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The development and evaluation of the Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP©) for use by healthcare staff

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Abstract

Background: The early identification of malnutrition and nutrition risk through nutrition screening is common practice in adult clinical care but, in children, this has been hampered by the lack of an appropriate nutrition screening tool. The present study aimed to develop and evaluate a simple, child-specific nutrition screening tool for administration by non-nutrition healthcare professionals.
Methods: In a two-phase observational study, significant predictors of nutrition risk were identified using a structured questionnaire. These were then combined to produce a nutrition screening tool. For evaluation purposes, the reliability, sensitivity and specificity of the newly-developed Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP©) were estimated by comparing the classification of nutrition risk using the tool with that determined by a full nutritional assessment by a registered dietitian.
Results: A total of 122 children were recruited for development phase and a separate cohort of 238 children was recruited for the evaluation phase. Low percentile weight for age, reported weight loss, discrepancy between weight and height percentile and recently changed appetite were all identified as predictors of nutrition risk. These predictors, together with the expected nutrition risk of clinical diagnoses, were combined to produce STAMP©. Evaluation of STAMP© demonstrated fair to moderate reliability in identifying nutrition risk compared to the nutrition risk classification determined by a registered dietitian (κ = 0.541; 95% confidence interval = 0.461–0.621). Sensitivity and specificity were estimated at 70% (51–84%) and 91% (86–94%), respectively.
Conclusions: The present study describes the development and evaluation of a new nutrition screening tool specifically for use in a UK general paediatric inpatient population.

Introduction

Nutrition screening is a quick and simple process aiming to identify individuals with (or at risk of developing) malnutrition so that appropriate nutritional intervention can be initiated. The ideal nutrition screening tool is one that can be completed by any member of the healthcare team without specialist nutrition training or knowledge, is reproducible and reliable in the identification of individuals at risk of malnutrition, and facilitates referral for appropriate nutritional assessment (Taylor-Baer & Bradford-Harris, 1997). By contrast, nutritional assessment is the detailed process of quantifying the degree of malnutrition in an individual, requiring specialist training and expert knowledge of nutrition. Malnutrition, both under-nutrition and over-nutrition, has recognised clinical and financial consequences for the individual and for healthcare services. In adults, under-nutrition is associated with poor

wound healing, increased risk of infection, increased length of hospital stay and increased morbidity and mortality (Green, 1999; Correia & Waitzberg, 2003; Stratton *et al.*, 2003; Norman *et al.*, 2008). In children, there are the additional consequences of poor growth and impaired cognitive development (Hall, 2000; Corbett & Drewett, 2004).

With the economic cost of under-nutrition in the UK estimated at up to £13 billion annually (Elia *et al.*, 2005; Elia, 2006; Russell, 2007; Elia & Russell, 2009), the screening of all patients on admission to hospital has been advocated. Although several nutrition screening tools are available for use in adults (Kondrup *et al.*, 2003; van Venrooij *et al.*, 2007), in paediatric practice, there are few screening tools available that have undergone formal evaluation of their effectiveness in the identification of children at risk of under-nutrition. Those that are reported in the literature have mainly been developed either for use in specific clinical conditions such as cancer, or are more akin to a full nutritional assessment taking time and expertise to complete (Attard-Montalto *et al.*, 1998; Secker & Jeejeebhoy, 2007). The Royal College of Nursing (RCN) has specifically identified nurses as having an active role in the identification and monitoring of children with under-nutrition (RCN, 2006). In the absence of an effective screening tool, the RCN has called for nurses working with children and young people to use 'triggers' to identify children potentially at nutrition risk (RCN, 2006). Thus, the identification of children at risk of under-nutrition has tended to rely on clinical judgement, although this has been demonstrated to be subjective and unreliable (Cross *et al.*, 1995), and/or on anthropometric indices only that are widely reported to be subject to errors, both in their measurement and their interpretation (Poustie *et al.*, 2000; O'Connor *et al.*, 2004; Hutteman *et al.*, 2008). The present study aimed to develop and evaluate a quick, simple and reliable nutrition screening tool for use by nursing staff in the early identification of under-nutrition in children admitted to hospital.

Materials and methods

Participants

The present study was conducted in the children's division of Central Manchester and Manchester Children's Hospitals University NHS Trust. It comprised of two phases: the development phase, which took place between April and June 2004, and the evaluation phase, which took place between November 2007 and February 2008.

Recruitment of participants to both phases of the study was based on the same inclusion and exclusion criteria. Children eligible for inclusion were those aged 2–17 years who were admitted to participating medical and surgical wards during each phase of this study. Exclusion criteria included a hospital admission of <24 h or an unobtainable weight or height measurement. Children aged under 2 years were excluded because the Trust had a longstanding protocol in place for the identification and management of faltering growth in this group. In addition, for the development phase, children attending a dietitian (from the Dietetic Department of the admitting Trust or of another Trust) were also excluded on the basis that this may have introduced a bias towards under-nutrition and associated questionnaire responses. Children were recruited within 24 h of admission.

Collection of clinical and nutritional data

In the development phase, families were asked to complete a structured questionnaire in relation to their child consisting of 27 closed questions grouped as dietary, growth or health issues. Questions were derived from information (gathered from a number of UK paediatric units) that was typically recorded by medical, nursing or dietetic staff when assessing nutrition risk in children. This included questions relating to parental concern about eating habits, growth and weight gain, and general health. After completion of the structured questionnaire, children underwent a full nutritional assessment, which consisted of a face-to-face interview with a registered dietitian, providing detailed information on current and recent changes in dietary intake, as well as the retrieval of relevant personal and clinical information from medical and nursing notes. The full nutritional assessment classified children as 'at risk' or 'not at risk' of under-nutrition. Risk of under-nutrition was considered if a child presented with one or more of: a low weight percentile relative to height percentile and age; sub-optimal dietary intake over the recent past that would be unlikely to improve in the next 3–5 days; and a clinical history/treatment plan that might result in either increased metabolic stress, decreased dietary intake or increased nutritional losses.

Structured questionnaire responses and anthropometric measurements were compared with the classification of nutritional status by the full nutritional assessment aiming to identify factors that were significant predictors of nutrition risk. These predictors were then combined to generate a model that would best predict nutrition risk on admission to hospital. Significant predictors of nutrition risk were then grouped into anthropometric or dietary factors, providing two elements for the final tool. Within each of these elements, scores were arbitrarily assigned on the basis of univariate analysis of relationship with nutrition risk outcome. For example, factors that were found to have no significant relationship with nutrition risk outcome were scored as zero (e.g. no change in appetite), whereas those found to have a highly

significant relationship were scored as 3 (e.g. complete absence of dietary intake). A third element in relation to clinical diagnosis was also included based on published evidence. Clinical conditions recognised in the literature as having an impact on nutrition status were scored similarly to the other predictors. This provided the final three elements used in the tool. The tool was then piloted to verify the clarity and appropriateness of language for the user (24 participants screened by six nurses).

For the evaluation phase of the study, the newly developed Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP©) was used to screen all children admitted to the participating wards as a routine component of the nursing admission process. Nursing staff working on the participating wards took part in a 30-min prestudy training session addressing the purpose of nutrition screening, the techniques for weighing and measuring children, and instructions on completing STAMP©. Children screened using STAMP© then underwent a full nutritional assessment by a registered dietitian, using the same format as described for the development phase. Participants were again classified as 'at risk' or 'not at risk' of under-nutrition. The outcome of STAMP© and the full nutritional assessment were compared to evaluate the reliability (or criterion validity) of the tool.

A convenience sub-sample of participants (20%) from both phases of the study was independently reviewed by a second registered dietitian to assess the reliability of the classification of nutrition risk as determined by the full nutrition assessment.

Anthropometric data

Standardised techniques of weighing and measuring children were used for the full nutritional assessment during both the development and the validation phases. Weight was recorded using ward scales (Seca 770 flat electronic scales; Seca Ltd, Birmingham, UK) and height was recorded using a Leicester height measure (Harlow Printing Ltd, Tyne & Wear, UK). Before use, the equipment was checked for accuracy using a standard weight and a metre rod. All children were weighed and measured in light indoor clothing or night wear. Where necessary, the carer or a member of the nursing staff assisted with the measurements. Weight was recorded to the nearest 10 g and height was measured to the nearest 1 mm. All measurements were plotted on UK90 growth reference charts (Harlow Printing Ltd, Newcastle, UK).

Statistical analysis

Statistical analysis was carried out using SPSS, version 11.5 (SPSS Inc., Chicago, IL, USA). As a result of the unique nature of the present study, *a priori* calculations of sample size for the development phase were not possible because the number of predictive variables to be included was unknown (Jones, 2004). Participant characteristics between the two study phases were compared using a chi-squared test. In the development phase, univariate analysis using chi-squared tests identified factors that were related to the outcome of nutritional risk. Multivariate analysis of the significant risk factors by linear logistic regression was then used to produce a reduced profoma consisting of factors most significantly associated with nutrition risk. In the evaluation phase, the κ statistic (a chance-corrected index of agreement) was calculated to determine the strength of agreement (criterion validity) between STAMP© and the full nutritional assessment. The sensitivity and specificity of STAMP© were calculated along with the positive predictive values. $P < 0.05$ was considered statistically significant.

Ethical approval was obtained from the Salford and Trafford Research Ethics Committee and all participants were recruited after obtaining fully informed written consent from parents/carers and assent from children.

Results

Characteristics of participants

Of the 300 children eligible to participate in the development phase, consent was obtained for 170 participants and complete data were available for 122 participants. Reasons for exclusion of participants from the development phase included being under the care of a dietitian at another centre, changes in clinical condition including early discharge, voluntary withdrawal or conflicting or incomplete data being available. Of the 48 participants excluded in this phase, 30 were on the basis of 'incomplete data', which included a lack of weight and/or height measurement. In the evaluation phase, of the 314 children admitted during the study period, consent was obtained for 251, of which complete data were available for 238 participants. Of the 13 participants excluded in this phase, 10 were on the basis of 'incomplete data'.

The characteristics of the development and evaluation cohorts are shown in Table 1. There were no significant differences between the two cohorts with the exception of mean weight percentile and weight *Z*-score, which were significantly lower in the evaluation cohort. A greater proportion of the participants were medical admissions in the evaluation cohort compared to the development cohort, although this did not reach statistical significance ($P = 0.060$).

There were no significant differences between the development and evaluation phases in terms of the prevalence of nutrition risk, nor in the proportion of children classified as being undernourished or overnourished ($P = 0.105$ and $P = 0.195$, respectively; not shown). A sample of the participants from both phases of the study was

Table 1 Characteristics of participants recruited to either the development phase (2004) or the evaluation phase (2007–2008)

	Development phase (n = 122)	Evaluation phase (n = 238)	P*
Male : Female (% male)	59 : 63 (48)	135 : 103 (57)	0.132
Age (years)	8.2 (4.2)	8.4 (4.6)	0.693
Weight percentile	56.6 (34)	47.9 (33.2)	0.019
Weight *Z*-score	0.34 (1.6)	−0.01 (1.4)	0.008
Height percentile	50.4 (28.6)	46.1 (33.3)	0.224
Height *Z*-score	0.03 (1.4)	−0.19 (1.3)	0.144
Medical : Surgical (% medical)†	49 : 73 (40)	122 : 116 (51)	0.060

Values given as the mean (SD), except where otherwise indicated. Age is reported in decimal years.
*Derived from Student's *t*-test or a chi-squared test as appropriate, $P \leq 0.05$.
†Medical admissions (Evaluation phase) include general medical (10%), routine gastroenterology (21%), neurology (3%), respiratory (3%), urology/renal (3%). Surgical admissions (Evaluation phase) include general surgery (3%), ENT and dental (28%), routine orthopaedic surgery/fractures (3%), burns/plastic surgery including cleft (24%). For the development phase, nutritionally high-risk conditions were excluded; for details, see text.

independently reviewed by a second registered dietitian and complete agreement was found in the classification of nutrition risk.

Development phase

Structured questionnaire responses and anthropometric measurements were compared with the classification of nutritional status by the full nutritional assessment using chi-squared tests (not shown). This analysis identified significant predictors of nutrition risk: a difference >2 centile spaces between weight and height percentile for age and gender ($P < 0.001$), weight loss in the past month as reported by parents ($P < 0.001$) and a recent reduction in appetite as reported by parents ($P = 0.034$). Additionally, parents reporting irregular meal patterns was of borderline significance as an independent predictor of being classified at risk of under-nutrition ($P = 0.051$).

These predictors were then entered into a linear logistic regression analysis to select the model that would best predict nutrition risk on admission to hospital (Table 2). The proposed model was supported by the Hosmer and Lemeshow test for goodness of fit ($P = 0.984$), with an accuracy of classification of 88%. The predictive sensitivity and the specificity of the model were calculated as 77% and 91%, respectively, suggesting that the model was valid and would reliably identify children at nutrition risk.

Significant predictors of nutrition risk were found to be poor or decreased dietary intake, as well as discrepancies in anthropometric measurements. Scores for each element were arbitrarily assigned based on the relationship with nutrition risk.

Table 2 Predictors of nutrition risk (identified from structured questionnaire responses) compared with classification of nutrition risk by a full nutrition assessment carried out by a registered dietitian (development phase)

Predictor	Odds ratio	95% confidence intervals		P*
		Lower	Upper	
Centile difference†	39.70	4.52	348.46	0.001
Weight centile <2nd/>98th	16.02	3.88	66.10	<0.001
Parent reported weight loss in past month	12.68	2.81	57.16	0.001
Parent reported irregular meal pattern	6.34	0.56	71.29	0.135
Parent reported reduction in appetite	2.20	0.55	8.82	0.266

*Derived from linear logistic regression analysis; Wald test, $P \leq 0.05$.
†Anthropometric measurements interpreted using UK90 growth charts (Harlow Printing Ltd, Newcastle, UK).

Evaluation phase

Of the 238 participants in the evaluation phase, the full nutritional assessment by a registered dietitian identified 33 (14%) as being at nutrition risk, whereas STAMP© identified 42 (18%) with a score of 4 or greater, and therefore at nutrition risk.

To establish the reliability of the tool, the proportion of children identified as being at nutrition risk by both the full nutritional assessment and STAMP© were used to calculate the κ statistic (Table 3). A value of 0.541 [95% confidence interval (CI) = 0.384–0.698] was calculated, which indicated a fair to moderate reliability based on the classification system of Shrout (1998). The sensitivity of STAMP© was calculated as 70% (51–84%) and the specificity was calculated as 91% (86–94%). The positive predictive value was calculated as 0.548 (0.388–0.698) and the negative predictive value was calculated as 0.949 (0.905–0.974).

From the convenience sub-samples of both the development and evaluation phases of the study that were independently reviewed to assess reliability of nutrition risk classification, inter-rater agreement was shown to be 0.882 (95% CI = 0.646–1.000) and 0.921 (95% CI = 0.763–1.000), respectively (not shown).

Discussion

Screening for nutrition risk on admission to hospital has been recommended by a number of national and international

Table 3 Reliability, sensitivity, specificity and predictive values of the nutrition screening tool compared with full nutritional assessment by a registered dietitian in identifying nutrition risk (evaluation phase)

	Nutrition screening tool		
	Nutrition risk	No nutrition risk	Total (n = 238)
Full nutrition assessment			
Nutrition risk	23 (9)	10 (4)	33 (14)
No nutrition risk	19 (8)	186 (78)	205 (86)
Total	42 (18)	196 (82)	

Data are given as n (%).
κ (a chance-corrected index of agreement): 0.541 [95% confidence interval (CI) = 0.384–0.698].
Sensitivity (proportion of disease positive who test positive) = 70% (51–84%).
Specificity (proportion of disease negative who test negative) = 91% (86–94%).
Positive predictive value (probability of a positive test being true positive) = 0.548 (0.388–0.698).
Negative predictive value (probability of a negative test being a true negative) = 0.949 (0.905–0.974).

bodies (Council of Europe, 2003; Kondrup *et al.*, 2003; NHS Modernisation Agency, 2003; National Collaborating Centre for Acute Care, 2006). However, the majority of these recommendations focus on the nutrition screening of adults and elderly populations as a result of the absence of an appropriate nutrition screening tool for the identification of nutrition risk in children on admission to hospital. The present study aimed to address this deficit through the development and evaluation a child-specific tool for the early identification of nutrition risk.

The results obtained in the development phase of the present study found that the objective information relating to weight and height was the strongest predictor of nutrition risk. This was not unexpected because anthropometric measurements are commonly used as the only defining criteria for under-nutrition and over-nutrition. However, although they provide a useful proxy for nutrition status, anthropometric measurements alone do not give a complete picture of nutrition risk in a clinical setting, and additional (although somewhat subjective) information, such as dietary intake and underlying clinical condition and management, is also required (Bunting & Weaver, 1997; Motil, 1998; Gibson, 2005; National Collaborating Centre for Acute Care, 2006). Other factors identified as predictors of under-nutrition in the present study related to changes in appetite and poor dietary intake. These factors were also highlighted by Sermet-Gaudelus *et al.* (2000) in a study reporting the development of a nutrition screening tool specifically for use with children. Using a prospective assessment of nutritional status in children admitted to hospital in Paris, with an endpoint criterion of >2% weight loss during admission, Sermet-Gaudelus *et al.* (2000) identified decreased food intake to <50% of the daily dietary allowance as a significant predictive factor. Although, in the present study (development phase), clinical condition appeared to be unrelated to nutrition risk, strong evidence exists indicating that there are important nutritional consequences of certain diseases in children, such as cystic fibrosis, cerebral palsy and Crohn's disease (Sentongo *et al.*, 2000; Sermet-Gaudelus *et al.*, 2000; Sullivan *et al.*, 2002; Weidemann *et al.*, 2007). It was therefore considered important to include clinical condition in STAMP©. These conditions were, however, excluded from the development phase of the present study because the participants would already have been under the care of a dietitian and it was considered that this could introduce bias to the parental questionnaire responses. This aspect of the study design may be a possible reason for our finding that there was no significant relationship between clinical condition and nutrition risk in the development phase. Children with these and other nutritionally high-risk clinical conditions were included in the evaluation phase of the study, thereby allowing an evaluation of STAMP© with secondary and tertiary level hospitalised children.

When compared with the tool reported by Sermet-Gaudelus *et al.* (2000), the present study found that similar predictors contributed to the risk of under-nutrition, with the exception of pain, the presence of which was found to contribute significantly to under-nutrition in the previous study by Sermet-Gaudelus *et al.* (2000). Although the present study did not specifically investigate the predictive value of pain in relation to an outcome of nutrition risk in children, the fact that pain is generally linked to the nature of the diagnosis, and is recognised to frequently result in decreased dietary intake, is a likely explanation for its contribution to under-nutrition in the study by Sermet-Gaudelus *et al.* (2000). More recently, the Paediatric Yorkhill Malnutrition Score (PYMS) developed by a team from Yorkhill Children's Hospital utilised four elements that were reported as recognised predictors of nutrition risk (Gerasimidis *et al.*, 2010). These were body mass index, history of recent weight loss, change in nutritional intake and the predicted effect of the underlying clinical condition.

Results of the evaluation phase of the present study clearly demonstrated that the newly-developed STAMP© was reliable compared to the outcome of a full nutritional assessment with respect to identifying children at risk of under-nutrition on admission to hospital. The overall reliability of STAMP© could be classified as fair to moderate, or moderate to substantial, based on the classifications of Shrout (1998) and Landis & Koch (1977), respectively. Gerasimidis *et al.* (2010) reported a similar criterion validity of κ = 0.46 for Paediatric Yorkhill Malnutrition Score, although with a lower sensitivity of 59% and a positive

predictive value of 47% (Gerasimidis *et al.*, 2010). In the present study, the higher sensitivity and positive predictive values of STAMP© reflect a greater likelihood that a child who is identified as being at nutritional risk using the tool will indeed be so. This, coupled with the high specificity and negative predictive value, reduces the risk of over-identifying high nutritional risk children.

STAMP© utilised information that should be routinely collected by nursing staff as part of the admission process, including anthropometric measurements, changes in dietary intake and underlying clinical condition. Nursing staff required minimal training to complete the tool, and it was quick to use and easily interpreted using a simple scoring system. The introduction of such a tool would therefore require neither significant amounts of time in training nursing staff on its use or interpretation, nor take a significant amount of time to complete. This is important because such factors are commonly recognised as barriers to the successful implementation of nutrition screening (NHS National Patient Safety Agency, 2006). Additionally, in the evaluation phase of the present study, nursing ward staff of all grades were included in the training and administration of STAMP©. Because the ideal tool should be usable by all staff, the inclusion of student nurses and nursing support staff in this process is essential for optimal uptake and the effective use of any nutrition screening tool.The use of any screening tool to identify children with (or are at risk of) malnutrition can only be considered effective if it results in early intervention and improved clinical outcomes. Evidence from adult literature has suggested that the use of nutrition screening as a component of a positive nutrition strategy can reduce the prevalence and development of under-nutrition in inpatient populations (O'Flynn *et al.*, 2005). This evidence does not currently exist in paediatrics, although a large multicentred international study to address this issue is currently being co-ordinated by the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN). Similalrly, it is well recognised that patients who are admitted to hospital malnourished have become so when in the community. Ongoing research into the effectiveness of STAMP© in a non-acute setting is currently in progress.

The present study used the expert opinion of a trained and highly experienced registered dietitian for the classification of nutrition risk in all subjects in the development and validation phases. Although there are potential limitations with this approach, including the subjective nature of the assessment, the use of one observer with considerable experience would tend to minimise any bias (Cross *et al.*, 1995). Additionally, complete agreement in the classification of nutrition risk by a second registered dietitian in the present study suggests that this method was reproducible. The small sample size in the development phase might be considered an additional limitation of the present study. As a result of the unique nature of the present study, power calculations to estimate the sample size before conducting the study could not be made because of the lack of published data on which to base such estimates. No child under the age of 2 years was included in the present study and yet this age group would frequently present with faltering growth. Although there was a rationale for this at the time the study was undertaken, further work to demonstrate the effectiveness of STAMP© with the under 2-year-old age group would extend the applicability of the tool within most acute hospital settings.

Conclusions

The present study describes the development and evaluation of STAMP©, a screening tool specifically developed for use in hospitalised children aged 2–17 years in the UK. It met the requirements of a nutrition screening tool in that it was quick and easy to use, requiring no nutritional expertise and minimal training to implement. Further investigations are required to establish the effectiveness of the tool within different healthcare settings (e.g. community health services). Additionally, further studies are required to demonstrate the benefits of nutritional screening in children in terms of reducing the prevalence of malnutrition and the related morbidity and mortality, as well as the health economic implications of nutrition risk.

Conflict of interest, source of funding and authorship

The authors declare that they have no conflict of interest.
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HMcC conceived and designed the study, supervised and participated in data collection, analysis and interpretation, and drafted this article. MD conceived and contributed to the study design and execution, interpretation of data and critical revision of this article. MJE-E acted as scientific advisor, was involved in the interpretation of data, contributions to the drafts and critical revisions of this article. IC contributed to the study implementation and collection of data and critical revision of this article. HMcN acted as academic supervisor, was involved in the interpretation of data, contributions to drafts and critical revision of this article. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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