Original Article

Validity of Thai Nutritional Assessment Form and Nutrition Triage 2013 to Diagnose Malnutrition in Non-Dialytic Chronic Kidney Disease

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Background: Malnutrition inflammation score (MIS) is a universal tool to assess the presence of malnutrition among patients with chronic kidney disease (CKD). An appropriate diagnosis coding for malnutrition affects hospital reimbursement in Thailand. The Nutrition Alert Form (NAF) and the Nutritional Triage (NT-2013) have been approved as standard nutrition assessment tools for general populations.

Objective: To study the validity of the NAF and the NT-2013 among patients with MIS at non-dialytic CKD stages 3 to 5.

Materials and Methods: A cross-sectional study was conducted among the patients with non-dialytic CKD stages 3 to 5. NAF, NT-2013, and MIS nutritional assessment tools were performed in all subjects. Cohen's kappa statistics and Pearson's correlation were used to determine the validity of NAF and NT-2013.

Results: Two hundred seven participants were included in the present study. According to the MIS assessment classification, normal to mild, moderate, and severe malnutrition were diagnosed in 59.9%, 34.8%, and 5.3%, respectively. The correlation between NAF and NT-2013 when compared with MIS were r=0.619 and r=0.689 (p<0.001), respectively. The sensitivity, specificity, and area under receiver operating characteristic (ROC) curve of assessment score to diagnose moderate to severe malnutrition were 47.6, 75.9, and 0.698 (95% CI 0.628 to 0.768) in NAF score greater than 5, and 100, 3.6, and 0.707 (95% CI 0.637 to 0.777) in NT-2013 score greater than 7, respectively.

Conclusion: Among patients with CKD stages 3 to 5, the nutritional assessment tool NAF and NT-2013 correlated well with MIS. It seemed that NAF score is an alternative nutritional assessment tool with moderate sensitivity and specificity test, and NT-2013 score is suitable for a screening nutritional assessments tool to identify malnutrition with high sensitivity but very low specificity in a CKD population.

Keywords: Nutritional assessment form (NAF); Nutritional Triage 2013 (NT-2013); Malnutrition inflammation score (MIS); Chronic kidney disease

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Uremia-induced increased energy expenditure, inflammation, acidosis, and multiple endocrine disorders lead to excess catabolism of muscle and fat and contributes to protein-energy wasting (PEW) syndrome. The International Society of Renal Nutrition and Metabolism (ISRNM) defined PEW syndrome as the state of decreased body stores of protein and energy fuels associated with high morbidity and mortality[1]. The prevalence of PEW among maintenance hemodialysis patients varies between 30% and 75%[2,3]. According to the meta-analysis, prevalence of PEW in non-dialysis chronic kidney disease (CKD) by subjective global assessment or malnutrition-inflammation score reported ranged between 11% and 54%[4,5]. Additionally, Pisetkul et al reported that prevalence of PEW was 45% among maintenance hemodialysis patients of Thailand[6]. Early recognition of PEW is important to improve patients' outcomes, quality of life, and hospitalized duration[7].

The practice guidelines and criteria to evaluate the nutritional status among patients with CKD recommend the coordinated use of biochemical measures, body mass, muscle mass, dietary intake, and an integrative nutritional scoring[8,9]. The ISRNM also suggested using scoring systems such as the semi-quantitative "Subjective Global Assessment of Nutrition" (SGA) or its fully quantitative and CKD-tailored refinements such as the "Malnutrition-

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Table 1. Nutritional assessment components

	MIS	NAF	NT-2103
Categories	10	8	8
History	• Body weight change • Poor dietary intake • Gastrointestinal symptom • Activity daily life • Dialysis duration	• Body weight change • Poor dietary intake • Gastrointestinal symptom • Food assessment	• Body weight change • Poor dietary intake
Physical examination	• Body mass index • Fat mass • Muscle mass	• Body mass index	• Fluid accumulation • Fat mass • Muscle mass • Muscle strength
Co-morbidity	• CHF III, IV • Severe COPD • AIDS	• Underlying diseases • DM, CKD-ESRD, septicemia, cancer, CHF, COPD, hip fracture, head injury, burn, cirrhosis	• Acute illness • Underlying diseases • Cancer, CHF, COPD, CKD, cirrhosis, bed sore, chronic wound, ascites
Blood chemistry	• Serum albumin • TIBC	• No lab • Serum albumin, total lymphocyte count - is optional	• No lab
Score for diagnosis malnutrition	≥3	≥6	≥8

AIDS=acquired immunodeficiency syndrome; CKD=chronic kidney disease; CHF=congestive heart failure; COPD=Chronic obstructive pulmonary disease; DM=diabetes mellitus; ESRD=end stage renal disease; TIBC=total iron binding capacity

Inflammation Score" (MIS)[9]. Malnutrition-inflammation complex syndrome among maintenance hemodialysis patients is related to anorexia and exhibits good reliability and validity to diagnose PEW in a hemodialysis population[10]. However, MIS score is a complex tool and not designed to be used as a screening tool. Therefore, it might not be practical for screening malnutrition among patients with advanced CKD. Different nutrition screening and assessment scoring tools have been proposed to aid in identifying PEW syndrome[11,12]. The Nutrition Alert Form (NAF) and the Nutritional Triage (NT-2013) have been approved as standard and simple nutrition assessment tools for hospitalized patients[13]. Both tools are currently used to screen malnutrition in surgical and internal patients, but only limited data in CKD population were studied. Therefore, the authors aimed to study the validity of NAF and NT-2013 as compared with MIS among patients with CKD stages 3 to 5.

Materials and Methods

The present study was a cross-sectional study to evaluate the validity of NAF and NT-2013 compared with MIS to diagnose malnutrition among patients with CKD at Phramongkutklao Hospital between April 2019 and January 2020. Written informed consents were provided by all patients. The present study was conducted in accordance with the Good Clinical Practice Guidelines and the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board, Royal Thai Army Medical Department (R036h/62_Exp).

Study population

Patients aged 18 years or older diagnosed of CKD stages 3 to 5 without dialysis were eligible for the present study. Patients were excluded if they had dialysis, transplantation, malignancy, cirrhosis, active infection, or cardiovascular diseases. The medical records of each patient were thoroughly reviewed. Any data pertaining to underlying diseases, cardiovascular illness, or other comorbid conditions were extracted. Patients were included in the study for all investigated nutrition-related tests. The following information were necessary, SGA-score, gender, body mass index (BMI), body weight, medical history with underlying diseases, serum albumin, serum creatinine, and total iron-binding capacity.

Evaluation tools for malnutrition

MIS, NAF, and NT-2013 nutritional assessment tools were performed (Table 1) in all subjects by nephrologists at nephrology OPD, Phramongkutklao Hospital between April 2019 and January 2020. MIS score greater than 4, NAF score greater than 5, and NT-2013 score greater than 7 were used as indicators for malnutrition according to the hospital

reimbursement criteria in Thailand.

The MIS consisted of the nutritional history, physical examination, BMI, and laboratory values with a fully quantitative and comprehensive scoring system[14]. Each MIS component had four levels of severity from 0 as normal to 3 as very severe. The sum of the ten MIS components resulted in an overall score between 0 as well-nourished and 30 as severely malnourished and were from issues of 1) change in body weight, 2) dietary intake, 3) gastrointestinal symptoms, 4) functional capacity, 5) comorbidity, 6) decreased fat stores or loss of subcutaneous fat, 7) signs of muscle wasting, 8) BMI, 9) serum albumin, and 10) serum total iron-binding capacity[15]. The overall score of 1 to 2 points indicated normal or mild malnutrition, 3 to 5 points indicated moderate malnutrition, and 6 or more points indicated severe malnutrition.

The NAF involved body weight change, poor dietary intake, gastrointestinal symptom, food assessment, BMI, underlying diseases, blood chemistry including serum albumin, and total lymphocyte count. Each component had three levels of severity from 0 as normal to 2 as severely abnormal, but underlying diseases had two levels of severity with 3 for moderate and 6 for severe. The sum of all components equating 0 to 5 points indicated normal or mild malnutrition, 6 to 10 points indicated moderate malnutrition, and more than 10 points indicated severe malnutrition.

The NT-2013 involved body weight change, poor dietary intake, fluid accumulation, fat mass, muscle mass, muscle strength, acute illness, and underlying diseases. Each component had four levels of severity from 0 as normal to 3 as severely abnormal. The sum of all components equating 0 to 4 points indicated normal or no risk malnutrition, 5 to 7 points indicated mild malnutrition, 8 to 10 points indicated moderate malnutrition, and more than 10 points indicated severe malnutrition.

Statistical analysis

Continuous variables were presented as mean ± standard deviation (SD). Categorical variables were presented as frequency, percentage, or ratio. Pearson's correlation coefficient was calculated to determine correlations between nutrition-related tests and MIS score. A sensitivity analysis and area under receiver operating characteristic (ROC) curve for diagnosing moderate and severe PEW by MIS were performed using IBM SPSS Statistics, version 21.0 (IBM Corp., Armonk, NY, USA).

Table 2. Patient demographic data

Characteristics (n=207)	Mean±SD
Sex; n (%)	
Male	86 (41.5)
Female	121 (58.5)
Age (years)	70.9±12.6
Body weight (kg)	65.7±13.7
Body mass index (kg/m^2)	24.0±4.3
Serum creatinine (mg/dL)	2.1±1.3
Glomerular filtration rate (mL/minute/1.73m^2)	35.2±15.0
Serum albumin (g/dL)	3.9±0.6
Serum TIBC (ug/dL); median (P25 to P75)	296.7 (191 to 402.5)
Co-morbidities; n (%)	
Hypertension	165 (79.7)
Diabetes mellitus	105 (50.7)
Dyslipidemia	106 (51.2)
Ischemic heart disease	15 (7.2)
Chronic obstructive pulmonary disease	15 (7.2)

TIBC=total iron binding capacity; SD=standard deviation

Results

Two hundred seven patients with CKD stages 3 to 5 without dialysis were included in the present study. The majority was female (58.5%) and presented with hypertension (79.7%). The mean age was 70.9±12.6 years and estimated glomerular filtration rate was 35.2±15.0 mL/minute/1.73m², while BMI was 24.0±4.3 kg/m². All patient characteristics are shown in Table 2.

Based on MIS assessment classification in 207 non-dialysis CKD patients, the prevalence of normal to mild, moderate, and severe malnutrition were diagnosed in 59.9%, 34.8%, and 5.3%, respectively. For NAF assessment classification, prevalence of normal to mild, moderate, and severe malnutrition were diagnosed in 38.2%, 58%, and 3.8%, respectively. For NT-2013 assessment classification, prevalence of normal to mild, moderate, and severe malnutrition were diagnosed in 98.5%, 1%, and 0.5%, respectively (Figure 1).

The correlation coefficients between the NAF, NT-2013, and MIS score are summarized in Figure 2. These results showed a significant correlation between NAF and MIS scores with correlation coefficients at 0.619 ($p<0.001$). NT-2013 also correlated with MIS score ($r=0.689$, $p<0.001$). As the number of patients with severe PEW was low in the present study, the authors only determined the sensitivity, specificity, area under ROC curve, and agreement of NAF

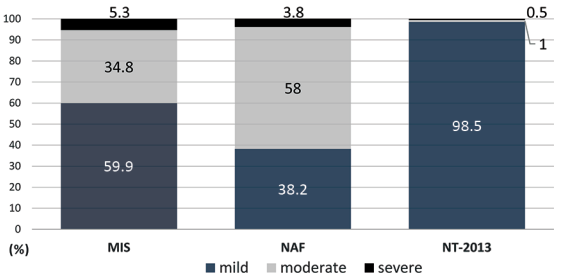

Figure 1. Prevalence of malnutrition by MIS, NAF and NT-2013 nutritional assessment tools.

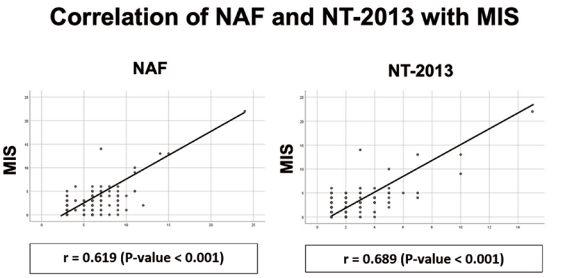

Figure 2. Correlation of NAF and NT-2013 compared with MIS by Pearson correlation.

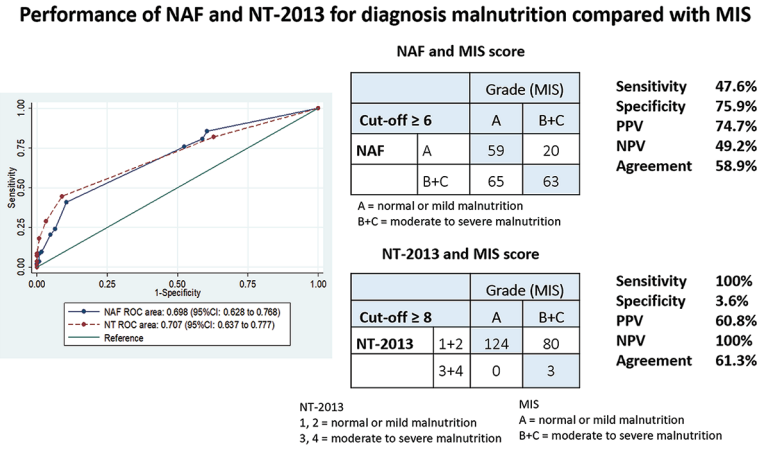

Figure 3. The sensitivity, specificity and area under ROC curve of assessment score to diagnose moderate to severe malnutrition among subjects with CKD.

and NT-2013 compared with MIS for total patients with CKD. The sensitivity, specificity, and area under ROC curve of assessment score to diagnose moderate to severe malnutrition among subjects with CKD is shown in Figure 3. Compared with MIS, the sensitivity, specificity, and area under ROC curve of NAF were 47.6, 75.9, and 0.698 (95% CI 0.628 to 0.768), respectively. Those of NT-2013 were 100, 3.6, and 0.707 (95% CI 0.637 to 0.777), compared with MIS, respectively. The Cohen's kappa coefficients were determined to be 0.589 for NAF and 0.613 for NT-2013, indicating a moderate agreement between the NAF and NT-2013 with MIS scores.

Discussion

The gold standard to determine PEW remains debatable. Early detection of PEW from a nutrition-related scoring system can help to maintain and improve clinical outcomes in CKD population[16]. MIS has been proposed as a tool with an adequate reliability and validity to assess malnutrition and inflammation, which is common for an increase in morbidity and mortality in dialysis and among patients with CKD. MIS was a superior to the conventional SGA for predicting clinical outcomes and quality of life among patients undergoing dialysis[6,17]. Few studies compared various nutrition-related tests in general population with MIS among patients with CKD. The present study was the first to validate the Thai nutritional assessment tools, which are the NAF and the NT-2013, correlation with MIS score. Both the NAF and the NT-2013 showed moderate performance for diagnosing moderate to severe PEW among subjects with CKD when compared with MIS scores. Both scoring tools were found to be clinically confident to rule out patients who did not present with PEW syndrome.

In the present study, patients with CKD were categorized in three groups based on MIS, NAF, and NT-2013 classification. Based on MIS and NAF tools, 40.1% and 61.8% of patients with CKD had moderate to severe PEW, but NT-2013 had only 1.5%.

Therefore, it showed that NAF determined moderate and severe PEW similarly to MIS. The NAF score is a diagnostic tool and is verified as a simple and early diagnostic tool for screening malnutrition among hospitalized patients[18]. Some clinicians prefer NAF to screen malnutrition for being easy and concise to use and not requiring nutrition expertise. However, based on the present study findings, the NAF score was the only diagnostic tool that could provide diagnostic benefits in ruling out among patients with CKD with moderate and severe PEW at a specificity of 75.9%, but with a low sensitivity test of 47.6%. Clinicians are reminded that some patients with CKD with moderate or severe PEW may be missed when the NAF is used as the only diagnostic tool for PEW syndrome identification due to its lower sensitivity than the MIS scores. In contrast to NT-2013, it could provide diagnostic benefits in ruling out patients without moderate and severe PEW syndrome at a sensitivity of 100%. It may falsely capture those not at risk for PEW with a very low specificity of 3.6%.

The practice guidelines and criteria to evaluate the nutritional status among patients with CKD or ESRD, recommend the coordinate use of several modalities such as biochemical measures, body mass, muscle mass, dietary intake, and an integrative nutritional scoring[8,9]. MIS assessment evaluated both patient profiles and biochemical measurement to diagnose malnutrition status, while NAF and NT-2013 assessed only history taking and physical examination. For NAF, biochemical measurement such as serum albumin and absolute neutrophils count is an option and does not affect the scoring. This might explain the effect on the low validity of NAF and NT-2013 when compared with MIS. Similar to related studies, diagnosis of PEW with MIS and biochemical measurement had high validity and predicted mortality among patients with pre-dialysis CKD[1,19].

The advantage of the present study was the first to evaluate the prevalence of patients with CKD patients and malnutrition and validity of NAF and NT-2013 compared with the conventional MIS tool to diagnose PEW among patients with CKD. The presents study encountered several limitations that should be considered in interpreting the findings. First, the present study was limited to a cross-sectional and observational design. The study team did not have the opportunity to assess and interview the patients in-person, so they potentially had unmeasured and residual confounding variables during the study. Second, the results of NAF, NT-2013, and MIS scores were dichotomized as either ''moderate or severe malnutrition'' or ''normal or mild malnutrition'' for the analyses. As patients may be at different stages of PEW based on the ratings of the scoring tools, such cutoffs may have affected the study's results. Therefore, further studies determining the appropriate cutoff points for the scoring tools may further strengthen the use of these scores in identifying PEW for patients with CKD at stages 3 to 5. Finally, the results of the present study showed that 5.3% of patients were rated as presenting severe malnutrition using the MIS, 3.8% of patients were rated as presenting severe malnutrition using the NAF score, and 0.5% of patients were rated as presenting severe malnutrition using the NT-2013 score. Such low numbers of patients in those ratings may have affected the overall representations for patients with CKD. A study focusing on severely malnourished patients with CKD may improve the strength of the current study.

Conclusion

Among the patients with CKD stages 3 to 5, the nutritional assessment tool NAF and NF-2013 moderately correlated with MIS score. The present study demonstrated that differences were observed in using the NAF and NT-2013 score to identify PEW among patients with CKD. The NAF score could be used to identify PEW with a sensitivity of 75.9% and a specificity of 47.6% compared with the MIS. The NT-2013 score is a screening scoring tool to identify PEW, and exhibited very high sensitivity at 100%, but very low specificity at 3.6% when compared with the MIS. Further research to determine the best cut-off points of the NAF and NT-2013 would be needed.

What is already known on this topic?

MIS has been proposed as a tool presenting adequate reliability and validity to assess measurement to diagnose malnutrition status, while NAF and NT-2013 assessed only history taking and physical examination that have been approved as standard and simple nutrition assessment tools for hospitalized patients, which affects the hospital reimbursement in Thailand.

Both tools are currently used to screen malnutrition in all surgical and medical patients, but limited data in a CKD.

What is this study adds?

In this study, among patients with CKD stages 3 to 5, the nutritional assessment tool NAF and NT-

2013 were moderately correlated with MIS score to diagnose moderate to severe malnutrition.

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Conflicts of interest

The authors declare they have no conflict of interest in this study.

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