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Original article

Nutritional risk screening and its clinical significance in hospitalized children

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SUMMARY

Background & aims: To analyse nutritional risk in hospitalized children and its relationship with clinical outcomes to provide evidence for improved nutritional management.
Methods: The investigation involved 1325 consecutively enrolled hospitalized children from Nanjing Children's Hospital. The nutritional risks in the hospitalized children were evaluated using the STRONGkids tool. During hospitalization, the incidence of infectious complications, length of hospital stay, weight loss, hospital expenses and nutritional support were recorded.
Results: The percentages of children with high, moderate and low nutritional risk were 9.1% (121), 43.3% (574) and 47.6% (630), respectively. Children with cardiac, respiratory or oncologic disease were most likely to have high nutritional risk. STRONGkids scores were correlated with clinical outcome. Higher complication rates, longer stay lengths, greater weight loss and greater hospital expenses were observed in children with high nutritional risk compared to those with moderate or low risk ($p < 0.001$). Nutritional support during hospitalization was given to 62.8% (76) of children with high nutritional risk, 18.6% (107) of children with moderate nutritional risk and 8.9% (56) of children with low nutritional risk.
Conclusions: Hospitalized children exposed to high or moderate nutritional risks have poor clinical outcomes. Nutritional support is not yet performed appropriately. Evidence-based guidelines should be created to improve this situation.

1. Introduction

Hospitalized children are at risk of malnutrition,[1–3] especially children with underlying disease, pain and inadequate nutritional intake. The detrimental effects of malnutrition on growth, morbidity and mortality in hospitalized children are often underappreciated. Despite major advances in the quality of care, the prevalence of malnutrition in hospitalized children has not decreased over the last 20 years. Therefore, the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) called for nutritional risk screening for hospitalized children in 2005[4] to prevent the occurrence and development of malnutrition. Nutritional risk screening is distinct from global nutritional assessment[5] because nutritional risk screening combines personal nutritional status with clinical disease information, leading to a prediction of the potential nutritional dysfunction induced by the increase in stress-induced metabolic factors.[6] Nutritional screening allows the physician to adjust the probability of a good or poor outcome based on nutritional factors and make the appropriate nutritional care and support plans (e.g., food, oral supplements, tube feeding, parenteral nutrition or a combination of these) to improve clinical outcomes.

With the recent growth in the awareness of the importance of adequate nutritional management,[1] several nutritional risk screening tools for children have been developed in industrialized countries, such as the Netherlands, the USA and the UK. Although these risk screening tools for hospitalized children have been published, none is universally accepted. The most suitable nutritional screening tool for patients is the one that best predicts nutrition-related clinical outcomes during a hospital stay.[5] Hulst's STRONGkids was developed and tested extensively in the Netherlands and used in a national wide setting.[7] It consists of four parameters: (1) subjective global assessment; (2) high risk disease;

Non-standard abbreviations: STRONGkids, Screening Tool for Risk On Nutritional status and Growth; WFH, weight for height; HFA, height for age; WFA, weight for age; MUAC, middle upper arm circumstance; BMI, body mass index.

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(3) nutritional intake and loss; and (4) weight loss or poor weight gain. Children with high risk scores according to this tool were found to have negative standard deviation scores (SD scores) in WFH and prolonged hospital stays. The high reliability and validity of STRONGkids was confirmed in Rebecca's study.[8]

However, very little research has been performed on this subject, and nutritional management in hospitalized children is still poorly executed in many developing countries. In China, there is no widely accepted risk screening tool for children, nutrition risk screening is not routine carried out in most children's hospital and no investigation of nutritional risks has been reported to date. Malnutrition remains prevalent among hospitalized children in China.

The primary aims of this study were to use STRONGkids as a tool to identify nutritional risk in hospitalized children in the Nanjing Children's Hospital, to evaluate its correlation with clinical outcomes and to provide a scientific basis for further nutritional support strategies in China.

2. Subjects and methods

2.1. Subjects

This was a prospective study conducted at Nanjing Children's Hospital, which is a tertiary care centre affiliated with Nanjing Medical University in southeast China. It is one of the largest children's hospitals in China, with approximately 30,000 children admitted every year. Approximately 29,850 children were admitted to the Nanjing Children's Hospital from Feb. 2011 to Jan. 2012. The following departments were surveyed for one month (30 days): Cardiothoracic Surgery, Neurosurgery, Orthopaedics, Abdominal Surgery, Burns and Plastic Surgery, Urological Surgery, Neurology, Nephrology, Cardiology, Gastroenterology, Respiratory, Haematology, and Infectious Diseases. For each department, admitted children were recruited unless they met the following criteria: age <28 days, a hospital stay length <1 day, missing height or weight data and admission to the Paediatric Intensive Care Unit or the Day Surgery Ward.

2.2. Assessment of nutritional risk and nutritional status

STRONGkids was used as a tool to assess the nutritional risk of hospitalized children. This tool consists of 4 items with a score of 1–2 points for each item and a maximum total score of 5 points.[7] STRONGkids screening generally provides three alternative scores for nutritional risk classification: 0 = low nutritional risk; 1–3 = moderate nutritional risk; and 4–5 = high nutritional risk. The nutritional risk was assessed by trained professionals.

Furthermore, the global nutritional status of the patients was assessed, including anthropometric examination and biochemical testing. Weight measurements were taken at admission and discharge. Supine length or standing height was measured on admission only. Weight was recorded to 0.1 kg, and height/length was recorded to 0.1 cm. All measurements were carried out using a standardized protocol with calibrated equipment. Nutritional status was determined, and *Z*-scores (standard deviation scores based on children growth standards 2006 by World Health Organization) of anthropometric parameters such as WFA, HFA, WFH (<5 years old), BMI and MUAC were calculated. Patients with a WFH *Z*-score less than -2 were classified as thin, those with HFA *Z*-scores less than -2 were classified as having growth retardation and those with WFA *Z*-scores less than -2 were classified as low weight.

Nutritional support during hospitalization, infectious complications, length of hospital stay (LOS), hospital expenses and weight loss were recorded for each subject. A decrease of more than 2% from the reference weight was chosen as the criterion[1] for "weight loss". Children were diagnosed as having infectious complications when any one of the following three items occurred together with the clinical syndrome[9]: (1) fever (body temperature above 38.5 °C without the presence of other fever-causing factors such as surgery, blood transfusion, infusion reactions or drug fever), together with incision pain, swelling, cough, sore throat, abdominal pain, diarrhoea, frequent urination, urgent urination, dysuria and other clinical manifestations; (2) presence of pathogens in incision secretions, throat swabs, sputum, urine, faeces, blood and bone marrow specimens were positively in culture; or (3) chest X-ray or other auxiliary examination showing infection. The reasons for admission were classified as respiratory, traumatic, infectious, surgical, oncological, gastrointestinal, cardiac, neurological or other.

The total hospitalization expenses were calculated on nursing, ward, surgical treatment, west medicine and traditional Chinese medicine, laboratory diagnosis, and obtained from the financial centre of Nanjing Children's Hospital. The estimates of the association between nutritional risk at hospital admission and total hospitalization expense were carried out.

The data for all questionnaires were recorded in an EpiData 3.1 database and verified twice to ensure that the original medical records were inputted correctly.

2.3. Ethical approval

Although this study represents the first use of STRONGkids as a tool for routine nutritional risk screening at the Nanjing Children's Hospital, China, this study serves as an audit of existing practice against a published and validated instrument.[8] Thus, no formal ethical approval was required. Informed verbal consent was obtained from the parents of all children involved in the study.

2.4. Statistics

The data were analysed by Statistical Package for the Social Sciences (SPSS) software (version 13.0, SPSS Inc., Chicago, IL, USA). The results were expressed as the mean ± SD for normally distributed data or as the median (range) for non-normally distributed data. The clinical outcomes of the three groups were compared with ANOVA (for normally distributed data) or the Kruskal–Wallis test (for non-normally distributed data). Percentages between groups were compared with the chi-square test. The economic impact of nutrition risk on total hospital expenses were based on Univariate analysis of variance and adjusted for relevant confounders. Differences were considered statistically significant when p was less than 0.05.

3. Results

3.1. Patient characteristics

A total of 1325 children were enrolled according to the described inclusion criteria. Their clinical characteristics are shown in Table 1. There was no significant difference in median *Z*-scores for WFH, WFA, HFA, MUAC and BMI between genders. Therefore, gender was not considered in the subsequent analysis.

3.2. Risk categories in hospitalized children

Overall, 47.6% of the children were categorized as low risk, 43.3% as moderate risk and 9.1% as high risk. The differences in diagnosis and nutritional assessment among the three groups are shown in Tables 2 and 3. On admission, the three systemic diseases that are most associated with high nutritional risk were cardiac disease, respiratory disease and oncologic disease. The mean median

Table 1
Patient characteristics.

Characteristics	
Male/female	859/466
Age (years)	3.1 (29 days, 17 years)
0–	32.5% (431)
1–	28.5% (377)
≥3	39% (517)
Urban/rural	532/793
LOS*	9 days (3 days, 85 days)
HFAZ[a] <−2	7.2% (95)
WFAZ[b] <−2	11.5% (152)
WFHZ[c] <−2	13.3% (134)
BMIZ[d] <−2	14.5% (192)
MUACZ[e] <−2	14.2% (188)
Diagnosis groups	
Cardiac disease	156
Respiratory disease	108
Oncologic disease	94
Gastrointestinal disease	137
Surgery	437
Neurologic disease	100
Trauma	62
Infection	157
Other disease	74

* Length of hospital stay.
a, Median *Z*-score of length or height for age. b, Median *Z*-score of weight for age.
c, Median *Z*-score of weight for height. d, Median *Z*-score of BMI for age.
e, Median *Z*-score of middle upper arm circumference for age.

Z-scores for WFA, HFA, WFH, MUAC and BMI were significantly lower in children with high nutritional risk than in those with low or moderate nutritional risk. Moreover, the incidence of infants with high nutritional risk (16.7%) was higher than 1–3 years old (6.4%, $p < 0.001$) or 3 years old over (4.8%, $p < 0.001$).

3.3. Clinical outcomes of children with high nutritional risk

As shown in Table 4, high nutritional risk status was associated with significantly longer hospital stays, greater weight loss and higher incidence of infectious complications compared to moderate or low risk status. Furthermore, hospital expenses were also increased in high nutritional risk ($F = 75.4$, $p < 0.01$). Univariate analysis revealed that the disease classification ($F = 9.9$, $p < 0.01$), LOS ($F = 49.7$, $p < 0.01$) and infectious complications ($F = 31.3$, $p < 0.01$) were all significantly related to the increase of hospital expenses. After controlling for all these relevant confounders, the hospital expenses in high nutritional risk children remained higher than the average of the low and moderate risk children ($F = 67.7$, $p < 0.01$).

3.4. Nutritional support during hospitalization

Of the children included in the study, 183 (13.8%) were supported by parenteral nutrition (PN), and 46 (3.5%) were supported by enteral nutrition (EN). No children received both PN and EN simultaneously (Table 5).

Table 2
Risk category distributions of patients with different diseases.

Diagnosis	Low risk ($n = 630$)	Moderate risk ($n = 574$)	High risk ($n = 121$)
Cardiac disease	30 (19.2%)	96 (61.5%)	30 (19.2%)
Respiratory disease	67 (62%)	22 (20.4%)	19 (17.6%)
Oncologic disease	39 (41.5%)	45 (47.9%)	10 (10.6%)
Gastrointestinal disease	34 (24.8%)	90 (65.7%)	13 (9.5%)
Surgery	227 (51.9%)	173 (39.6%)	37 (8.5%)
Neurologic disease	58 (58%)	38 (38%)	4 (4%)
Trauma	24 (38.7%)	36 (58.1%)	2 (3.2%)
Infection	112 (71.3%)	43 (27.4%)	2 (1.3%)
Other disease	39 (52.7%)	31 (41.9%)	4 (5.4%)

Table 3
Differences in nutritional evaluated data among nutritional risk categories.

Evaluated data	Low risk	Moderate risk	High risk	*F*	*p*
WFAZ*	0.3 ± 1.5	0.1 ± 1.5[a]	−0.8 ± 1.5[ab]	22.8	<0.001
HFAZ	0.7 ± 1.7	0.5 ± 1.4[a]	−0.2 ± 1.7[ab]	13.2	<0.001
WFHZ	−0.1 ± 1.5	−0.2 ± 1.6	−1.1 ± 1.5[ab]	17.9	<0.001
BMIZ	−0.1 ± 1.3	−0.3 ± 1.6	−1.1 ± 1.4[ab]	16.2	<0.001
MUACZ#	0.2 ± 1.2	−0.1 ± 1.2[a]	−0.9 ± 1.4[ab]	26.5	<0.001

* World Health Organization weight-for-age growth standards are only published for ages 10 years and under; # World Health Organization growth standards for upper arm circumference range from 3 months to 5 years old; a, $p < 0.001$ compared with the low risk group; b, $p < 0.001$ compared with the moderate risk group.

4. Discussion

To our knowledge, this is the first prospective case series study to investigate the nutritional risk among patients in a children's hospital in China. Our results showed that the children who were admitted to the hospital were exposed to nutritional risk, especially those with underlying cardiac disease, respiratory disease or oncologic disease. Higher nutritional risk was associated with malnutrition, younger age and the presence of an underlying disease, and it contributed to a longer LOS, greater weight loss, higher incidence of infectious complications and greater hospital expenses. There are evidences that malnutrition has serious detrimental effects on growth, morbidity and mortality in hospitalized children, which may also be associated with a variety of neurodevelopmental, behavioural and cognitive deficits in later childhood.[7,10] Therefore, the issue of nutritional risk in hospitalized children requires immediate attention from paediatricians and nurses in China.

Malnutrition is common among hospitalized children but is often unaddressed or treated inadequately.[10] Over the past ten years, the incidence of nutritional risk in hospitalized children, as assessed by nutritional risk screening tools, was reported in several countries. As early as 2001, Sermet assessed 296 children[1] with paediatric nutritional risk scores in General Children's Hospital of Paris, and found that 44.3% of the children were classified as high nutritional risk, with approximately 40.9% classified as moderate nutritional risk. In 2010, Geradimidis[11] published the Yorkhill paediatric malnutrition screening tool, which showed that approximately 13.8% of hospitalized children were at high nutritional risk in Yorkhill Hospitals of UK. In 2011, Hulst[7] used STRONGkids to assess a group of hospitalized children and showed that 8% of the children were at high risk, and 54% were at moderate nutritional risk in Dutch. In the present study, 9.1% of the 1325 hospitalized children were at a high nutritional risk, and 43.3% were at moderate nutritional risk in Nanjing Children's Hospital according to their overall STRONGkids risk score. The cardiac disease, respiratory disease and oncologic disease exhibited the

Table 4
Differences in clinical outcomes among nutritional risk categories.

	Low risk	Moderate risk	High risk
LOS (days)	10 (3, 52)	11 (3, 62)	18 (4, 85)[ab]
Weight loss	54.8% (345/630)	46.3% (266/574)	76% (92/121)[ab]
Infection (%)	7.1% (45/630)	14.6% (84/574)[a]	21.5% (26/121)[ab]
Costs (USD)	1243.6 (64.6, 1776.5)	1808.8 (64.6, 20058.3)[a]	5119.6 (129.2, 74096.2)[ab]

a, $p < 0.001$ compared with the low nutritional risk group.
b, $p < 0.001$ compared with the moderate nutritional risk group.

Table 5
Nutritional support rates in different nutritional risk categories.

STRONG	*N*	Nutritional support	Method of nutritional support	
			EN[#]	PN[*]
Low risk	630	8.9% (56)	2.5% (16)	6.3% (40)
Moderate risk	574	18.6% (107)	1.4% (8)	17.2% (99)
High risk	121	62.8% (76)	18.2% (22)	44.6% (54)

#, PN: parenteral nutrition; *, EN: enteral nutrition.

greatest incidence of high nutritional risk. Moreover, the incidences of infants with high nutritional risk were more than that in elder children. The difference in the incidence of nutritional risk from reports is more likely due to the presence of an underlying disease,[2,12] the seriousness of the disease, the child's age and the method used in the investigation.

Anthropometric examination and biochemical testing have been used to classify patients into nutrition categories and predict outcomes.[13–15] We confirmed that children with high nutritional risk had significantly lower median *Z*-scores at WFH, WFA, HFA, MUAC and BMI, consistent with the findings reported by Secker[16] and Hulst.[7] However, there was no significant difference in the levels of biochemical markers such as haemoglobin, C-reactive protein, serum albumin and globulin among the three risk groups (data not shown). Although these biochemical markers are important indicators of nutritional status, their levels can vary based on the underlying disease, especially the presence of inflammation, oedema and some metabolic disorders, as reported previously.[17,18]

The most suitable nutritional screening tool for patients is the one that best predicts nutrition-related clinical outcomes during a hospital stay,[6,19] such as LOS, loss of body weight and the incidence of infectious complications and mortality.[20–23] The nutritional risk screening tool STRONGkids was successfully applied in 98% of hospitalized children in the Netherlands in a multi-centre study of 44 paediatric hospitals, in whom it predicted a significant relationship between "high risk" score, a negative SD-score in WFH and a prolonged hospital stay.[7] Similarly, we classified hospitalized children into three risk groups according to their overall STRONGkids risk score and confirmed that children in the high nutritional risk group had longer hospitalization, greater weight loss and higher infection rates, as previously reported.[7,16] Notably, we found that the total hospital expenses were highest in the high nutritional risk group at admission, and the difference among the groups persisted significant after adjusting for confounding variables such as disease classification, LOS and infectious complications. Thus, high nutritional risk is associated with poor prognosis and increases the economic and social burden on the patients' families. This suggests that extra attention to nutritional status should always be given to this specific group of children, and interventions should be planned as soon as possible upon admission.

Clinical nutritional support can improve clinical outcomes in patients with existing malnutrition or nutritional risk, but nutritional support in well-nourished patients may lead to an increase in infectious complications.[19,24–27] In this study, 37.2% of the children with high nutritional risk were supported by neither EN nor PN, but 8.9% of the children with low nutritional risk received nutritional support. EN utilization was lower compared to PN at nutrition initiation. This phenomenon may be attributed to inaccurate assessment of nutrition requirements, fluid restriction and use of vasoactive medications. In addition, awareness of nutrition support and PN utilization has been increased over the years in China, but knowledge on EN and bedside assessment tool was quite limited. The paediatricians are worried about increasing feeding-related complications and prefer to PN at initiation nutrition. Worthy of note, PN by central venous catheter may lead to an increase in infectious complications that related to clinical outcomes and increasing cost during hospitalization. Therefore, future efforts in paediatric nutrition include implementing patients to screen their nutritional risk, identifying patients who require nutritional support, ensuring provision of effective nutritional management and educating hospital staff with respect to identification and management of nutritional problem.[4]

One limitation of this study is the representation of the cohort. Our study was a single-centre case series survey, we need to extend our study cohort and cooperate with other hospitals to map the epidemiology of nutritional risk in China. Another limitation is that the STRONGkids score does not include any objective assessment, but we assessed the global nutritional statuses of the children by anthropometric examination, which provides more reliable results. The third limitation is that the types of diseases and severity of a disease included in STRONGkids are not sufficient to account for clinical diagnosis in China. A realistic assessment requires a combination of children's clinical features to better reflect the type of illness and disease severity scores. Future multi-centre studies will be necessary to establish China's own risk screening tool for children.

In conclusion, we show that a number of children hospitalized in Nanjing Children's Hospital affiliated with Nanjing Medical University exhibit nutritional risk, and that the children in the high nutritional risk group have poor clinical outcomes. Moreover, nutritional support is not yet performed appropriately. We hope that our data and analysis will bring more attention to the field of nutritional screening and allow paediatricians to provide more adequate and individualized nutritional support for children in the high risk category after admission.

Statement of authorship

Conceived and designed the study: XNL. Performed the investigation: JC, LTP and RL. Analysed the data: JC and BQM. Wrote the manuscript: JC and LTP. All authors read and approved the final manuscript.

Conflict of interest

None declared.

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References

1. Sermet-Gaudelus I, Poisson-Salomon AS, Colomb V, Brusset MC, Mosser F, Berrier F, et al. Simple pediatric nutritional risk score to identify children at risk of malnutrition. *Am J Clin Nutr* 2000;**72**(1):64.
2. Pawellek I, Dokoupil K, Koletzko B. Prevalence of malnutrition in paediatric hospital patients. *Clin Nutr* 2008;**27**(1):72.
3. Campanozzi A, Russo M, Catucci A, Rutigliano I, Canestrino G, Giardino I, et al. Hospital-acquired malnutrition in children with mild clinical conditions. *Nutrition* 2009;**25**(5):540.
4. Agostoni C, Axelson I, Colomb V, Goulet O, Koletzko B, Michaelsen KF, et al. The need for nutrition support teams in pediatric units: a commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr* 2005;**41**(1):8.

5. Mueller C, Compher C, Ellen DM. A.S.P.E.N. clinical guidelines: nutrition screening, assessment, and intervention in adults. *J Parenter Enteral Nutr* 2011;**35**(1):16.
6. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. *Clin Nutr* 2003;**22**(4):415.
7. Hulst JM, Zwart H, Hop WC, Joosten KFM. Dutch national survey to test the STRONGkids nutritional risk screening tool in hospitalized children. *Clin Nutr* 2010;**29**(1):106.
8. Rebecca E, Ling VHPB. Nutritional risk in hospitalised children: an assessment of two instruments. *e-SPEN Eur e-J Clin Nutr Metab* 2011;**6**:153.
9. Bone RC, Balk RA, Cerra FB, Dellinger RP, Fein AM, Knaus WA, et al. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine. *Chest* 1992;**101**(6):1644.
10. Joosten KF, Hulst JM. Malnutrition in pediatric hospital patients: current issues. *Nutrition* 2011;**27**(2):133.
11. Gerasimidis K, Keane O, Macleod I, Flynn DM, Wright CM. A four-stage evaluation of the Paediatric Yorkhill Malnutrition Score in a tertiary paediatric hospital and a district general hospital. *Br J Nutr* 2010;**104**(5):751.
12. Sylvestre LC, Fonseca KP, Stinghen AE, Pereira AM, Meneses RP, Pecoits-Filho R, et al. The malnutrition and inflammation axis in pediatric patients with chronic kidney disease. *Pediatr Nephrol* 2007;**22**(6):864.
13. Hals J, Ek J, Svalastog AG, Nilsen H. Studies on nutrition in severely neurologically disabled children in an institution. *Acta Paediatr* 1996;**85**(12):1469.
14. Hulst JM, van Goudoever JB, Zimmermann LJ, Hop WC, Albers MJ, Tibboel D, et al. The effect of cumulative energy and protein deficiency on anthropometric parameters in a pediatric ICU population. *Clin Nutr* 2004;**23**(6):1381.
15. Lambe C, Hubert P, Jouvet P, Cosnes J, Colomb V. A nutritional support team in the pediatric intensive care unit: changes and factors impeding appropriate nutrition. *Clin Nutr* 2007;**26**(3):355.
16. Secker DJ, Jeejeebhoy KN. Subjective global nutritional assessment for children. *Am J Clin Nutr* 2007;**85**(4):1083.
17. Marvin VA, Brown D, Portlock J, Livingstone C. Factors contributing to the development of hypophosphataemia when refeeding using parenteral nutrition. *Pharm World Sci* 2008;**30**(4):329.
18. Bauer J, Jurgens H, Fruhwald MC. Important aspects of nutrition in children with cancer. *Adv Nutr* 2011;**2**(2):67.
19. Johansen N, Kondrup J, Plum LM, Baka L, Nørregaarda P, Bunchb E, et al. Effect of nutritional support on clinical outcome in patients at nutritional risk. *Clin Nutr* 2004;**23**(4):539.
20. Pirlich M, Schutz T, Kemps M, Luhman N, Burmester GR, Baumann G, et al. Prevalence of malnutrition in hospitalized medical patients: impact of underlying disease. *Dig Dis* 2003;**21**(3):245.
21. Robinson G, Goldstein M, Levine GM. Impact of nutritional status on DRG length of stay. *J Parenter Enteral Nutr* 1987;**11**(1):49.
22. BAPEN. *Malnutrition costs the UK more than £7.3 billion of actual expenditure each year e double the projected £3.5 billion cost of obesity: internet communication* 2006.
23. Stratton RJ, Green CJ, Elia M. *Disease related malnutrition: an evidence-based approach to treatment*. Cambridge: CABI Publishing; 2003. p. 1.
24. Heyland DK, MacDonald S, Keefe L, Drover JW. Total parenteral nutrition in the critically ill patient: a meta-analysis. *J Am Med Assoc* 1998;**280**(23):2013.
25. Koretz RL, Lipman TO, Klein S. AGA technical review on parenteral nutrition. *Gastroenterology* 2001;**121**(4):970.
26. Klein S, Kinney J, Jeejeebhoy K, Alpers D, Hellerstein M, Murray M, et al. Nutrition support in clinical practice: review of published data and recommendations for future research directions. Summary of a conference sponsored by the National Institutes of Health, American Society for Parenteral and Enteral Nutrition, and American Society for Clinical Nutrition. *Am J Clin Nutr* 1997;**66**(3):683.
27. Perioperative total parenteral nutrition in surgical patients. The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group. *N Engl J Med* 1991;**325**(8):525.