritional status; 2) identify the mean anthropometric Z-scores of infants with different nutritional status; and 3) explore the influence of covariates (age, gender, primary diagnostic category, and other nutrition focused medical history from the SGNA) on the nutritional status of hospitalized infants.

Subjects and methods

Subjects

This study was conducted at the Mater Children's Hospital and Mater Children's Private Hospital, tertiary pediatric hospitals in Brisbane, Australia. The eligibility criteria were infants aged 31 days to 12 months corrected for gestational age, whose hospital length of stay (LOS) was greater than 24 hours. Infants who were: unable to be weighed or measured; admitted for less than 24 hours; diagnosed with medical conditions that markedly affect hydration; deemed by nursing staff as clinically unstable; or admitted to the Pediatric Intensive Care Unit were excluded from the study. Infants with parents or caregivers of non-English speaking backgrounds were also excluded from the study, as the SGNA requires clear verbal communication with parents/caregivers. All infants meeting the study eligibility criteria were identified and whose parents/caregivers were available and present on the ward were approached to participate in the study. A researcher trained in nutritional assessment collected all data from February to March 2013 over a six-week period.

SGNA and anthropometry measurements

Nutritional status was assessed using the SGNA, using methods described previously (19). Body weight was measured to the nearest 0.01 kg using baby scales (1583, Tanita, Japan or 727, Seca, Germany), and supine length was measured to the nearest 0.5 cm using length measuring mat (2101821009, Seca, Germany or WN2006138, Wyeth, USA). The LMS parameters from the World Health Organization (WHO) growth standards for 0-2 years of age (20) were used to calculate Z-scores for weight-for-age, length-for-age, weight-for-length, and BMI-for-age Z-scores. These Z-scores were then grouped to ≥-1, <-1, <-2, and <-3.

Statistical analysis

The sample size was calculated using the formula to estimate the sample size for prevalence studies (21). Briefly, the expected prevalence of malnutrition was based on the results of the Dutch national malnutrition screening study (3) among hospitalized infants aged <1 year. Assuming an 18% rate of overall malnutrition, 57 infants were needed to estimate the sample size required to determine the prevalence of malnutrition with 95% confidence interval and 10% precision. However, it was intended to recruit more infants in order to explore the influence of covariates using multiple regression (22). Descriptive statistics were reported as n (%), mean (SD) for normally distributed continuous variable or median (interquartile ranges (IQR)) for non-normally distributed continuous variables. The three nutritional status groups identified by SGNA (normal, moderately malnourished, and severely malnourished) were compared with the means of Z-scores using one-way ANOVA and Scheffe's post-hoc analysis. Spearman's rank correlation was used to test the correlation between nutritional status identified by SGNA and WHO anthropometric Z-scores. The association between malnutrition and covariates was first investigated using univariate logistic regression, then multivariate logistic regression adjusting for age, gender, and LOS. A log transformation was undertaken to manage non-normal (skewed) data for LOS. Firth logistic regression was used to address a small sample size. The covariates were based on SGNA; unintentional changes in body weight, adequacy of dietary intake, gastrointestinal symptoms, and functional capacity. Sensitivity analysis was undertaken by removing any outliers (i.e. LOS ≥ 30days, z-scores ≤ -4) and results were compared with the complete dataset. Statistical analyses were carried out using Stata 13 software (Statacorp LP, TX).

Ethics

The study was performed in accordance with the Australian National Health and Medical Research Council's National Statement of Ethical Conduct in Research Involving Humans. The Children's Health Services Human Research Ethics Committee (HREC/12/QRCH/107), Mater Research (RG-30CP) and Griffith University Research Ethics (RBH/16/13/HREC) approved this study. Written informed consent was obtained from parents and caregivers.

Results

Patient characteristics

A total of 116 infants were enrolled in the study, a total of 6 infants were excluded due to the following reasons: three infants were discharged before both weight and length were measured, and three were discharged before length was measured, leaving 110 infants for the final analyses. The patient characteristics and nutritional status are shown in Table 1. More than 60% were male (n=70) and the median age was 4.3 months (IQR: 2.1-7.3 months). The median LOS at the time of data collection was 2 days (IQR: 2-4 days). The most common reason for admission was respiratory illness/infection (44.6%), followed by other infections (23.6%), surgery (10.0%), and gastroenterology (7.3%). Admissions for other reasons totaled 14.5%. The most common primary diagnostic category was respiratory illness/infection (39.1%), followed by cardiac conditions (12.7%) and gastroenterology (10.9%). There were also a number of surgical patients (6.4%). Approximately 30% of patients had a primary diagnostic category 'other' than the aforementioned categories.

Nutritional status of hospitalized infants

There were 78 infants (70.9%) who were identified as having normal nutritional status, 30 (27.3%) were moderately malnourished, and 2 (1.8%) were severely malnourished. There were 16.4% of infants identified with acute malnutrition (weight-for-length Z-score <-2) and chronic malnutrition (length-for-age Z-score <-2) was 3.6%.

Nutritional status of infants by different primary diagnostic category

The SGNA nutritional status grouped by primary diagnostic category is shown in Table 2. The highest proportion of moderately malnourished infants belonged to those with a cardiac condition (n=10). Two of the severely malnourished infants were diagnosed with respiratory illness/infection.

[Insert Table 2 here]

Association between nutritional status identified using SGNA and anthropometric Z-scores

The differences in mean anthropometric Z-scores among the three SGNA nutritional status groups are shown in Table 3. All mean Z-scores were significantly lower in moderately malnourished infants compared to infants who were identified as having normal nutritional status (p <0.001). Infants in the severely malnourished groups had significantly lower mean Z-scores compared to infants with normal nutritional status, except in mean length-for-age Z-score. The correlation between nutritional status identified using the SGNA and WHO Z-scores was strong for weight-for-length (0.60 p<0.001) and BMI-for-age Z-scores (0.65 p<0.001), moderate for weight-for-age Z-scores (0.54 p<0.001), and weak for length-for-age Z-score (0.19 p=0.05).

Association between malnutrition and covariates

Univariate analyses identified that compared to primary diagnostic category of 'other', infants with cardiac conditions had increased odds of being malnourished (OR 6.2; 95%CI 1.7-23.7). The following variables were associated with malnutrition; decrease in serial weight (crossing ≥1 centile downwards) (OR 3.2; 95%CI:1.7-4.7); decrease in weight over the past 2 weeks (OR 12.7; 95%CI: 1.9-83.9); decrease in dietary intake for more than 2 weeks (OR 5.7; 95%CI: 1.1-29.2); presence of daily gastrointestinal symptoms (OR 2.3; 95%CI: 1.1-4.9); prolonged gastrointestinal symptoms (OR 3.5; 95%CI: 1.7-7.1); decreased nutritional related functional capacity (OR 75.5; 95%CI: 12.9-442.3); and prolonged decrease in nutritional related functional capacity (OR 15.5; 95%CI: 2.25-107.3). Using multivariate analysis, decreased serial weight (OR44.4; 95%CI: 4.3-451.5), having prolonged daily gastrointestinal symptoms (OR 18.8; 95%CI 1.5-234.7), and decreased nutritional related functional capacity (OR 27.6; 95%CI: 2.5-301.7) were associated with malnutrition after adjusting for gender, age, and LOS. Sensitivity analysis did not alter the results, thus results using the full dataset were used. Admission reasons or primary diagnostic category were not associated with malnutrition in multivariate analysis.

Discussion

Nutritional assessment should be an essential part of patient care in hospital settings, as malnutrition can lead to further complications and delay the recovery process. Malnutrition can have long-term adverse consequences in children due to higher nutrient requirements for optimal growth and development. Reports from published studies have identified malnutrition amongst pediatric patients of various ages, but to our knowledge, this is the first study to use the SGNA exclusively on hospitalized infants aged less than 12 months to assess their nutritional status. In this study, 16.4% of infants had acute malnutrition (weight-for-length Z-score <-2) and 3.6% had chronic malnutrition (length-for-age Z-score <-2). Using the SGNA, 29% of children were categorized as malnourished. These infants had significantly lower mean anthropometric Z-scores compared to infants identified as having normal nutritional status. Notable differences can be observed between the numbers of infants categorized as malnourished using the SGNA and anthropometric Z-scores. This may be because the SGNA combines both objective and subjective measures, facilitating a more comprehensive analysis of nutritional status.

In the current study, the largest number of hospital admissions and primary diagnostic category were respiratory infections/illness. This was a surprising result, given that the study was conducted in February-March, which is summer/autumn month in southern hemisphere. Respiratory infection such as Respiratory Syncytial Virus (RSV) is one of leading causes of infant hospitalization (23), and poor growth and malnutrition increases the risk of hospitalization for RSV (24). Although primary diagnostic category was not associated with malnutrition in multivariate analysis, two infants identified as severely malnourished in this study were diagnosed with a respiratory infection/illness. A previous study has found that providing early nutrition support with protein and energy-enriched formulas in critically ill infants with RSV was effective in promoting adequate nutrient intake and improving energy and nitrogen balance (25). One of the covariates identified to be associated with malnutrition in this study included a decrease in serial weight by crossing ≥1 centile downwards, which emphasizes the need for monitoring weight status in infants. Obtaining such information is only possible with regular measurements and recording growth of infants. However, results from a recent study of hospital chart-audits have shown that on many occasions, anthropometric measures were not recorded in patient charts in a tertiary pediatric hospital (26).

Malnutrition is an economic burden to healthcare systems and providers. Disease associated malnutrition in children is correlated with the hospital LOS and increased complications (8). A study in the US identified the direct cost of malnutrition due to a longer LOS was estimated to be US$18 billion (27). Meanwhile, indirect costs of undiagnosed and unrecorded malnutrition may result in considerable financial deficits for hospitals due to unclaimed hospital reimbursements (28, 29). Yet, treatment of malnutrition in the form of nutrition consultation and nutritional supplements is relatively low cost and non-invasive (30). Early detection and treatment, as well as documentation of malnutrition are therefore warranted in order to achieve the best clinical outcomes of patients as well as the most cost-effective management for the healthcare system. Furthermore, International Classification of Diseases-10 which is commonly used in the hospital coding system internationally including Australia, defines malnutrition as observed weight below the mean value of the reference population in children, but it does not specify the reference population and only makes reference to weight loss. Shortfalls in the coding system and documentation of malnutrition have been identified in a previous study (31).

While adequacy of dietary intake was not found to be associated with malnutrition in the multivariate analysis, obtaining information on dietary intake should be an integral part of any nutritional screening and assessment, as dietary intake is the primary determinant of nutritional status (32). The SGNA incorporates both objective and subjective measures, including the estimation of dietary intake which requires individual assessment that is appropriate for age and the level of activity. It allows dietitians to apply their clinical judgements based on a broad range of nutrition focused variables to assess the nutritional status of hospitalized infants. These variables are also useful indicators for identifying those at risk of malnutrition, who are often difficult to identify with objective anthropometric measures alone. The SGNA therefore enables healthcare team to determine those who require nutritional intervention.

Despite infants being recognized as having a higher risk of malnutrition in previous literature on malnutrition among hospitalized children (4, 8, 9), only a limited number of published studies on nutritional assessment have included infants. This study applied the SGNA to hospitalized infants and obtained anthropometric measurements, which allowed assessment using both objective and subjective methods of nutritional assessment. Although more infants were recruited in this study than the sample size required to identify malnutrition in order to conduct multiple logistic regression analysis, the confidence intervals were wide, which may lessen the generalizability of this study. Further, the LOS at the time of assessment was variable and the study did not assess subsequent nutritional status, therefore the total hospital LOS or clinical outcomes could not be considered in the analysis. Limitations in relation to the subjective nature of the SGNA should also be noted. The scoring of the SGNA relies on the investigator's ability to collect and interpret information; therefore the investigator's errors in judgement may have affected the results. To minimize errors, the investigator in this study was extensively trained in nutritional assessment and borderline cases were verified by a senior pediatric dietitian. Having one assessor strengthened findings for this study as it reduced inter-rater variability.

This study has identified the nutritional status of hospitalized infants using two different approaches. Nutritional assessment outcomes identified using the SGNA and anthropometric Z-scores were found to be highly correlated, however, nutritional status varied between the two methods. The SGNA detected a higher number of malnourished infants compared to anthropometric Z-scores. As the SGNA considers individual requirements and circumstances, it provides a more comprehensive analysis of nutritional status compared to anthropometry alone. Methods applied to identify malnutrition may continue to present challenges when attempting to provide nutritional intervention in hospitalized infants and children. Nonetheless, findings in this study have highlighted that regardless of the method applied, malnutrition is relatively common among hospitalized infants, one of the most vulnerable populations. A concerted team-effort is required in healthcare settings to ensure that infants who are malnourished and/or at risk of malnutrition are identified and documented. This will facilitate appropriate level of nutritional support and care to be provided.

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Table 1 Subject characteristics and nutritional status and WHO anthropometric Z-scores of hospitalized infants (n = 110)

Patient characteristics		**n (%)**
Gender	Male	70 (63.6 %)
	Female	40 (36.4 %)
Age (months)		4.3 (IQR 2.1-7.3)
Reason for admission	Respiratory infection/illness	49 (44.6 %)
	Infection	26 (23.6 %)
	Surgery	11 (10.0 %)
	Gastroenterology	8 (7.3 %)
	Other	16 (14.5 %)
Primary Diagnosis	Respiratory infection/illness	43 (39.1%)
	Cardiac	14 (12.7%)
	Gastroenterology	12 (10.9%)
	Surgical	7 (6.4%)
	Other	34 (30.9%)
LOS* (days)		2 (IQR 2-4)
Nutritional status and anthropometric Z-scores		
SGNA	Normal	78 (70.9%)
	Moderately malnourished	30 (27.3%)
	Severely malnourished	2 (1.8%)
Weight-for-length Z-score	≥-1	65 (59.1%)
	<-1	27 (24.5%)
	<-2	10 (9.1%)
	<-3	8 (7.3%)
Weight-for-age Z-score	≥-1	84 (76.4%)
	<-1	15 (13.6%)
	<-2	6 (5.5%)
	<-3	5 (4.5%)
Length-for-age Z-score	≥-1	97 (88.2%)
	<-1	9 (8.2%)
	<-2	3 (2.7%)
	<-3	1 (0.9%)
BMI-for-age Z-score	≥-1	66 (60.0%)
	<-1	26 (23.6%)
	<-2	13 (11.8%)
	<-3	5 (4.6%)

*LOS at the time of data collection

Table 2 SGNA nutritional status grouped by primary diagnostic category

SGNA	**Primary diagnostic category (n)**				
	Respiratory illness/infection	Cardiac	Gastroenterology	Surgical	Other
Normal	37	4	7	5	25
Moderate	4	10	5	2	9
Severe	2	0	0	0	0

Table 3

Differences in mean anthropometric Z-scores of nutritional status groups identified using SGNA and correlation between nutritional status identified using SGNA and anthropometric Z-scores

WHO anthropometric Z-scores	SGNA Normal (n=78)	Moderate (n=30)	Severe (n=2)	F	p	r_s[c]	p
weight-for-length Z-score	0.02 (1.29)	-1.96 (1.33)[a]	-4.16 (0.52)[a]	33.21	< 0.001	0.60	< 0.001
weight-for-age Z-score	0.67 (1.10)	-1.59 (0.95)[a]	-2.97 (0.56)[a]	57.05	< 0.001	0.54	< 0.001
length-for-age Z-score	1.26 (-0.24)	-0.24 (1.51)[a]	-0.06 (0.52)	11.37	< 0.001	0.19	0.05
BMI-for-age Z-score	0.06 (1.10)	-1.98 (1.08)[a]	-4.17 (0.31)[ab]	48.83	< 0.001	0.65	< 0.001

[a] < 0.001 compared to SGNA normal category group [b] < 0.05 compared to SGNA moderate category group, according to Scheffe's test

[c] Spearman's Rank Correlation analyzed by combing Z-score categories ≥-1and <-1