

ORIGINAL ARTICLE

Validation of the Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP) in patients with spinal cord injuries (SCIs)

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Objectives: To validate the Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP) in paediatric spinal cord injuries (SCIs) patients admitted to the tertiary SCI centre.

Methods: children's baseline clinical data, anthropometric measurements and STAMP score were assessed on admission. The validity of STAMP was assessed by (i) comparison with a full dietetic assessment (criterion validity); (ii) comparison with generic paediatric screening tools: the Paediatric Yorkhill Malnutrition Score (PYMS; concurrent validity); and (iii) completion of an additional STAMP to assess inter- and intra-rater reliability. The agreement was assessed using Cohen's κ -statistics.

Results: Fifty-one children were screened by STAMP. The prevalence of undernutrition risk was 58.8%. STAMP had moderate agreement with dietitian assessment (κ : 0.507) and a fair agreement with PYMS (κ : 0.314). The STAMP had substantial reliability (inter-rater reliability: κ : 0.752; intra-rater reliability: κ : 0.635). When compared with dietetic assessment as a reference standard, STAMP had a sensitivity of 83.3%, specificity of 66.7% and an overall agreement of 76.5%.

Conclusion: The present study shows that undernutrition is common in children with SCI. The STAMP is an acceptable (valid and reliable) tool to identify paediatric SCI patients at risk of undernutrition.

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Keywords: malnutrition; paediatrics; spinal cord injuries; nutrition screening tool

INTRODUCTION

Rapid identification of malnourished children is of clinical importance as it is associated with poorer outcomes and increased healthcare costs.^{1–6} In addition, childhood malnutrition is associated with poorer somatic growth and development, reduced or delayed mental and psychomotor development.^{1,4,6} There is a relationship between impaired growth status and both poor school performance and reduced intellectual achievement.⁶ Growth faltering in early childhood is also associated with significant functional impairment in adult life and reduced work capacity, thus affecting economic productivity.⁶

The need to have a validated paediatric nutrition screening tool (PNST) is becoming increasingly apparent, and this is further supported by national^{1,7} and international guidelines.^{4,8} In the absence of a gold standard, researchers have taken different approaches to tackle identification and recognition of 'at-risk' children, including delineation of the problem by developing PNSTs. Examples include the 'Paediatric Nutritional Risk Score'⁹ and the 'Subjective Global Nutritional Assessment Tool'.¹⁰ However, both of these tools have been found to be relatively complicated and too time-consuming for ready use in screening. Hulst *et al.*¹¹ developed the STRONG_{kids} tool, but this is designed for use by paediatricians (as this would require a clinical assessment), which probably renders it less suitable for use by nurses and other healthcare professionals. More recently, the Screening Tool for the Assessment of

Malnutrition in Paediatrics (STAMP)^{12,13} was developed in the UK, specifically for use by members of the multi-disciplinary team.

The STAMP incorporates three components, all of which are recognised indices or symptoms of undernutrition: the presence of a clinical diagnosis that has nutritional implications; estimated current nutritional intake; and differences in weight/height centile chart (Figure 1). Each component carries a score of up to 3 and the total score reflects the risk of undernutrition. A score of 2 or 3 indicates medium risk and ≥ 4 indicates high risk.

To date, there is only a very limited literature reporting the practical utility and validity of STAMP. Nonetheless, in response to national guidance,^{1,3,5,7} the STAMP was selected to screen all paediatric patients admitted to the UK's National Spinal Injuries Centre (NSIC) at Stoke Mandeville Hospital. A prospective study was therefore performed with the aim of describing the nutritional profile of children admitted to the spinal cord injury (SCI) centre and indicated that malnutrition (both under- and over-nutrition) is common in the paediatric SCI population.¹⁴ No such study can be considered definitive without confidence that the tools being used are indeed valid in the context of SCI. The present study accordingly aims (i) to compare the performance of the STAMP with a variety of other published tools; (ii) to investigate the concurrent validity of STAMP with these PNSTs and assess whether the same patients are identified at risk of undernutrition; (iii) and to compare the ease of use of STAMP with other PNSTs.

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MATERIALS AND METHODS

The present study was approved by the National Research Ethics Committee (09/H0604/132). Written informed consent from parents (with oral agreement from the children themselves whenever possible) was obtained before data collection.

Subject recruitment

The parents of every child admitted to the NSIC between January 2010 and December 2010 were invited to allow their child to participate in the study. The inclusion criteria were: age between 6 months and 18 years old; presence of SCI; and an expected in-patient stay of at least 1 day. Day-care patients and those who were treated exclusively in the intensive care unit were excluded.

Data collection

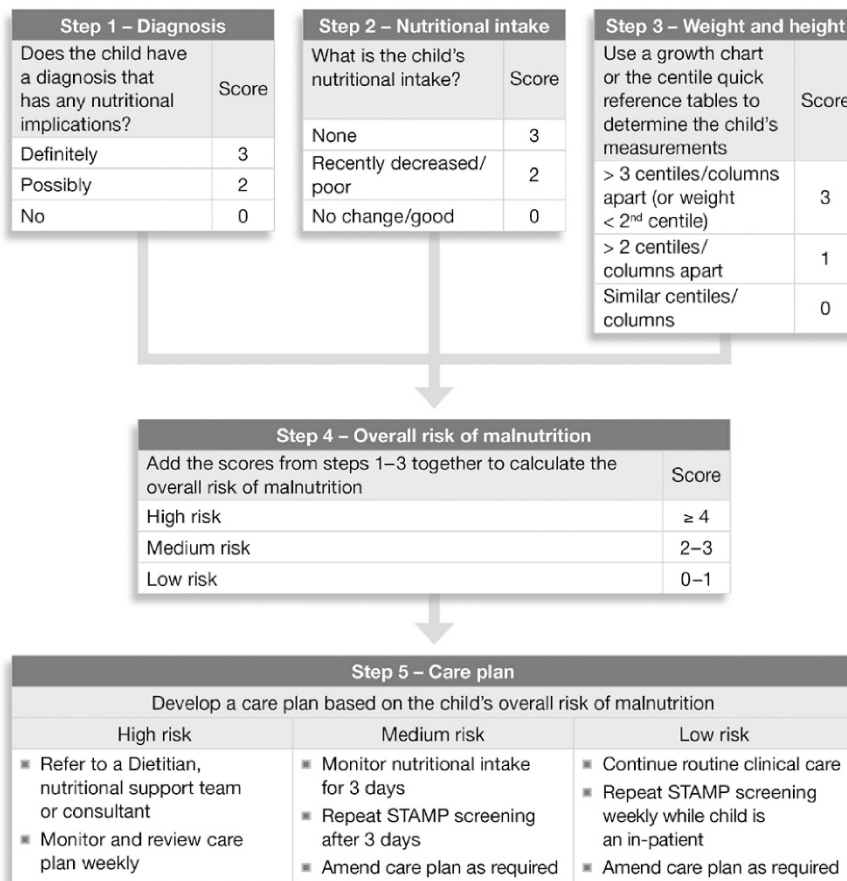
As part of the NSIC admission process, it is expected that STAMP score and growth chart centile are routinely obtained by the nurses, using standardised

equipment (calibrated digital scales and anthropometer). The infant's length was recorded to the nearest 0.1 cm. If the child was ≥ 2 years old, but could not stand, their length was measured and 0.7 cm subtracted to convert it to height.¹³

A post-admission dietetic assessment using all available clinical, nutritional and biochemical information was carried out by the research dietitian. This included baseline demographics and clinical characteristics (including age, gender, level of SCI, American Spinal Injury Association Impairment Scale (AIS) and cause of SCI). Nutrition-related factors such as route of nutrition; appetite estimated by food record chart (nil by mouth, less than half, half, more than half and all eaten); and interruptions and supplementation of nutrition were recorded. In addition, clinical data, including the presence of co-morbidity, use of mechanical ventilation, history of intensive care unit stay, and the number of medications, were recorded. Ethical approval did not extend to venesection purely for the purposes of the study.

The present study used paediatric staff nurses as raters and then used a research dietitian for inter-rater reliability to screen on two occasions for

A step-by-step guide to using STAMP



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Figure 1 Screening Tool for Assessment of Malnutrition in Paediatrics (STAMP). A full color version of this figure is available at the *Spinal Cord* journal online.

Diagnosis table

To be used to assign a score
for step 1 of STAMP



Definite nutritional implications	Possible nutritional implications	No nutritional implications
<ul style="list-style-type: none"> ▪ Bowel failure, intractable diarrhoea ▪ Burns and major trauma ▪ Crohn's disease ▪ Cystic fibrosis ▪ Dysphagia ▪ Liver disease ▪ Major surgery ▪ Multiple food allergies/intolerances ▪ Oncology on active treatment ▪ Renal disease/failure 	<ul style="list-style-type: none"> ▪ Behavioural eating problems ▪ Cardiology ▪ Cerebral palsy ▪ Cleft lip and palate ▪ Coeliac disease ▪ Diabetes ▪ Gastro-oesophageal reflux ▪ Minor surgery ▪ Neuromuscular conditions ▪ Psychiatric disorders ▪ Respiratory syncytial virus (RSV) ▪ Single food allergy/intolerance 	<ul style="list-style-type: none"> ▪ Day case surgery ▪ Investigations

- While every effort has been made to include diagnoses that have nutritional implications, this list is not exhaustive
- If you have any queries, please discuss them with a Dietitian

STAMP should be used in association with Trust referral guidelines and policies



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Figure 1 Continued.

intra-rater reliability (within 24 h period). To avoid bias, the results of the previous screening result were made unavailable when the second screening was done.

We used the infant centile quick reference tables developed from the UK-WHO growth charts to assign a score for step 3 of STAMP for those aged <2 years old.¹³

Data required for the Paediatric Yorkhill Malnutrition Score (PYMS) were also normally recorded and were obtained by the researcher if these had not already been done. A senior clinical adviser (AG) was available throughout the study period to help with questions from the participants or their families.

Definition of undernutrition risk criteria

The risk of undernutrition was determined from the following published criteria:

- (1) STAMP score ≥ 2 (McCarthy *et al.*¹² and Central Manchester University Hospitals NHS Foundation Trust.¹³)
- (2) PYMS ≥ 1 .¹⁵

For comparison, each set of risk scores was consolidated into two risk categories: 'low' (low risk category: STAMP score: ≤ 1 ; PYMS: score = 0) or 'at risk' (at risk category: STAMP score ≥ 2 ; PYMS score ≥ 1).

Validity and reliability of the STAMP: criterion validity

Each child's undernutrition risk (according to their STAMP score) was compared with a reference standard—a full dietitian assessment and review of the medical notes (*n* = 51).

Validity and reliability of the STAMP: concurrent validity

The child's STAMP score was compared with the other published criteria (PYMS) using agreement and chance-corrected agreement (Kappa-statistics)¹⁵ (PYMS: *n* = 51).

Validity and reliability of the STAMP: inter-rater reliability

The reliability of the STAMP in yielding the same risk categories in the same patients by different assessors (nurses and dietitian) was assessed using agreement and chance-corrected agreement. (*n* = 50).

Validity and reliability of the STAMP: intra-rater reliability

The reliability of the STAMP in producing the same risk categories in the same patients by the same assessor on two occasions (within 24h period) was assessed using agreement and chance-corrected agreement (*n* = 46).

Validity and reliability of the STAMP: statistical analysis

To test the concurrent validity between the two PNSTs (STAMP and PYMS), agreement and chance-corrected agreement between pairs of tools applied to the same patients was assessed by Cohen's Kappa, and 95% confidence intervals were calculated.¹⁶ Values of κ equal to 1, 0 and -1 indicate perfect agreement, no agreement and perfect disagreement, respectively. In order to calculate the diagnostic values (sensitivity, specificity, positive- and negative-predictive values) of the STAMP, we combined the medium- and high-risk categories on contingency tables. Chi-square tests were used to compare percentages between groups. Comparison of continuous data between groups was carried out using Student's *t*-test, or the Mann-Whitney test depending on the distribution of data, with statistical significance set at the 5% level (*P* = 0.05). Statistical analysis was undertaken using the Minitab statistical software (Version 15.0, Minitab Inc., Coventry, UK).

RESULTS

Sixty-two children (19.4% new admissions, aged 1–18 years (median: 13 years, interquartile range 7.8–15.6), 39.4% female and 83.6% Caucasian) were assessed. The median time since onset of SCI was 4 years with an interquartile range of 2–8.3 years.

Twenty-seven patients (46.5%) were tetraplegic (13 complete tetraplegic: American Spinal Injury AIS: A), and 31 were paraplegic (18 complete paraplegic: AIS: A).

There were no statistical differences between the genders on anthropometric, biochemical or nutritional indices, apart from a

higher serum creatinine in boys than in girls ($50 \mu\text{mol l}^{-1}$ vs $43 \mu\text{mol l}^{-1}$, *P* < 0.05).

Practical utility of the STAMP

Of the 62 recruited children, it was possible to screen 51 (82.3%) using the STAMP tool; the remaining children were too unwell to measure weight/height.

Undernutrition risk

Of the 51 patients screened, 30 (58.8%) were found to be nutritionally 'at risk' (STAMP ≥ 2) and 12 (23.5%) were at 'high risk' (STAMP ≥ 4). When comparing low-risk children with those at risk of undernutrition (identified by STAMP screening), those at risk of undernutrition were found to receive more medications and had a lower height centile. No statistical significant difference was found in other anthropometric, clinical and nutritional indices, but undernourished children with paraplegia were found to have a lower height centile when compared with low-risk paraplegics (Table 1).

Dietitian assessment

Of 51 patients, 32 (62.7%) were at-risk after dietetics assessment. When comparing low-risk with at-risk children, at-risk patients were found to have statistically significant lower body mass index (BMI), BMI centile and appetite and higher C-reactive protein; they also received more prescribed medications (Table 2).

PYMS screening

PYMS scoring was possible in the 51 STAMP-screened children and 23 (45.1%) were deemed to be at risk of undernutrition (PYMS score ≥ 1). When comparing the low risk group with the at-risk group, children at risk of undernutrition were found to have a lower weight centile; lower BMI; lower weight for height centile; lower appetite and received more prescribed medications.

Criterion validity

Overall, 39 out of 51 (76.5%) patients were classified at the same degree of nutritional risk when using dietetic assessment and STAMP (Table 4). The agreement between the dietetic assessment and STAMP was statistically moderate ($\kappa = 0.507$).

Seven patients (13.7%) who were judged to be at risk of undernutrition by dietetic assessment had not been rated as at risk by the STAMP. This gives the STAMP a sensitivity of 83.3%. Five patients (9.8%) who were rated at risk by the STAMP were assessed as at low

Table 1 Comparison of anthropometric indices with STAMP

	Low risk (STAMP score ≤ 1)					At-risk (STAMP score ≥ 2)				Overall P-value
	Median (range)	Overall	Tetra	Para	P-value	Overall	Tetra	Para	P-value	
					(Tetra vs Para)				(Tetra vs Para)	
Age (years)	11.3 (1–17.9)	12.4	14.1	11.9	NS	12.5	14.1	11.9	NS	NS
Height (m)	1.33 (0.67–1.88)	1.45	1.48	1.36	NS	1.35	1.36	1.35	NS	NS
Height centile ^a	25 (0.4–98)	37.5	17	50*	NS	9	9	2	NS	0.041
Weight centile	50 (0.4–99.6)	50	50	50	NS	25	50	25	NS	NS
BMI (Kg m^{-2})	20.1 (12.1–34.7)	21.3	19.1	21.5	NS	18.9	20.7	17.8	0.0108	NS
BMI centile	50 (0.4–99.6)	91	62.5	94.5	NS	50	62.5	25	NS	NS
Wt for Ht (%)	113 (69–177.9)	119	107	135.5	NS	105	112.4	94	0.0081	NS
Ht for age (%)	95.3 (78.3–111.8)	92.8	95	90.6	NS	98.8	97.4	98.9	NS	NS

Abbreviations: BMI body mass index; Ht, height; NS, non-significant; Para, paraplegic; STAMP, Screening Tool for the Assessment of Malnutrition in Paediatrics; Tetra: tetraplegic; Wt, weight.
^aBetween paraplegia.

Table 2 Comparison of anthropometric indices with RD assessment

	Low risk (RD assessment: low risk)					At risk (RD assessment: at risk)				Overall P-value
	Median (range)	Overall	Tetra	Para	P-value	Overall	Tetra	Para	P-value	
					(Tetra vs Para)				(Tetra vs Para)	
Age (years)	11.3 (1–17.9)	11.7	13.0	11.7	NS	12.0	15.0	12.0	NS	NS
Height (m)	1.33 (0.67–1.88)	1.37	1.43	1.34	NS	1.41	1.25	1.41	NS	NS
Height centile	25 (0.4–98)	9	9	17	NS	50	50	29.5	NS	NS
Weight centile	50 (0.4–99.6)	25	50	25	NS	9	29.5	0.4	NS	NS
BMI (Kg m ⁻²)	20.1 (12.1–34.7)	18.7	18.9	16.9	NS	14.7	16.8	13.3	NS	0.034
BMI centile	50 (0.4–99.6)	50	50	25	0.049	5.5	37.5	1.2	NS	0.041
Wt for Ht (%)	113 (69–177.9)	97.5	110.5	94.5	0.008	90.9	99	77.4	NS	NS
Ht for age (%)	95.3 (78.3–111.8)	95	94.6	95.5	NS	98.3	100.3	95.5	NS	NS

Abbreviations: BMI body mass index; Ht, height; NS, non-significant; Para, paraplegic; RD: dietitian; Tetra, tetraplegic; Wt, weight.

Table 3 Cross classification of malnutrition risk on Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP), Paediatric Yorkhill Malnutrition Screening (PYMS) tool and full dietetic assessment

Risk (n):	STAMP							
	Low	Medium	High	At risk	Low	Medium	High	At risk
Assessment:	RD				PYMS			
Low risk	14	4	1	5	14	13	1	14
Medium risk	–	–	–	–	3	4	2	6
High risk	–	–	–	–	1	4	9	13
At risk	7	17	8	25	4	8	11	19
Agreement (%)	76.5				64.7			
Sensitivity (%)	83.3				57.5			
Specificity (%)	66.7				77.8			
PPV (%)	78.1				82.6			
NPV (%)	73.6				50.0			

Abbreviations: At risk, combination of medium risk and high risk; NPV, negative-predictive value; PPV, positive-predictive value; PYMS, paediatric yorkhill malnutrition screening score; STAMP, screening tool for the assessment of malnutrition in paediatrics.

risk by dietetic assessment and thus were false positive, this gives the SNST a positive-predictive values of STAMP of 78.1% (Table 3).

Concurrent validity of STAMP with other published criteria

When comparing the STAMP with PYMS as a reference method, STAMP had a sensitivity of 57.5% and a specificity of 77.8%. The agreement of these two tools was fair ($\kappa = 0.314$).

Reliability

Inter-rater reliability. The inter-rater agreement of the STAMP completed by dietitians was substantial ($\kappa = 0.752$) and concurred (agreed) for 88.8% of children.

Intra-rater reliability. The intra-rater agreement of STAMP to produce the same risk categories on the same children by the same assessor on two occasions was substantial ($\kappa = 0.635$) and concurred (agreed) for 84.8% of children (Table 4).

DISCUSSION

The data from the present study addressed the need for a formal validation of the STAMP in a disease-specific population, children

Table 4 Validity studies on Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP) in patients with SCI

	Agreement				
	N	%	κ	95% CI value	s.e.
<i>Criterion validity</i>					
STAMP vs RD assessment	51	76.5	0.507	0.266–0.749	0.123
<i>Concurrent validity</i>					
STAMP vs PYMS	51	66.7	0.314	0.076–0.552	0.121
<i>Reliability</i>					
<i>Inter-rater validity</i>					
RD vs Nurses	50	88.8	0.752	0.568–0.935	0.094
<i>Intra-rater validity</i>					
RD1 vs RD1	46	84.8	0.635	0.392–0.878	0.124

Abbreviations: CI, confidence interval; PYMS, Paediatric Yorkhill Malnutrition Screening score; RD, Dietitian; SCI, spinal cord injury.

with SCI. It is suggested that this generic PNST presents an acceptable level of sensitivity and specificity when compared with dietetic assessment.

In the absence of a gold standard, it has been assumed that an assessment by a specialist dietitian is most likely to be accurate, reflecting additional knowledge and training. The present study comparing screening results with dietetic assessment thus adds extra weight to the validity of the STAMP. In this study, the STAMP showed a moderate agreement when compared with dietetic assessment ($\kappa = 0.507$, sensitivity: 83.3%, specificity: 66.7%). These values were numerically similar to those from previous validation studies comparing STAMP and dietetic assessment in other clinical contexts and include the original work by McCarthy *et al.*¹² (STAMP vs dietetic assessment: $\kappa = 0.541$, sensitivity: 70%, specificity: 91%) and from Gerasimidis *et al.*¹⁷ (STAMP vs dietetic assessment: $\kappa = 0.34$, sensitivity: 81%, specificity: 78%). In addition, the results of the present study are comparable with other concurrent validation studies, such as dietetic assessment vs a variety of PNSTs (Subjective Global Nutritional Assessment: $\kappa = 0.24$, sensitivity: 100%, specificity: 100%; PYMS: $\kappa = 0.51$, sensitivity: 85%, specificity: 87%).¹⁸

The agreement between STAMP and PYMS is fair ($\kappa = 0.314$) and is comparable to other concurrent validation study.¹⁹

The sensitivity, specificity and positive-predictive values shown by the STAMP are in line with the general expectations of a screening tool,¹⁸ but it needs to be borne in mind that the positive-predictive value of 78.1% could potentially lead to an unwarranted increase in dietetic referrals. In the present study, 22% (4/18) false negatives were identified, therefore it will be vital to remind healthcare staff that a low STAMP does not necessarily exclude true risk of undernutrition and to reconfirm that periodic nutrition screening and monitoring is essential.

Reproducibility and reliability are important measures in assessing the accuracy of a nutrition screening tool. For a tool to give a reproducible measurement, there must be a good agreement between users to reflect a high level of reliability. The present study found that different assessors agreed in >85% of the cases. The substantial reliability of STAMP is better than that for other tools.¹⁷

The STAMP considers 'neuromuscular conditions' as one of the possible risk factors for nutritional implications, and one may consider that all children with SCI are at risk of undernutrition. In the present study, we considered SCI as a neurological disorder, and therefore we did not give an automatic score of 2 in step one of STAMP.

This current study did not assess the time taken to complete the STAMP, but as plotting the growth chart, including weight and height, is independently mandatory on admission to British paediatric units, it is estimated that the STAMP can be completed within a minute or two of additional time given appropriately trained nursing staff.

The present study identified 12 children (19%) who had not been screened by the nursing staff at admission. Absence of key data (height: 17.4%; and weight: 11.3%) was responsible, and it is recognised that these values may not always be available. While we acknowledge seven children who were at undernutrition risk will be potentially under-detected and under-managed. It is of clinical importance to use clinical judgement skill to refer for nutritional assessment. Further work is needed to determine the best surrogates for use when this occurs in SCI.

SCI in children are rare and are estimated to account for no more than 5.4% of total SCI cases.²⁰ In UK, this would equivalent to 43 paediatric SCI cases per year.¹⁶ The present study did not calculate a sample size but instead we enrolled a reasonable number of paediatric patients with SCI admitted to a national SCI centre over period of 1 year and this includes a reasonable number of children with SCI (62 children, of which 12 were new case).

This study found that almost half of the children (45.5%) who are at true risk of undernutrition (assessed by the research dietitian) were not referred for dietetic assessment. Although they were highlighted to the team for action, it is also suggesting that both local and national standards³ are still poorly implemented and probably still insufficient to prevent some vulnerable children becoming malnourished, especially so when there are predisposing factors.¹⁴

CONCLUSIONS

We conclude from this formal validation that the STAMP presents acceptable levels of sensitivity and specificity in children with SCIs when compared with assessment by a dietitian and with other screening tools. We recommend its use to any SCI centre who are not already employing an effective screening strategy.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

Part of the study data were presented at the International Spinal Cord Society annual meeting in September 2012 and at the British

Association of Parenteral and Enteral Nutrition annual meeting in November 2011.

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Author contributions: SW—protocol development, data collection, data analysis, manuscript preparation; AG—protocol development, clinical supervision, manuscript revision; SPH—statistical supervision, manuscript revision; GG—Academic supervision, manuscript revision; AF—Academic supervision, manuscript revision.

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