Comparing Performance of NAF and NT-2013 to SGA as Nutritional Assessment Tools in Systemic Sclerosis Patients

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Article

Comparing Performance of NAF and NT-2013 to SGA as Nutritional Assessment Tools in Systemic Sclerosis Patients

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Abstract

Malnutrition is one of common complications of patients with systemic sclerosis (SSc). However, several nutritional assessment tools are implemented in Thailand. The study aimed to compare the performance of nutritional assessment tools including Nutritional Assessment Form (NAF) and Nutritional Triage 2013 (NT-2013) to Subjective Global Assessment (SGA) in SSc patients. A cross-sectional diagnostic study was conducted in adult SSc patients at Srinagarind Hospital, Thailand. To elucidate the efficacy and correlations of these tools, descriptive statistics, Pearson correlation analyses, and Kappa coefficient of agreement were employed. A total of 208 SSc patients were included, of which 71.6% were females. The respective mean age and body mass index was 59.3 years and 21.1 kg/m^2. Nearly half (45.7%) were malnourished based on SGA. Malnutrition diagnosis using the NAF and NT-2013 criteria were found in 80.3% and 34.6%, respectively. The respective sensitivity and specificity of NAF for diagnosis of malnutrition was 93.7% and 31.9%, while NT-2013 was 60.0% and 90.3%. Both NAF and NT-2013 had slight agreement with SGA with a kappa of 0.149 for NAF and 0.131 for NT-2013. Adjusting the cut-off points of NAF and NT-2013 could enhance sensitivity, specificity, and improve agreement for diagnosis with SGA.

Keywords: systemic sclerosis; malnutrition; Subjective Global Assessment (SGA); Nutritional Assessment Form (NAF); Nutritional Triage 2013 (NT-2013)

1. Introduction

Systemic sclerosis (SSc) is a rare immune-mediated connective tissue disease with a prevalence of 17.6 per 100,000 around the world.[1] Explained by its pathophysiology, vasculopathy and diffuse fibrosis, the disease affects multiple systems of the body leading to high rates of morbidity and mortality.[2–4] Cardiovascular and pulmonary complications were considered the primary cause of death in systemic sclerosis patients. However, a large number of evidence-based treatments has been developed, leading to a notable reduction in mortality associated with such complications.[4,5] While many serious complications are now treatable[4], non-lethal manifestation steps up as the new challenge in improving the patient's quality of life. One of the most common clinical features in systemic sclerosis is the gastrointestinal involvement, often caused by dysmotility and fibrosis, affects approximately 90% of the patients with systemic sclerosis.[6–8] These symptoms, including dysphagia, malabsorption, constipation, diarrhea etc., not only reduced the patients' quality of life[9], but also put the them at risk of malnutrition.[4,6,9,10] Since malnutrition was proved to be associated with morbidity and mortality, it has become essential that all systemic sclerosis patients must be screened for malnutrition.[8,9,11,12]

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In the past, malnutrition was assessed based on history taking, physical examination and objective parameters including anthropometric measurements, such as midarm circumference, and laboratory results, such as albumin level and total lymphocyte count, etc. The parameters could be interfered by various insults leading to a large number of misdiagnosis of malnutrition.[13] However, in 1987, after the construct of Subjective Global Assessment (SGA), nutritional assessment has been easier and more convenient for all medical staffs.[14] Malnutrition has been assessed and diagnosed more accurately since then. While SGA has long been considered the gold standard, its subjective nature and time-consuming process have led to the exploration of alternative tools for more convenient clinical use. Over the past decades, many other new nutritional assessment tools have been announced both in Thailand and internationally. The commonly used nutritional assessment tools in Thailand include Nutritional Alert Form (NAF), Nutritional Triage 2013 (NT-2013). Both are clinical scoring systems developed by Thai experts.[13,15]

NAF is designed to be easy, concise, and does not require specialized nutrition expertise. Additionally, it can be utilized in settings where body weight measurement may not be feasible, as it incorporates the effects of serum albumin and total lymphocyte count [13]. NT-2013 consists of 9 questions including dietary history, changes in body weight, fluid retention, loss of subcutaneous fat, loss of muscle mass, muscle function, chronic illness severity, acute illness severity, and a summarized score for each category [15].

As far as our concern, the nutritional assessment tools mentioned were based-on experience of other diseases and there were no specific tools for assessing malnutrition in systemic sclerosis.[2,6] The aim of the study is to compare, in systemic sclerosis patients, the performances of nutritional assessment tools including NAF and NT-2013 to SGA, which is now a gold standard in diagnosing malnutrition but inconvenient in clinical practice.

2. Materials and Methods

A cross-sectional study enrolled systemic sclerosis patients from the scleroderma clinic, Srinagarind hospital, Thailand, between 1st May 2022 and 31st January 2024. The inclusion criteria were patients diagnosed with systemic sclerosis according to ACR/EULAR criteria, aged 18 years or older and able to provide informed consent. Patients with critically ill conditions or patients who could not undergo nutritional assessment were excluded. In each patient, baseline characteristic data including age, gender, signs and symptoms of SSc as well as organ involvement, and medication were collected. Three nutritional assessment tools, including NAF, NT-2013, and SGA (Appendix A1, A2, and A3), through questionnaires and physical examination, were performed in each patient by single assessor to minimize interpersonal variability. SGA included items related to dietary intake, weight changes, gastrointestinal symptoms, functional status, medical history of illness, and physical examination for loss of subcutaneous fat, muscle wasting, ankle edema, sacral edema, and ascites. To diagnose malnutrition, SGA relied on a combined subjective assessment of data from history and physical examination. NAF included information about current body weight, history of weight change, height, arm span, body mass index (BMI), serum albumin or total lymphocyte count if body weight was not available, dietary intake, capacity to assess food, underlying diseases, and physical examinations emphasized on general appearance. A total NAF score of 6 or more indicated malnutrition. NT-2013 incorporated details about current body weight, usual body weight, ideal body weight, change in body weight, height, patient performance status, dietary intake, underlying diseases, severity of stress affecting nutrition and metabolism, physical signs of body fat and fat loss, signs of fluid accumulation, as well as motor power assessed handgrip strength. NT-2013 diagnosed malnutrition when the score reached 5 or higher. The primary outcome was to compare performance in diagnosing malnutrition between NAF and NT-2013 with SGA. The secondary outcome was to determine appropriate cut-off points of NAF and NT-2013 in SSc patients.

To elucidate the efficacy and correlations of these tools, descriptive statistics, Pearson correlation analyses, and Kappa coefficient of agreement were employed. Categorical variables were expressed as percentages and absolute values, while continuous variables were presented as mean ± standard

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deviation (SD). Pearson's correlation coefficient (r) was used to determine the correlation between NAF and NT-2013 score [16]. Kappa (κ) statistic was calculated to measure the agreement between all assessment tools. The results were interpreted as follows: ≤0.20, poor agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; and 0.81-1.00, almost perfect agreement [17]. To analyze the sensitivity and specificity of NAF and NT-2013 for detection malnutrition, receiver operating characteristics curves (ROC curves) were generated, including area under the curve (AUC) and their 95% confidence intervals (CI). Statistical significance was set at $P < 0.05$ for all tests. Statistical analysis was performed using SPSS version 28.0 (IBM, Armonk, NY). A sample size of at least 97 participants was required to provide the level of significance of 0.05.

The study protocol was approved by the Institutional Review Board of Khon Kaen University. All participants were provided written informed consent prior to enrollment in the study. Confidentiality of participant information was strictly maintained throughout the study period, and data were anonymized for analysis.

3. Results

The study incorporated a total of 208 patients diagnosed with systemic sclerosis. Among these participants, 149 were identified as female, representing approximately 71.6% of the total sample, while 59 were male, accounting for approximately 28.3%. Basic characteristics were shown in Table 1.

Table 1. Characteristics of SSc patients.

	Mean	Standard deviation	Minimum	Maximum
Age, years	59.3	11.0	18.0	84.0
Height, cm	157.7	7.7	139.0	175.0
Weight, kg	52.6	10.7	24.0	83.3
BMI, kg/m^2	21.1	3.9	12.4	31.7

From history taking, it was noted that a subset of patients experienced challenges in accessing food, with 6 patients (2.9%) reporting limitations in their ability to independently access food. Among these, 2 patients exhibited slight limitations, 3 were partially dependent, and 1 was entirely reliant on others for food intake. Additionally, 20 individuals (9.6%), reported significant weight loss within the past 6 months.

Gastrointestinal symptoms were prevalent among the study population, with 50 patients (24.0%) reporting symptoms upon intake. Specifically, 12 patients experienced aspiration, 42 reported dysphagia, 5 reported diarrhea, 4 reported anorexia, and 8 reported symptoms of nausea or vomiting. Importantly, it was observed that some patients experienced multiple gastrointestinal symptoms simultaneously, underscoring the complexity and multifaceted nature of gastrointestinal involvement in systemic sclerosis.

Physical examination further elucidated aspects of nutritional status and overall health. Hyposthenic build was observed in a considerable proportion of patients, with 63 individuals (30.3%) exhibiting thin or cachexic physique. Edema, indicative of fluid retention, was noted in 12 patients (5.8%), with varying degrees of severity ranging from mild to severe. Additionally, assessments of fat and muscle mass revealed significant proportions of patients with low fat mass (42 patients, 20.2%) and low muscle mass (42 patients, 20.2%) emphasizing potential sarcopenia among SSc patients.

Table 2 indicated findings that a significant proportion of the patients, specifically 95 cases (45.7%), were reportedly categorized as malnourished based on SGA. The mean and standard deviation of NAF and NT score was 8.4 $\pm$ 4.19 and, 4.0 $\pm$ 2.46 respecitively. Malnutrition diagnoses

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using NAF and NT-2013 criteria were identified in 167 patients (80.3%) and 72 patients (34.6%), respectively.

Table 2. Malnutrition diagnosed by SGA, NAF, and NT-2013.

Nutritional assessment tool	Mean score (SD)	Current cut-off point for malnutrition	Prevalence of malnutrition by using current cut-off (N = 208)
Subjective Global Assessment (SGA)	NA	No score (using global assessment)	45.7%
Nutrition Alert Form (NAF)	8.4 (4.19)	6 or more	80.3%
Nutrition Triage 2013 (NT-2013)	4.0 (2.46)	5 or more	34.6%

Figure 1 showed a strong correlation between the NAF and NT-2013 total scores (r= 0.71, p<0.001). However, both NAF and NT-2013 exhibited slight agreement with SGA, displaying kappa values of 0.149 for NAF and 0.131 for NT-2013. Moreover, the sensitivity and specificity of NAF for diagnosing malnutrition were determined to be 93.7% and 31.9%, respectively, while the sensitivity and specificity of NT-2013 were found to be 60.0% and 90.3%. ROC curves of NAF and NT-2013 were shown in Figure 2.

Adjusting the cut-off points of NAF and NT-2013 could enhance sensitivity, specificity, and improve agreement for diagnosis with SGA. From our study, increasing the cut-off points of NAF from 6 to 7 leaded to improved specificity of 69.9% (from 31.9%) while sensitivity of 89.5% remained. On the other hand, decreasing the cut-off point of NT-2013 from 5 to 4 resulted in improvement of sensitivity (60.0% from 48.4%) in exchange of less specificity (72.6% from 90.3).

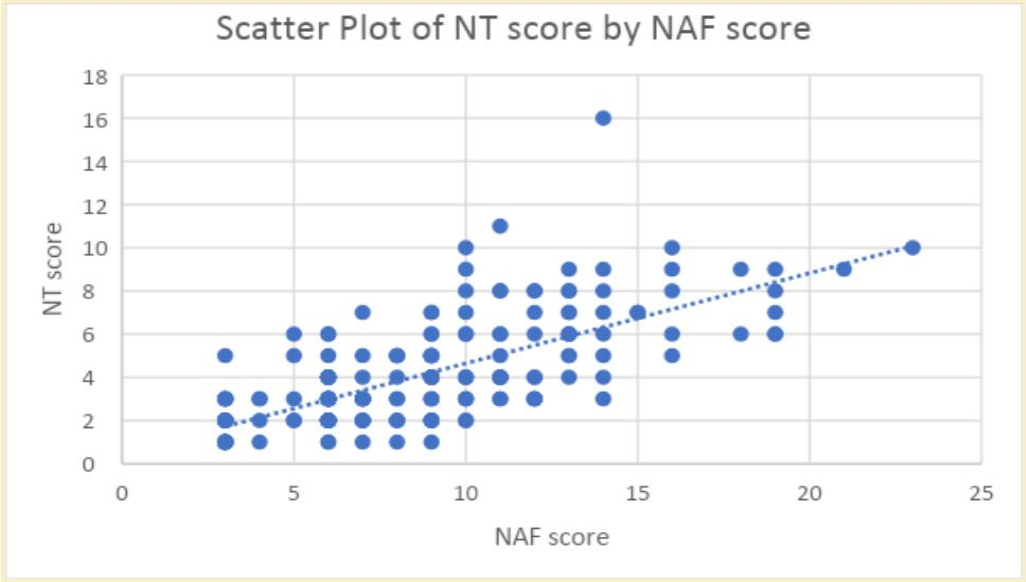

Figure 1. Scatter plot of NT-2013 score by NAF score.

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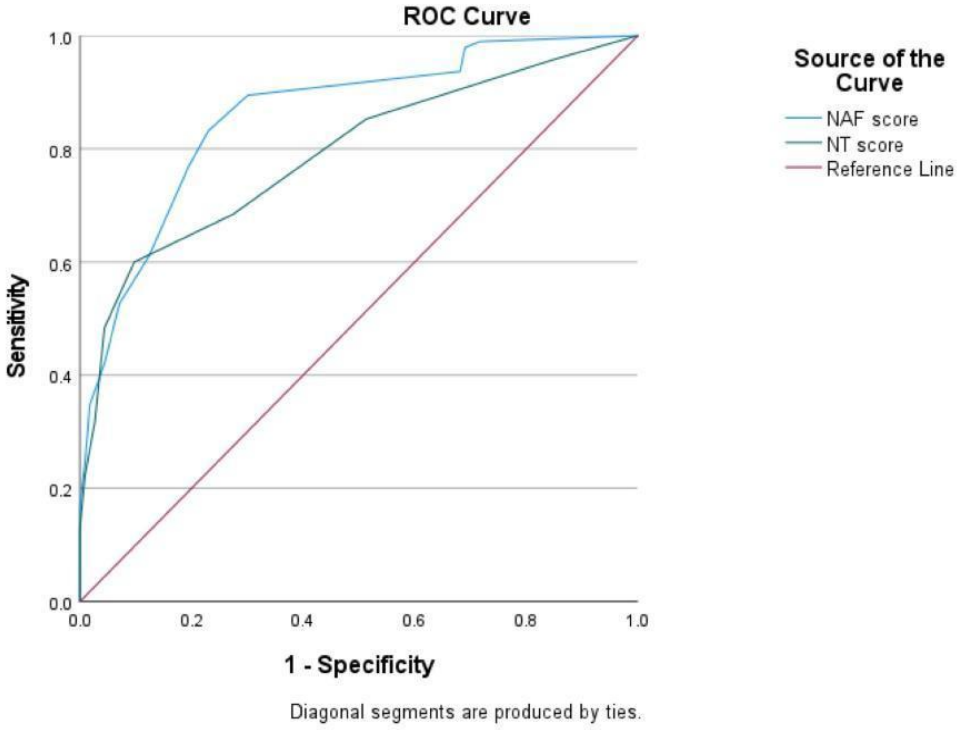

Figure 2. Receiver operation characteristic (ROC) curve for NAF and NT-2013.

4. Discussion

Malnutrition is common in SSc patients. In this study, the findings revealed a high prevalence of malnutrition among SSc patients, with almost half of the participants (45.7%) diagnosed as malnourished based on SGA criteria. Previous study with 56 SSc patients showed that prevalence of malnutrition, assessed by the same method, was approximately 23.2%.[10] The difference in prevalence may be due to the number of enrolled patients. Our study included 208 SSc patients which was one of the largest sample sizes in this area of research.

This cohort also found that prevalence of malnutrition was also varied when assessed by different nutritional assessment methods. With NAF, 80.6% of SSc patients were malnourished, while only 34.6% were reported by NT-2013. Although difference in prevalence, a strong correlation between NAF and NT-2013 total scores indicated that these tools assess similar aspects of nutritional status among SSc patients. Both tools included data of weight loss, abnormal GI symptoms, food intake, functional capacity, illness, physical exam, as well as illness; however, both methods emphasized different factors in calculation.

Despite the correlation of score, both NAF and NT-2013 showed only slight agreement with SGA in diagnosing malnutrition which could be explained by several factors.

Firstly, NAF and NT-2013 emphasized different criteria compared to SGA. SGA relied heavily on subjective evaluation by healthcare providers, including physical examination and extensive patient history involving a comprehensive assessment that considered various factors beyond objective measurements, while NAF and NT-2013 focused more on objective measures categorizing nutritional status.[13–15] As a result, SGA provides a more holistic understanding of the patient's nutritional status and may be more sensitive to subtle changes in nutritional status or may capture aspects of malnutrition that were not adequately addressed by NAF and NT-2013.[14]

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Secondly, SGA, NAF and NT-2013 have been developed based on populations with diverse illnesses, but not SSc. SSc patients exhibited variability in their nutritional status. Factors such as disease severity, comorbidities, and individual dietary habits may contribute to discrepancies in the diagnosis of malnutrition and could impact the agreement between different assessment tools.[6–9] As a result, they may not capture certain nuances or characteristics of malnutrition that were relevant to SSc patients, leading to difference in diagnostic agreement.[13–15]

Thirdly, SGA, NAF, and NT-2013 differed in details and the weighting of scores. Nonetheless, they shared the same underlying principle as SGA, as evidenced by the improvement in sensitivity when adjusting the cut-off points. This was due to the fact that these tools operate based on the same principle.[13–15]

Adjusting the cut-off values of NAF and NT-2013 may improve performance of both tools in diagnosing malnutrition in SSc patients. The current cut-off point of NAF may resulted in overly sensitive diagnosis, increasing the threshold could improve specificity without losing sensitivity. Nonetheless, adjusting the cut-off values of NT-2013 was more challenged since improved in sensitivity accompanied by decreased specificity.

The strengths of the study included minimizing selection bias, as all eligible patients were included. Moreover, there was absence of interpersonal variability since all patients were evaluated by a single examiner. Additionally, the robust sample size, considered one of the highest in this area of research, underscored the reliability of the findings. Although this study proposed a new cut-off point, the diagnostic value would be greater if there were long-term follow-ups to assess clinical outcomes.

Overall, while NAF and NT-2013 may correlate well with each other in assessing nutritional status among SSc patients, their agreement with SGA in diagnosing malnutrition may be influenced by various factors related to assessment approach, tool specificity, and patient variability. Adjusting the cut-off points of NAF and NT-2013 could enhance sensitivity, specificity, and improve agreement for diagnosis with SGA. Further research is still needed to understand the underlying reasons for these discrepancies and to refine nutritional assessment tools for SSc patients. Future studies could explore additional factors that may influence the diagnosis of malnutrition in SSc patients and evaluate the effectiveness of interventions aimed at improving nutritional status in this population.

5. Conclusions

Malnutrition is common in SSc patients. Early detection of such condition may lead to proper management, resulting in improved clinical outcomes. Prevalence of malnutrition in SSc patients may be varied among different nutritional assessment tools. NAF and NT-2013 exhibited a strong correlation of diagnosis of malnutrition between the two tools, but only displayed slight agreement of diagnosis of malnutrition with SGA. Adjusting the cut-off points of NAF and NT-2013 could enhance sensitivity, specificity, and improve agreement for diagnosis with SGA. Further research is needed to understand the underlying reasons for these discrepancies and to refine nutritional assessment tools for systemic sclerosis patients.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of KHON KAEN UNIVERSITY (protocol code HE651010).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

NAF	Nutrition Alert Form
NT-2013	Nutrition Triage 2013
SGA	Subjective Global Assessement
SSc	Systemic sclerosis

Appendix A

Appendix A.1. Subjective Global Assessment Form

Features of subjective global assessment (SGA)

(Select appropriate category with a checkmark, or enter numerical value where indicated by "#.")

A. History
1. Weight change
Overall loss in past 6 months: amount = # _____kg; % loss = # _____.
Change in past 2 weeks: _____increase,
_____no change,
_____decrease.
2. Dietary intake change (relative to normal)
_____No change,
_____Change _____duration = # _____weeks.
_____type: _____suboptimal solid diet, _____full liquid diet
_____hypocaloric liquids, _____starvation.
3. Gastrointestinal symptoms (that persisted for >2 weeks)
_____none, _____nausea, _____vomiting, _____diarrhea, _____anorexia.
4. Functional capacity
_____No dysfunction (e.g., full capacity),
_____Dysfunction _____duration = # _____weeks.
_____type: _____working suboptimally,
_____ambulatory,
_____bedridden.
5. Disease and its relation to nutritional requirements
Primary diagnosis (specify) _____
Metabolic demand (stress): _____no stress, _____low stress,
_____moderate stress, _____high stress.
B. Physical (for each trait specify: 0 = normal, 1+ = mild, 2+ = moderate, 3+ = severe).
_____loss of subcutaneous fat (triceps, chest)
_____muscle wasting (quadriceps, deltoids)
_____ankle edema
_____sacral edema
_____ascites
C. SGA rating (select one)
_____A = Well nourished
_____B = Moderately (or suspected of being) malnourished
_____C = Severely malnourished

Figure A1. Subjective Global Assessment Form.

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Appendix A.2. Nutrition Alert Form

Nutrition Alert Form

A simplified nutrition screening form for Nurse

Name ..... ☐Male ☐Female Age.....yr HN.....D/M/Y admitted ..... Time.....

Diagnosis ..... Data from ☐Patient ☐Pt.'s relative ☐from.....

Mark ✓in☐by choosing only one choice in each big topic and small topic (except topics 6 and 8 which more choices are allowed) and fill scores in the box — Scores

1. Height/Body's lenght/Arm span ☐ Height ..... cm

☐ Body's lenght..... cm ☐ Arm span ..... cm ☐ From Pt.'s relative ..... cm

2. Weight and Body mass index [Body mass index (BMI) = Weight (kg)/Height (m)^2]

2.1 Weight..... kg ☐Lie down position *(1)* ☐Stand position *(0)* ☐Not feasible *(0)* ☐From Pt.'s relative *(0)*

2.2 BMI.....kg/m^2 ☐BMI < 17.0 kg/m^2 *(2)* ☐BMI 17.0-18.0 kg/m^2 *(1)* ☐BMI 18.1-29.9 kg/m^2 *(0)* ☐BMI ≥ 30.0 kg/m^2 *(1)*

If weight is not available, use either Albumin or Total Lymphocyte Count (TLC) (TLC = Total WBC/mm^3 X % Lymphocyte/100)

2.1 Albumin ☐≤ 2.5 g/dl (< 25 g/l) *(3)* ☐2.6-2.9 g/dl (26-29 g/l) *(2)* ☐3.0-3.5 g/dl (30-35 g/l) *(1)* ☐>3.5 g/dl (35 g/l) *(0)*

2.2 TLC ☐≤ 1,000 cells/mm^3 (3) ☐1,001-1,200 cells/mm^3 *(2)* ☐1,201-1,500 cells/mm^3 *(1)* ☐>1,500 cells/mm^3 *(0)*

3. Body build ☐Too thin *(2)* ☐Thin *(1)* ☐Obese *(1)* ☐Normal-Overweight *(0)*

4. Weight change in the past 4 wk. ☐Decreased *(2)* ☐Increased *(1)* ☐Not available *(0)* ☐Stable *(0)*

5. Dietary intake in the past 2 wk.

5.1 Type ☐Clear liquid diet *(2)* ☐Full liquid diet/BD/Medical food *(2)* ☐Soft diet *(1)* ☐Regular diet *(0)*

5.2 Quantity ☐Too little *(2)* ☐Little *(1)* ☐Too much *(0)* ☐Adequate *(0)*

6. Persistent gastrointestinal symptoms in the past 2 wk. (more than one choice is allowed)

6.1 Chewing / Swallowing problems ☐Aspiration *(2)* ☐Chewing difficulty/Dysphagia/Tube feeding *(2)* ☐No *(0)*

6.2 Gastrointestinal problems ☐Diarrhea *(2)* ☐Abdominal pain (2) ☐No *(0)*

6.3 Problems during intake ☐Vomiting *(2)* ☐Nausea *(2)* ☐No *(0)*

7. Functional capacity ☐Bed ridden *(2)* ☐Needs assistance occasionally *(1)* ☐Self dependence *(0)* ☐Normal *(0)*

8. Pt.'s disease, please inform dietitian/nutritionist (more than one choice is allowed)

☐ DM *(3)* ☐ CKD-ESRD *(3)* ☐ CLD/Cirrhosis/Hepatic encephalopathy *(3)*

☐ Solid cancer *(3)* ☐ Chronic heart failure *(3)* ☐ Severe head injury *(3)*

☐ Hip fracture *(3)* ☐ COPD *(3)* ☐ ≥ 2° of burn *(3)*

☐ Stroke/CVA *(6)* ☐ Septicemia *(3)* ☐ Severe pneumonia *(6)*

☐ Multiple fracture *(6)* ☐ Malignant hematologic disease/ Bone marrow transplant *(6)* ☐ Critically ill *(6)*

Total Scores*

*Interpretation

☐ ***Scores of 0-5* (NAF = A : Normal-Mild malnutrition)**
No risk of malnutrition, nurse should rescreen the patient again within 7 days.

☐ ***Scores of 6-10* (NAF = B : Moderate malnutrition) *Please inform attending doctor and dietitian/nutritionist immediately.***
Moderate risk of malnutrition. Patient should be assessed by dietitian/nutritionist and received nutrition therapy by attending doctor **within 3 days.**

☐ ***Scores of 11 and more* (NAF = C : Severe malnutrition) *Please inform attending doctor and dietitian/nutritionist immediately.***
Severe risk of malnutrition. Patient should be assessed by dietitian/nutritionist and received nutrition therapy by attending doctor **within 24 hours.**

Screened by.....D/M/Y.....Time.....

Nutrition Alert Form : Developed by Prof. Surat Komindr, MD, Division of Nutrition and Biochemical Medicine, Department of Medicine, Ramathibodi Hospital

Figure A2. Nutrition Alert Form.

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Appendix A.3. Nutrition Triage 2013

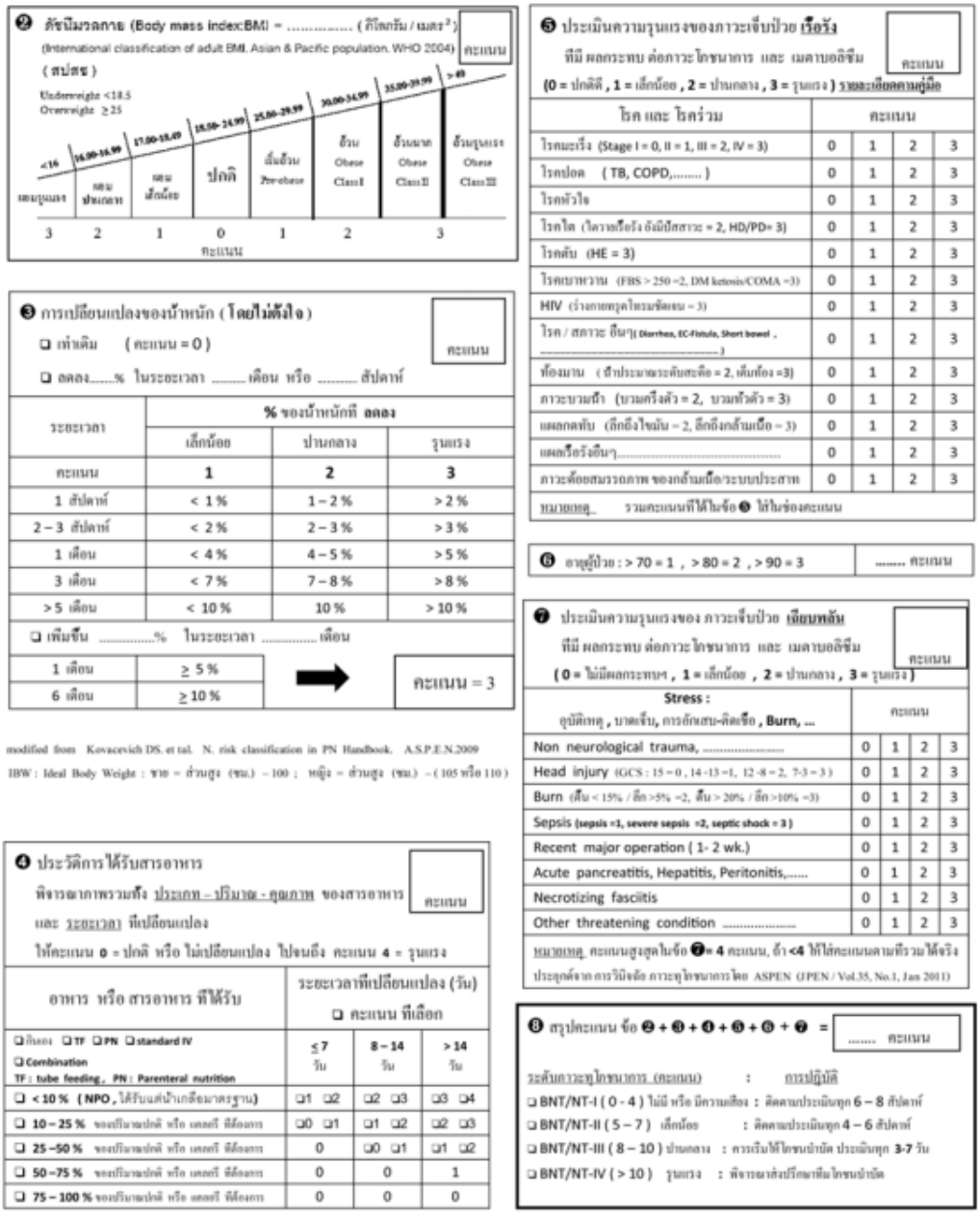

Figure A3. Nutrition Triage 2013.

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