Lim, Su Lin and Tong, Chung-Yan and Ang, Emily and Lee, Evan Jon-Choon and Loke, Wai-Chiong and Chen, Yuming and Ferguson, Maree and Daniels, Lynne A. (2009) ***Development and validation of 3-Minute Nutrition Screening (3-MinNS) tool for acute hospital patients in Singapore***. Asia Pacific Journal of Clinical Nutrition, 18(3). pp. 395-403.

Development and validation of 3-Minute Nutrition Screening (3-MinNS) Tool for acute hospital patients in Singapore

Su-Lin Lim[1], Chung-Yan Tong[1], Emily Ang[2], Evan Jon-Choon Lee[3], Wai-Chiong Loke[4], Yuming Chen[5], Maree Ferguson[6], Lynne Daniels[7]

[1]Dietetics Department, National University Hospital, Singapore, [2]The Cancer Institute, National University Hospital, Singapore, [3]Department of Medicine, National University Hospital, Singapore, [4]Quality & Resource Management, National Healthcare Group, Singapore, [5] Singapore Clinical Research Institute Pte Ltd, Singapore, [6]Nutrition & Dietetics, Princess Alexandra Hospital, Australia, [7]Institute of Health and Biomedical Innovation, Queensland University of Technology, Australia

ABSTRACT
It is important to detect and treat malnutrition in hospital patients so as to improve clinical outcome and reduce hospital stay. The aim of this study was to develop and validate a nutrition screening tool with a simple and quick scoring system for acute hospital patients in Singapore. In this study, 818 newly admitted patients aged above 18 years old were screened using five parameters that contribute to the risk of malnutrition. A dietitian blinded to the nutrition screening score assessed the same patients using the reference standard, Subjective Global Assessment (SGA) within 48 hours. The sensitivity and specificity were established using the Receiver Operator Characteristics (ROC) curve and the best cutoff scores determined. The nutrition parameter with the largest Area Under the ROC Curve (AUC) was chosen as the final screening tool, which was named 3-Minute Nutrition Screening (3-MinNS). The combination of the parameters weight loss, intake and muscle wastage (3-MinNS), gave the largest AUC when compared with SGA. Using 3-MinNS, the best cutoff point to identify malnourished patients is three (sensitivity 86%, specificity 83%). The cutoff score to identify subjects at risk of severe malnutrition is five (sensitivity 93%, specificity 86%). 3-Minute Nutrition Screening is a valid, simple and rapid tool to identify patients at risk of malnutrition in Singapore acute hospital patients. It is able to differentiate patients at risk of moderate malnutrition and severe malnutrition for prioritization and management purposes.

Key Words: 3-Minute Nutrition Screening, Subjective Global Assessment, Validation, Sensitivity, Specificity

INTRODUCTION
Studies have shown 25-40% of hospitalized patients are malnourished.[1-3] Malnutrition is associated with poor tolerance to medical treatment leading to poor clinical outcome, deterioration in muscular, respiratory and immune function, delayed wound healing, diminished quality of life, increased mortality and increased length and cost of hospital stay.[4-6] Previous studies have shown that patients with malnutrition had a 1.6-1.9 relative risk of death when compared to well-nourished inpatients.[4, 7] Malnourished patients also stay in hospitals 1.5 to 1.7 times longer than well-nourished patients.[4, 7]

Despite the prevalence and consequences of malnutrition on hospital admission, patients with malnutrition are often not identified and up to 70% of malnourished patients do not receive any nutrition intervention.[1-3] Up to 80% of patients who are already nutritionally compromised upon admission will experience further deterioration in nutritional status if no nutritional intervention is administered.[1]

Given that malnutrition is commonly unidentified, untreated and increases morbidity and mortality risks, [4, 8] it is important to systematically screen hospitalized patients on admission using a simple, quick, reliable, valid and cost effective tool. Nutrition screening is a process of identifying characteristics known to be associated with malnutrition risk. [9] The purpose of nutrition screening is to identify malnourished patients or those at risk of malnutrition to facilitate nutritional assessment and early delivery of nutritional intervention. [9]

A nutrition screening tool would typically include parameters such as anthropometric measures, pre-admission psychosocial risk factors and self-reported weight loss and appetite history.[10] The selection, reporting and interpretation, including cutoffs, of these parameters may differ between different racial groups, healthcare system and cultural contexts. Hence validation of screening tools in the specific setting and population in which they are to be used is required. No nutritional screening tool has been developed and validated for use in Singapore with its particular racial mix. The aim of this study was to develop and validate a quick and simple nutrition screening tool for the Singapore adult population admitted to a large tertiary teaching hospital.

METHODS

Study Design

The National Healthcare Group Domain Specific Review Board approved this study. To ensure that study subjects were as representative of the institution's patient profile as possible, consecutive patients admitted to a pre-determined sequence of 16 wards were screened for eligibility during a ten-month period. Patients were included if they were aged 18 to 74 years old and had not been enrolled in the study during their previous admission. The wards excluded were the paediatric, psychiatric, intensive care units (ICU), and maternity wards. Paediatric patients were excluded because nutrition indicators and escalation criteria differ between adults and children. Psychiatric, ICU and maternity patients were excluded based on hospital's request. Demographics of the study sample were compared with all patients, except those in the excluded categories admitted over the period of the study. Data on hospital population were retrieved from the hospital's Management Information Services.

A set of parameters was chosen for the development of the malnutrition screening tool, to comprise established risk factors for malnutrition and 1) be simple and quick to administer (less than 3 minutes), 2) non-invasive; 3) use routinely available data; and 4) minimize incomplete screening due to missing data. The parameters chosen were indicators for nutrition risk that could be scored, with potential to define a single or total score that could be used to determine subsequent action in a care plan. The parameters were presence of unintentional weight loss in the past six months, intake in the past one-week, body mass index (BMI), disease with nutrition risks and the presence of muscle wasting in the temporalis and clavicular areas. If patients were unable to communicate, their main caregivers were interviewed to determine the scores for weight loss and intake. By including "unsure" and "don't know" response options in the weight loss column we minimized missing data. A single dietitian screened the patients using the set of parameters chosen (Figure 1) within 24 hours of patient admission with the exception of body mass index. Body mass index was calculated from the routine weight and height completed by ward nurses during admission process. Using a simple "checkbox" method, each criterion was assigned a quantitative score according to severity ranging from zero to three (3 = most severe) as shown in Figure 1.

The guidelines to use the nutrition screening study table (Figure 1) were:
1) Each column can only be ticked once except for 'disease with nutrition risk' column whereby a patient can present with more than one illness upon admission;
2) If there are more than one tick in the 'disease with nutrition risk' column or different scoring between muscles of the temporalis and clavicular, the higher score will supersede and circled as such in the scoring section.

Subjective Global Assessment (SGA) was selected as the reference method for validation.[11] A single dietitian blinded to the nutrition screening results assessed the same patients using SGA within 48 hours of admission. This validated and widely used nutrition assessment tool involves evaluation of weight and dietary intake changes, gastrointestinal symptoms, functional capacity and physical examination for evidence of fat depletion, muscle wasting and nutritional related oedema.[11] The final SGA rank is based on the subjective weighting of these features to classify patients into three categories; well nourished, moderately malnourished and severely malnourished.[11]

Statistics

Data analysis was performed using the Statistical Package for the Social Sciences for Windows (version 11.0, SPSS Inc., Chicago, IL, USA). Descriptive data were presented as mean ± standard deviation (SD) or proportion (%) as appropriate. Chi-square test and t-test were used to determine if the study sample were representative of the hospital population for gender, race and age. Receiver operator characteristic (ROC) curve analysis was performed to determine the sensitivity and specificity of the individual nutrition parameters and their possible combinations using SGA as the reference method. The nutrition parameter (or its combination) with the biggest AUC was chosen as the final nutrition screening tool and named the 3-Minute Nutrition Screening (3-MinNS) tool. SGA has the first cutoff point to determine between patients who are well nourished and moderately malnourished and the second cutoff to differentiate between moderately malnourished and severely malnourished patients. Hence ROC analysis was performed twice on the total scores of 3-MinNS so that it could also be used to classify patients according to whether they are "not at risk of malnutrition", "at risk of moderate malnutrition" or "at risk of severe malnutrition". For this purpose, Youden's index (J) was used to determine these best cutoff scores.[12] The optimal cutoff score is where Youden's index gives the maximum value.[12]

$$\text{Youden's Index, } J = \text{sensitivity} + \text{specificity} - 1$$

The sensitivity and specificity were determined for the two cutoff points separately. The positive predictive value (PPV) and negative predictive value (NPV) for the individual nutrition parameters and of their possible combination were also established.

RESULTS

The number of patients screened was 1079 with 818 included in the study, 11 did not wish to participate and 250 were discharged before SGA could be completed. The percentage of subjects admitted to various specialties is displayed in Table 1. The demographic profiles of the subjects and of the hospital population are described in Table 2. The study sample was older than the hospital population (difference = 2.6 years, CI 1.48-3.58) but there was no difference in gender or race.

Nutritional assessment using SGA identified 4% of the patients as severely malnourished, 25% mild to moderately malnourished and 71% well nourished. The optimal cutoff points for the individual nutrition parameters and their possible combinations are provided in Table 3. Body Mass Index was not tested as combination because of the possibility of incomplete data, which was one of the exclusion criteria set out in the development of the nutrition screening tool. Body Mass Index could not be calculated for 84 (10%) patients because they were not able to stand for the height to be measured. Any missing data renders a nutrition screening tool incomplete and limits cutoff score validity.

The biggest AUC, which implied the most desirable sensitivity and specificity, was the combination of parameters, which comprised weight loss, intake and muscle wastage (AUC = 0.91, $p<0.001$). These combined parameters were extracted into Figure 2 and called the 3-MinNS tool.

The optimal cutoff score for 3-MinNS to identify all patients at risk of malnutrition was three with a sensitivity of 86% and specificity of 83%. The cutoff point of three was able to identify all severely malnourished patients (100% sensitivity, AUC = 0.95, $p<0.001$). However at the same cutoff of three, the specificity to identify severely malnourished patients was 66%. This indicated that some of the patients in the category of moderately malnourished might have been scored as at risk for severe malnutrition. To identify severely malnourished patients, a cutoff of five is preferable as it provides sensitivity and specificity of 93% and 86% respectively.

The AUC was 0.91 ($p<0.001$) for the cutoff between well nourished and moderately malnourished and 0.95 ($p<0.001$) for the cutoff between moderately malnourished and severely malnourished (Table 4). This gave rise to the 3 categories of scores: zero to two signified no nutritional risk, three to four signified risk of moderate malnutrition and five to nine signified risk of severe malnutrition. The 3-MinNS had a PPV of 67% and NPV of 94% using a cutoff score of three when compared with SGA.

DISCUSSION

The merits of this study are the large sample size comprising a broad range of patients recruited from a randomly determined sequential sample and the blinded reference method assessor. The study sample was representative of the hospital's admission profile for gender and race but not for age. Although the study sample was slightly older than the hospital population, this difference is unlikely to be clinically significant or impact on results. This is the first validation study done on a nutrition screening tool in Singapore, which provides data on the sensitivity, specificity, PPV and NPV of the tool. Jones (2005) critically appraised 44 published reports on nutrition screening and assessment tools and found that majority of nutrition screening tools have not been tested for sensitivity and specificity in large populations.[10]

3-Minute Nutrition Screening, which combines the scores for weight loss, intake and muscle wastage was able to differentiate between patients who were at risk of moderate and severe malnutrition. The first cut-off score at three determined by this validation study enables patients to be classified into two categories; a total score of less than three indicated the patient to be not at risk of malnutrition, a score of greater than or equal to three signifies risk of malnutrition. The cutoff score signals to staff to refer a patient scored as "nutritionally at risk" to the dietitian for a thorough nutritional assessment and intervention where needed. The second cutoff point of five enables prioritization of patients who are at risk of severe malnutrition that may require more urgent attention and facilitates resource planning, especially for hospitals with limited resources.

3-Minute Nutrition Screening is non-invasive and does not require expensive equipment or blood tests as is the case for a number of commonly used nutrition screening tools such as the Nutrition Risk Index (NRI), Prognostic Nutritional Index (PNI) and Maastrich Nutrition Index (MNI).[13,14] Additional blood tests (albumin, total lymphocyte count or prealbumin) on every new admission for the purpose of nutrition screening are costly and these are not routinely done on admission in Singapore hospitals. In this study, only 46% of participants had their serum albumin measured on the first two days of admission (data not shown). Although albumin, total lymphocyte count and prealbumin have been shown to be strong predictors of mortality, their use as indicators of malnutrition has been criticized because inflammation has been linked with low levels of these blood parameters, which may potentially lead to over-diagnosis of malnutrition.[15]

None of the published screening tools include muscle wastage, which has the advantage of being easy to observe and not dependent on patient response. In this study, temporalis and clavicular muscles were chosen as identification sites for muscle wasting because muscles on the upper body are less affected by aging and immobility.[16] Hence, they may be more representative of the person's nutrition status than the lower body muscles. In addition, it was easier for staff to view these two muscles without affecting the modesty of patients. SGA, which also requires physical examination of the muscles, has been found to have a high degree of inter-rater reliability. Several studies have reported the agreement on SGA rating between two observers as between 78 and 81 percent.[11,17,18] It has been proposed that the high inter-rater reliability in these studies may be due to training and standardised data collection techniques.[17] Healthcare professionals are therefore recommended to go through an hour of training on the use of the 3-MinNS tool and should be shown pictures of muscle wastage of different severity.

A number of design features in 3-MinNS enable quick and easy completion by staff. The "tick and circle the score" in a table format saves time as minimal writing is required and it facilitates a quick totaling up of the scores at a glance. Process evaluation (data not shown) with nurses indicated this format was acceptable and took about three minutes to complete. It is common for some patients not to know if they have experienced weight loss. Even if they noticed a weight loss, they may not be able to quantify it. 3-MinNS caters for these shortcomings by including the phrases "yes, unsure' and "don't know" in the weight loss column. This prevents the screening tool from being incomplete and the "cutoff score for action" invalid. In addition, the scoring in 3-MinNS gives the assessor a quantifiable method for describing loss of appetite and muscle wastage i.e. how much patients are eating compared to their usual amount or the extent of muscle wastage. Screening tools ideally should be administered to all patients admitted to the hospital, including people with reduced cognitive function, so the capacity for a caregiver or a proxy who knows the patient well is advantageous. Using a person who is well informed about the patient has been shown to be reliable.[19]

The combination of nutrition parameters, which forms 3-MinNS, gives the highest NPV (94%). A higher NPV is desirable because the main purpose of a screening tool is to minimize patients who are at risk of malnutrition being missed and not referred for nutritional assessment and intervention. With this intention, the PPV (67%) is compromised, which means that patients not at risk of malnutrition have 33% probability of being identified as at risk. Nutrition assessment by dietitians or a trained dietetic technician at the next level is able to identify this group of patients as well nourished and not requiring nutrition intervention.

The criterion for “disease with nutrition risks” was not included in 3-MinNS. Including “disease with nutrition risks” score would reduce the sensitivity of the 3-MinNS tool to 79%. Furthermore, an additional criterion to screen that requires reference to medical records would increase the time needed to complete the screen. Although certain diseases increase the risk of malnutrition, using this parameter may not be very accurate as indicated by the fairly low sensitivity and specificity (68% and 56% respectively). This may reflect that many patients are admitted for investigations without a finalized diagnosis. In addition, the list of diagnoses is likely to be extensive and requires clinical judgment regarding relevance to nutrition status.

There are other nutritional screening tools that can be scored with well-defined cutoffs but which require patients’ weight and height or knee height to be measured to calculate the BMI. Examples of these screening tools include the Nutrition Risk Index (NRI), Nutrition Risk Score (NRS) and Malnutrition Universal Screening Tool (MUST).[13, 20, 21] However practicalities, including availability of suitable equipment to accurately weigh and measure height in patients who are bed bound or old and frail are substantial impediments to the use of BMI. High patient to nurse ratios in Singaporean hospitals are a further barrier to height or knee height measurement and hence to BMI assessment.[22] As a result, screening that requires BMI may not be completed in a sizeable proportion of patients. An audit in three English hospitals on the use of the MUST nutrition screening tool, which includes BMI as one of three screening criteria, reported that one-third of patients remained unscreened, even after specific training of clinical staff to increase screening completions.[23] Furthermore, BMI and its associated cutoffs may be confounded by ethnicity, changes in body composition and fluid retention commonly associated with illness and ageing.[24, 25, 26] In this study the sensitivity of BMI was low (54%).
Subjective Global Assessment was chosen as the reference tool in this study because there was no objective gold standard tool for the assessing nutritional status in a large cohort of hospitalized patients. It has been widely used as a reference method for validating screening and assessment tools due to its good prognostic value for a range of clinical outcomes.[4, 27-29] It is a validated clinical tool for assessing nutrition status.[30, 31]

The study protocol required that the nutrition screening be completed within 24 hours and the assessment within 48 hours. However the effect of this potential limitation is minimal as nutritional assessment was completed within 24 hours for 90% of the study participants. The potential for observer bias due to variation in the style of questioning is another limitation, which may contribute to misclassification between 3-MinNS and SGA assessment. In addition, respondent bias may be present with patients answering queries differently depending on varying state of alertness and medical condition during the day of assessment. Patients with discomfort, pain or cognitive impairment may have less motivation to respond to questions.

It is recommended that nutrition screening be performed within 24 hours of hospital admission.[32] Patients who are at risk of malnutrition (3-MinNS score $\geq$ 3) should be referred to a dietitian for a detailed nutrition assessment and cases confirmed to be malnourished provided nutrition intervention. The two cutoff points in 3-MinNS whereby a range of 3-4 signifies risk of moderate malnutrition and 5-9 signifies risk of severe malnutrition can be used to prioritize patients requiring more urgent attention.

CONCLUSION

3-Minute Nutrition Screening was both sensitive and specific in the determination of the nutritional risk in newly admitted patients. It has the added advantage of summative scoring and cutoff points useful to define a protocol for subsequent action. It was able to differentiate patients at risk of moderate malnutrition and severe malnutrition for prioritization and management purposes.

As 3-MinNS is a simple and rapid tool to administer in acute hospital patients in Singapore, it will assist healthcare workers to carry out nutritional screening more accurately and promptly so that patients who require nutrition intervention can be managed appropriately.

ACKNOWLEDGEMENTS

We thank Ms Leong Si Jie (National University Hospital) for helping in part of the data collection and Mr Dennie Hsu (National University Hospital) for his useful advice and unwavering support for this study.

Conflict of interest and funding disclosure

This study was supported by the National Healthcare Group (Singapore) Small Innovative Grant. None of the authors has financial interest or conflict of interest in this study.

REFERENCES

1. Kruizenga HM, Tulder MWV, Seidell JC, Thijs A, Ader HJ & Van Bokhorst-de van der Schueren MA. Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients. Am J Clin Nutr. 2005;82:1082-1089.
2. McWhirter JP & Pennington CR. Incidence and recognition of malnutrition in hospital. BMJ. 1994;308:945-948.
3. Kelly LE, Tessier S, Cahill A, Morris SE, Crumley A, McLaughlin D, Mckee RF & Lean ME. Still hungry in hospital: identifying malnutrition in acute hospital Admissions. QJM. 2000;93:93-98.
4. Correia MITD, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr. 2003;22:235-239.
5. Isenring E, Bauer J, Capra S. The scored Patient-generated Subjective Global Assessment (PG-SGA) and its association with quality of life in ambulatory patients receiving radiotherapy. Eur J Clin Nutr. 2003;57:305-309.
6. Shepherd A. Nutrition for optimum wound healing. Nurs Stand. 2003;18:55-58.
7. Middleton MH, Nazarenko G, Nivison-Smith I, Smerdely P. Prevalence of malnutrition and 12-month incidence of mortality in two Sydney teaching hospitals. Intern Med J. 2001;31:455-461.
8. Thomas DR, Zdrowski CD, Wilson MM, Conright KC, Lewis C, Tariq S, Morley JE. Malnutrition in sub acute care. Am J Clin Nutr. 2002;75:308-313.
9. American Dietetic Association Council on Practice Quality Management Committee. Identifying patients at risk: ADA’s definitions for nutrition screening and nutrition assessment. J Am Diet Assoc. 1994;94:838-839.
10. Jones JM. The methodology of nutritional screening and assessment tools. J Hum Nutr Diet. 2002;15:59-71.
11. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, Jeejeebhoy KN. What is subjective global assessment of nutritional status? JPEN J Parenter Enteral Nutr. 1987;11:8-13.
12. Bewick V, Cheek L, Ball J. Statistics review 13: Receiver operating characteristic curves. Crit Care. 2004;8:508-512.
13. Corish CA, Flood P, Kennedy NP. Comparison of nutritional risk screening tools in patients on admission to hospital. J Hum Nutr Diet. 2004;17:133-139.
14. Schneider SM, Herbuterne X. Use of nutritional scores to predict clinical outcomes in chronic diseases. Nutr Rev. 2000;58:31-38.
15. Rosenthal AJ, Sanders KM, McMurtry CT, Jacobs MA, Thompson DD, Gheorghui D, Little KL, Adler RA. Is malnutrition overdiagnosed in older hospitalized patients? Association between the soluble interleukin-2 receptor and serum markers of malnutrition. J of Gerontol A Biol Sci Med Sci. 1998;53A:M81-M86.
16. Candow DG, Chilibeck PD. Differences in size, strength and power of the upper and lower body muscle groups in young and older men. J of Gerontol A Biol Sci Med Sci. 2005;60A:148-156.
17. Ek AC, Unosson M, Larsson J, Ganowiak W, Bjurulf P. Interrater variability and validity in subjective nutritional assessment of elderly patients. Scand J Caring Sci. 1996;10:163-168.

18. Baker JP, Detsky AS, Wesson DE, Wolman SL, Stewart S, Whitewell J, Langer B, Jeejeebhoy KN. Nutrition assessment: a comparison of clinical judgment and objective measurements. New Engl J Med. 1982;306:969-972.
19. Ostbye T, Tyas S, McDowell I, Koval J. Reported activities of daily living: agreement between elderly subjects with and without dementia and their caregivers. Age ageing. 1997;26: 99-106.
20. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN Guidelines for Nutrition Screening 2002. Clin Nutr. 2003;22:415-421.
21. Lyne PA, Prowse MA. Methodological issues in the development and use of instruments to assess patient nutritional status or the level of risk of nutritional compromise. J Adv Nurs. 1999;30:835-842.
22. Stratton RJ, Hackston A, Longmore D, Dixon R, Price S, Stroud M, King C, Elia M. Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal tool' ('MUST') for adults. Br J Nutr. 2004;92:799-808.
23. Wong S, Gandy J. An audit to evaluate the effect of staff training on the use of Malnutrition Universal Screening Tool. J Hum Nutr Diet. 2008;21:405-406.
24. Deurenberg-Yap M, Schmidt G, van Staveren WA, Deurenberg P. The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. Int J Obes (London). 2000;24:1011-1017.
25. Nightingale JM, Walsh N, Bullock ME, Wicks AC. Three simple methods of detecting malnutrition on medical wards. J R Soc Med. 1996;89:144-148.
26. Shirley S, Davis LL, Carlson BW. The relationship between body mass index/body composition and survival in patients with heart failure. J Am Acad Nurse Pract. 2008;20:326-332.
27. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. Nutrition. 1999;15:458-464.
28. Kyle UG, Kossovsky MP, Karsegard, VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: A population study. Clin Nutr. 2006;25:409-417.
29. Gupta D, Lammersfeld CA, Vashi PG, Burrows J, Lis CG, Grutsch JF. Prognostic significance of Subjective Global Assessment (SGA) in advanced colorectal cancer. Eur J Clin Nutr. 2005;59:35-40.
30. Christensson L, Unosson M & Ek A-C. Evaluation of nutritional assessment techniques in elderly people newly admitted to municipal care. Eur J Clin Nutr. 2002;56:810-818.
31. Thoresen L, Fjeldstad I, Krogstad K, Kaasa S, Falkmer UG. Nutritional status of patients with advanced cancer: the value of using the subjective global assessment of nutritional status as a screening tool. Palliat Med. 2002;16:33-42.
32. Joint Commission International Accreditation Standards for Hospitals. 3rd Edition. Assessment of Patients Standard AOP.1.6. Oakbrook, IL: Department of Publications of Joint Commission Resources. 2007. p.77-78.

Table 1. Number of study subjects admitted to various specialties

Specialty	Number	%
General Medicine	145	17.7
Surgery	121	14.8
Cardiology	90	11.0
Orthopaedic	88	10.8
Gastroenterology	60	7.3
Nephrology	58	7.1
Oncology	55	6.7
Neurology	52	6.4
Respiratory	36	4.4
Endocrinology	25	3.1
Cardiothoracic and Vascular Surgery	23	2.8
Urology	22	2.7
Neurosurgery	11	1.3
Others	32	3.9
Total	**818**	**100**

Table 2. Demographics (frequency or mean ± standard deviation) of study participants and hospital population[†]

		Study sample (n=818)	**Hospital population (n= 21348)**	***p* value**
Gender	Male Female	59% 41%	56% 44%	0.24
Race	Chinese Malay Indian Others	62% 20% 11% 7%	60% 18% 13% 9%	0.05
Age	Mean age (years)	51.9 ± 15.4	49.3 ± 15.9	<0.001

[†]Data from the profile of inpatient admissions from February-November 2006, National University Hospital's Management Information Services.

Table 3. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the nutrition parameters studied on 818 patients consecutively admitted to a tertiary hospital in Singapore

Nutrition parameters (n=818)	Best cutoff score	Area under Curve (AUC)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Weight Loss only	1	0.79	79	71	52	89
Intake only	1	0.72	69	72	50	85
Body Mass Index only‡	1	0.74	54	92	72	84
Muscle Wastage only	2	0.81	72	88	70	89
Disease With Nutrition Risks only	1	0.61	68	56	38	81
Weight Loss + Intake	2	0.83	80	72	53	90
Weight Loss + Muscle Wastage	2	0.89	89	74	58	74
Intake + Muscle Wastage	2	0.87	86	74	57	93
Weight Loss + Disease With Nutrition Risks	2	0.78	90	49	42	92
Intake + Disease With Nutrition Risks	3	0.72	54	78	50	81
Muscle Wastage + Disease With Nutrition Risks	3	0.81	57	89	67	84
Weight Loss + Intake + Muscle Wastage **(3-MinNS)**	3	0.91	86	83	67	94
Weight Loss + Intake + Disease With Nutrition Risks	3	0.82	83	66	49	90
Weight Loss + Muscle Wastage + Disease With Nutrition Risks	4	0.89	77	89	75	91
Intake + Muscle Wastage + Disease With Nutrition Risks	4	0.86	68	89	71	87
Weight Loss + Intake + Muscle Wastage + Disease With Nutrition Risks	5	0.90	79	91	78	91

▆ The biggest area under the ROC curve (AUC) was regarded as the most desirable parameters to be adopted as the new nutrition screening tool. These combined parameters are called the 3-Minute Nutrition Screening (3-MinNS).

‡n = 734 excluding missing data due to inability to obtain height of subjects.

Table 4. Sensitivity and specificity of 3-MinNS at different cutoff values to determine subjects at risk of malnutrition and subjects at risk of severe malnutrition using Subjective Global Assessment as the reference tool.

	3-MinNS to determine all subjects at risk of malnutrition (n= 818)			3-MinNS to determine subjects at risk of severe malnutrition (n= 818)		
3-MinNS Cutoff Score	Sensitivity %	Specificity %	J	Sensitivity %	Specificity %	J
1	96	46	0.42	100	35	0.35
2	94	61	0.55	100	47	0.47
3	86	83	0.69[§]	100	66	0.66
4	72	93	0.64	100	77	0.77
5	54	97	0.51	93	86	0.79[§]
6	32	100	0.32	80	93	0.73
7	17	100	0.17	50	97	0.47
8	7	100	0.07	20	99	0.19
9	2	100	0.02	10	100	0.10
Area under curve (AUC)	0.91			0.95		
p value	<0.001[*]			<0.001[*]		

Sensitivity and specificity of 3-MinNS in identifying different categories of nutrition risk at its best cut off score.
[§]Maximum J (Youden's Index = sensitivity + specificity – 1) represents best cutoff score
[*] Significant *p* values for Area Under the Curve

Figure 1. Nutritional parameters tested in the study

Score	Nutrition Parameters					
	Unintentional Weight Loss (past 6 months)	**Nutritional Intake (past 1 week)**	**BMI**	**Muscle Wastage**		**Diseases With Nutrition Risk** (Diagnosis in Admission Record)
				Muscle From Temple	**Clavicle Bone**	
3	☐ > 7kg	☐ Starvation or < ¼ of usual portion / meal ☐ Tube Feeding < 1 L/day (1kcal/ml feed) <1000kcal/day	$\leq$ 17 kg/m^2	☐ Hollowing, Depression of Temple Muscle	☐ Protruding & Prominent Clavicle Bone	☐ Pre / post major surgery ☐ Multiple major injuries / trauma ☐ Burns > 15% ☐ Acute Renal Failure
2	☐ >3 to 7 kg ☐ Yes, Unsure	☐ ¼ - <½ of usual portion / meal with no oral supplement ☐ Tube Feeding 1 – 1.25 L/day (1 kcal/ml feed) 1000 – 1250 kcal/day	>17- 18.5 kg/m^2	☐ Slight Depression of Temple Muscle	☐ Slight Protrusion of Clavicle Bone	☐ Cancer ☐ Infection / Sepsis ☐ Gastrointestinal Diseases ☐ Fracture of Femur / NOF ☐ Burns < 15% ☐ Pressure sores / deep wound ☐ ESRF not on dialysis yet ☐ Anorexia Nervosa ☐ Conditions affecting food intake
1	☐ 1 to 3 kg ☐ Don't Know	☐ ½ - <¾ of usual portion / meal or ¼ - <½ of usual portion / meal with oral supplement ☐ Tube Feeding >1.25 – 1.5 L/day (1 kcal/ml feed) >1250 – 1500 kcal/day	> 18.5 - < 20 kg/m^2			☐ Dialysis Patients
0	☐ No Change/ Weight gain/ Intentional weight loss ☐ < 1kg	☐ Normal intake with ¾ - 1 of usual portion / meal ☐ Tube Feeding > 1.5 L/day (1 kcal/ml feed) >1500 kcal/day	$\geq$ 20 kg/m^2	☐ Well Defined Temple Muscle	☐ No Protruding Clavicle Bone	☐ None of the above
Scoring (Circle one per column)	3 2 1 0	3 2 1 0	3 2 1 0	3 2 1 0		3 2 1 0

Figure 2. 3-Minute Nutrition Screening (3-MinNS)

3-Minute Nutrition Screening (3-MinNS)				
Score	**Nutrition Parameters**			
	Unintentional Weight Loss (past 6 months)	**Nutritional Intake (past 1 week)**	**Muscle Wastage**	
			Muscle From Temple	**Clavicle Bone**
3	☐ > 7kg	☐ Starvation or < ¼ of usual portion / meal ☐ Tube Feeding < 1 L/day (1 kcal/ml feed) <1000kcal/day	☐ Hollowing, Depression of Temple Muscle	☐ Protruding & Prominent Clavicle Bone
2	☐ >3 to 7 kg ☐ Yes, unsure	☐ ¼ - <½ of usual portion / meal with no oral supplement ☐ Tube Feeding 1 – 1.25 L/day (1 kcal/ml feed) 1000 – 1250 kcal/day	☐ Slight Depression of Temple Muscle	☐ Slight Protrusion of Clavicle Bone
1	☐ 1 to 3 kg ☐ Don't know	☐ ½ - <¾ of usual portion / meal or ¼ - <½ of usual portion / meal with oral supplement ☐ Tube Feeding >1.25 – 1.5 L/day (1 kcal/ml feed) >1250 – 1500 kcal/day		
0	☐ No change/ Weight gain/ Intentional weight loss ☐ < 1kg	☐ Normal intake with ¾ - 1 of usual portion / meal ☐ Tube Feeding > 1.5 L/day (1 kcal/ml feed) >1500 kcal/day	☐ Well Defined Temple Muscle	☐ No Protruding Clavicle Bone
Scoring (Circle one per column)	3 2 1 0	3 2 1 0	3 2 1 0	
Total Score		Patient is at nutritional risk if total score is **3 or more** • Score of 3-4 signifies patient is at risk of moderate malnutrition • Score above 5-9 signifies patient is at risk of severe malnutrition		