Combination of Controlling Nutritional Status Score and Systemic Immune-Inflammation Index as Predictors of Repeated Hospitalization in Chronic Kidney Failure Patients Undergoing Routine Hemodialysis

[1*]Lia Sasmithae, [2]Ni Nyoman Sri Yuliani, [3]Herlina Eka Shinta, [4]Didin Retno Indah Palupi
[1,2,3,4,5]Departemen Klinik, Fakultas Kedokteran, Universitas Palangka Raya, Indonesia
* Corresponding author:
Email: lia@med.upr.ac.id

Abstract
Repeated hospitalization is a major clinical problem among patients with chronic kidney disease (CKD) undergoing routine hemodialysis. Malnutrition and chronic systemic inflammation play important roles in the pathogenesis of complications in this population. This study aimed to analyze the association between the Controlling Nutritional Status (CONUT) score and the Systemic Immune-Inflammation Index (SII) with repeated hospitalization among patients with CKD undergoing routine hemodialysis. This analytical observational study employed a cross-sectional approach involving 121 patients with stage 5 CKD undergoing routine hemodialysis at dr. Doris Sylvanus Regional General Hospital, Palangka Raya, from January 2024 to July 2025. The CONUT score was calculated based on serum albumin, lymphocyte count, and total cholesterol levels. The SII was calculated using the formula (platelet count × neutrophil count)/lymphocyte count. Data were analyzed using Spearman's correlation test and multivariate logistic regression. The results showed a significant association between the CONUT score and repeated hospitalization (R = 0.462; p = 0.000), as well as between the SII and repeated hospitalization (R = 0.389; p = 0.000). Multivariate analysis showed that the CONUT score (OR = 1.619; 95% CI: 1.287–2.036; p = 0.000) and SII (OR = 1.097; 95% CI: 1.041–1.156; p = 0.001) were independent predictors. The model demonstrated good predictive performance with an AUC of 0.842 and a Hosmer–Lemeshow test result of p = 0.624. These findings indicate that the CONUT score and SII are significant independent predictors of repeated hospitalization among patients with CKD undergoing routine hemodialysis. The combination of these two indices has the potential to serve as a practical risk-screening tool in clinical practice.
Keywords*: CONUT score, repeated hospitalization and chronic kidney disease.*

1. INTRODUCTION

Chronic kidney disease (CKD) has become a global public health problem with increasing prevalence. According to the 2017 Global Burden of Disease Study, the global prevalence of CKD reached 9.1%, with a 29.3% increase in prevalence across all ages since 1990 (GBD Chronic Kidney Disease Collaboration, 2020). In Indonesia, analysis of 2018 Basic Health Research (Riskesdas) data showed a CKD prevalence of 0.5% in the population aged 18 years and older, with hypertension as the main comorbidity (40.8%), and diabetes mellitus and heart disease as significant risk factors (Hustrini et al., 2022). The prevalence in Central Kalimantan Province was recorded at 0.31% in the population aged 15 years and older, a figure below the national average (Ministry of Health of the Republic of Indonesia, 2019). Despite this, the burden of hemodialysis services in this province continues to increase; data from Dr. Doris Sylvanus Palangka Raya Hospital showed an increase in the number of outpatients with chronic kidney failure from 905 in 2019 to 1,045 in 2020, with 160 patients undergoing routine hemodialysis in 2024 (Dr. Doris Sylvanus Palangka Raya Hospital, 2021; Central Kalimantan Provincial Health Office, 2024).

Patients with advanced CKD require renal replacement therapy, and hemodialysis is the most prevalent modality, accounting for nearly 90% of all dialysis treatments worldwide (Webster et al., 2022). Although hemodialysis can prolong life expectancy, complications and morbidity remain significant challenges. Hemodialysis patients have a high rate of recurrent hospitalizations, which not only increases morbidity and mortality but also imposes a significant healthcare cost burden and reduces quality of life (Hsu & Wong, 2020). Malnutrition and inflammation are two important factors influencing clinical outcomes in this population. Protein-energy malnutrition and inflammation often coexist in hemodialysis patients and have been termed malnutrition-inflammation complex syndrome

(MICS) (Stenvinkel et al., 2000; Kalantar-Zadeh et al., 2003). The concept of MICS, first introduced by Stenvinkel et al. (2000), demonstrates the close, mutually reinforcing relationship between malnutrition, inflammation, and atherosclerosis. This condition is believed to be a major cause of erythropoietin hyporesponsiveness, atherosclerotic cardiovascular disease, and increased hospitalization and mortality in dialysis patients (Kalantar-Zadeh et al., 2003). In hemodialysis patients, inflammation can be caused by various factors, including exposure to the dialysis membrane, poor dialysis water quality, and foreign bodies in the dialysis access (Stenvinkel et al., 2000).

Challenges related to nutritional status and inflammation are also evident in Central Kalimantan. Research at Dr. Doris Sylvanus Regional General Hospital (RSUD) found significant differences in protein intake in patients before and after hemodialysis, indicating catabolic issues and nutrient loss during therapy (Maghfira et al., 2023). A study at Muara Teweh Regional General Hospital, North Barito Regency, also showed that complaints such as nausea (46.3%) and muscle/bone pain (36.6%) are common clinical features that can interfere with food intake and contribute to the risk of malnutrition (Putri et al., 2024). In fact, kidney failure cases in Central Kalimantan are no longer predominantly elderly; data from Dr. Doris Sylvanus Regional General Hospital recorded 219 patients aged 18–50 years out of a total of 447 inpatients, with several cases found in patients in their 20s who had undergone hemodialysis (RSUD Dr. Doris Sylvanus Palangka Raya, 2021). This phenomenon indicates that the burden of CKD as well as nutritional and inflammatory issues are relevant health problems and require serious attention in this region.

The CONUT (Controlling Nutritional Status) score is a simple, objective, and non-invasive nutritional screening tool first introduced by de Ulibarri et al. (2005). This score is designed to assess a patient's nutritional status using three commonly tested laboratory parameters: serum albumin level, total lymphocyte count, and total cholesterol level (de Ulibarri et al., 2005). Initial validation in a hospital population showed that CONUT had a sensitivity of 92.3% and a specificity of 85.0% compared with a complete nutritional assessment, with good concordance (kappa 0.669; p=0.003) (de Ulibarri et al., 2005). The SII (Systemic Immune-Inflammation Index) is an index of systemic inflammation calculated from a routine complete blood count using the formula (platelet count × neutrophil count) / lymphocyte count (Hu et al., 2014). This index integrates the pro-inflammatory activity of neutrophils and platelets with the regulatory potential of lymphocytes and has been shown to be a powerful predictor of prognosis in various diseases (Hu et al., 2014). In CKD patients, chronic inflammation due to uremia, dialyzer bioincompatibility, and oxidative stress increases the risk of infection, cardiovascular disorders, and endothelial dysfunction (Stenvinkel et al., 2000). Although the CONUT score and SII have been studied individually as predictors of outcome in CKD patients, studies specifically examining the simultaneous association of both indices with recurrent hospitalizations in hemodialysis patients are still limited. This study aimed to analyze the association of the CONUT score and SII with recurrent hospitalizations in CKD patients undergoing routine hemodialysis at Dr. Doris Sylvanus Regional Hospital, Palangka Raya, and to evaluate the potential of combining both indices as a practical and applicable clinical risk stratification tool in local healthcare facilities.

II. METHOD

This study used an analytical observational design with a cross-sectional approach (Setia, 2016). The study was conducted at Dr. Doris Sylvanus Regional General Hospital, Palangka Raya, from January 2024 to July 2025. The target population was all chronic kidney failure (CKF) patients undergoing routine hemodialysis at the hospital. The study sample consisted of patients who met the inclusion and exclusion criteria. The minimum sample size was calculated using the two-proportion ratio formula for hypothesis testing (Hajian-Tilaki, 2011), taking into account the proportion of recurrent hospitalizations in patients with malnutrition (55%) and without malnutrition (30%) based on previous research, a 95% confidence level, and a test power of 80%, resulting in a minimum sample size of 121 patients.

The inclusion criteria in this study were: (1) CKD patients undergoing routine hemodialysis for at least 3 months, (2) aged ≥18 years, and(3) have complete laboratory data including albumin, lymphocytes, total cholesterol, platelets, and neutrophils. Exclusion criteria included: (1) experiencing severe infection characterized by fever ≥38°C and an increase in leukocytes >15,000/µL, (2) having an active malignant disease undergoing chemotherapy or radiotherapy, and (3) having an autoimmune disease requiring immunosuppressant therapy. The independent variables in this study were the CONUT (Controlling Nutritional Status) score and SII (Systemic Immune-Inflammation Index). The dependent variable was recurrent hospitalization, which was defined as more than one hospitalization in a one-year period (Hsu & Wong, 2020). Covariate variables included age, gender, duration of hemodialysis (months), and comorbidities (diabetes mellitus, hypertension, and heart disease).

The CONUT score is calculated based on three laboratory parameters according to the method developed by de Ulibarri et al. (2005): serum albumin level (g/dL): >3.5 (scorer 0); 3.0–3.49 (score 2); 2.5–2.99 (score 4); and <2.5 (score 6); total lymphocyte count ($\times 10^9$/L): ≥1.6 (score 0); 1.2–1.59 (score 1); 0.8–1.19 (score 2); and <0.8 (score 3); and total cholesterol level (mg/dL): ≥180 (score 0); 140–179 (score 1); 100–139 (score 2); and <100 (score 3). The total score ranges from 0 to 12, which is then categorized into normal (0–1), mild malnutrition (2–4), moderate malnutrition (5–8), and severe malnutrition (9–12) (de Ulibarri et al., 2005). SII is calculated using the formula (platelet count × neutrophil count) / lymphocyte count, as first introduced by Hu et al. (2014).

The research data were collected retrospectively from patient medical records. All laboratory data used were the results of routine examinations immediately preceding the observation period. Data analysis was conducted in stages. First, descriptive analysis was used to present the characteristics of the study subjects; numeric data with a normal distribution were presented as means and standard deviations (mean ± SD), while data with a non-normal distribution were presented as medians and interquartile ranges (IQR), and categorical data were presented as frequencies and percentages (n, %). Second, the Shapiro-Wilk normality test was performed to determine the distribution of the data (Ghasemi & Zahediasl, 2012). Third, bivariate analysis used the Spearman correlation test to assess the relationship between variables because the data were not normally distributed (Schober et al., 2018). Fourth, multivariate analysis using binary logistic regression was conducted to identify independent predictors of recurrent hospitalizations, by including variables with a p-value <0.25 in the bivariate analysis (Bursac et al., 2008). The Hosmer-Lemeshow goodness of fit test was used to assess model suitability, with a p value >0.05 indicating a good model (Hosmer et al., 2013). The ROC (Receiver Operating Characteristic) curve was used to assess the model's discriminatory ability, as measured by the AUC (Area Under the Curve) value; an AUC value of 0.7–0.8 is considered acceptable, 0.8–0.9 is considered very good, and >0.9 is considered excellent (Hosmer et al., 2013). All statistical analyses were performed using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA) with a significance level set at p <0.05. This study has received approval from the Research Ethics Committee of the Faculty of Medicine, Palangka Raya University (Number: 001/KE/FK-UPR/2024).

III. ANALYSIS RESULTS

Characteristics of Research Subjects

The study involved 121 patients with stage 5 CKD undergoing regular hemodialysis. Subject characteristics are presented in Table 1.

Table 1. Characteristics of Research Subjects

Variables	Results

Variables	Results
Age (years)	52.34 ± 12.18
Male gender	68 (56.2%)
Woman	53 (43.8%)
Duration of Hemodialysis (months)	24 (12–48)
CONUT Score	4 (2–6)
Normal (0–1)	18 (14.9%)
Mild malnutrition (2–4)	46 (38.0%)
Moderate malnutrition (5–8)	42 (34.7%)
Severe malnutrition (9–12)	15 (12.4%)
SII	865 (542–1,420)
Repeat Hospitalizations (episodes/year)	1 (0–2)
Comorbidities: Diabetes Mellitus	49 (40.5%)
Hypertension	87 (71.9%)
Heart disease	36 (29.8%)

Note: Normal numerical data are presented as mean ± SD; abnormal data as median (IQR); categorical data as n (%). The mean age of patients was 52.34 ± 12.18 years. Most were male (56.2%). Median CONUT score was 4 (IQR 2–6), with the majority being mild (38.0%) and moderate (34.7%) malnourished. Median SII was 865 (IQR 542–1,420). Median recurrent hospitalization was 1 episode (IQR 0–2). The most common comorbidity was hypertension (71.9%).

Bivariate Analysis

The results of the Shapiro-Wilk normality test showed that the CONUT score (p=0.001), SII (p=0.000), and repeated hospitalization (p=0.000) variables were not normally distributed, so the correlation analysis used the Spearman test (Table 2).

Table 2. Correlation Analysis of CONUT Score, SII, and Repeat Hospitalizations

Variable 1	**Variable 2**	**R**	**p-value**
CONUT Score	Repeated Hospitalization	0.462	0,000
SII	Repeated Hospitalization	0.389	0,000
CONUT Score	SII	0.418	0,000

There was a significant relationship between CONUT score and recurrent hospitalization (R=0.462; p=0.000) and between SII and recurrent hospitalization (R=0.389; p=0.000). A positive correlation shows that the higher the CONUT score or SII, the higher the frequency of recurrent hospitalization. There is a significant relationship between CONUT score and SII (R=0.418; p=0.000), supporting the MICS concept.

Multivariate Analysis

Table 3. Multivariate Logistic Regression Analysis of Hospitalization >1 Time

Variables	β	OR	95% CI	p-value
CONUT score	0.482	1,619	1,287–2,036	0,000
SII (per 100 units)	0.093	1,097	1,041–1,156	0.001
Age	0.021	1,021	0.989–1.054	0.201
Duration of hemodialysis	0.015	1,015	1,002–1,028	0.024

Table 4. Goodness of Fit Model

Parameter	**Mark**
Hosmer-Lemeshow test	p = 0.624
Nagelkerke R^2	0.412
AUC	0.842

Multivariate analysis showed that CONUT score and SII were independent predictors of recurrent hospitalization. Each one-point increase in CONUT score increased the risk of recurrent hospitalization by 61.9% (OR=1.619; 95% CI 1.287–2.036; p<0.001). Meanwhile, each 100-unit increase in SII increased the risk of recurrent hospitalization by 9.7% (OR=1.097; 95% CI 1.041–1.156; p=0.001).

Discussion

This study shows that CONUT (Controlling Nutritional Status) score and SII (Systemic Immune-Inflammation Index) have a significant relationship with the incidence of recurrent hospitalizations in chronic kidney disease patients undergoing regular hemodialysis. Both parameters remained independent predictors after multivariate analysis. These findings strengthen the concept that nutritional disorders and systemic inflammation are two important interrelated aspects in determining the clinical condition of hemodialysis patients, as explained in the malnutrition-inflammation complex syndrome (MICS) framework proposed by Stenvinkel et al. (2000) and Kalantar-Zadeh et al. (2003).

The characteristics of the study subjects showed that most patients were in the adult to elderly age group (mean 52.34 ± 12.18 years) with hypertension as the most common comorbidity (71.9%). This condition is consistent with the epidemiological picture of CKD, where hypertension and diabetes mellitus are the main risk factors contributing to the progression of kidney disease (Hustrini et al., 2022; GBD Chronic Kidney Disease Collaboration, 2020). The aging process, the accumulation of comorbidities, and exposure to chronic inflammation during the disease course can lead to a decrease in the patient's physiological reserve and increase susceptibility to complications requiring hospitalization (Stenvinkel et al., 2000).

The results of this study showed a positive association between the CONUT score and recurrent hospitalization ($R = 0.462$; $p < 0.001$). Multivariate analysis also showed that each one-point increase in the CONUT score was associated with a 61.9% increased risk of recurrent hospitalization (OR = 1.619; 95% CI 1.287–2.036; $p < 0.001$). These findings suggest that poorer nutritional status is associated with an increased likelihood of clinical deterioration in hemodialysis patients. The CONUT score is a nutritional index that integrates albumin levels, lymphocyte counts, and total cholesterol levels (de Ulibarri et al., 2005). In hemodialysis patients, decreased nutritional status can occur due to various mechanisms, including chronic inflammation, metabolic disorders due to uremia, decreased appetite, dietary restrictions, and nutrient loss during dialysis (Kalantar-Zadeh et al., 2003). Low albumin not only reflects nutritional disorders, but can also be an indicator of the presence of a systemic inflammatory process, because chronic inflammation causes an increase in proinflammatory cytokines that contribute to increased protein catabolism and decreased albumin synthesis (Stenvinkel et al., 2000).

The results of this study are in line with previous findings showing that the CONUT score has prognostic value in hemodialysis patients. Cabezas-Rodríguez et al. (2022) in a cohort study of 354 hemodialysis patients reported that a high CONUT score (≥5) was associated with an increased risk of mortality (HR = 2.47; 95% CI 1.38–4.42; $p = 0.002$). Similarly, a study by Yılmaz Aydın et al. (2022) in 98 hemodialysis patients found that the CONUT score had a significant correlation with the duration of hospitalization ($r = 0.321$; $p = 0.003$) and the incidence of rehospitalization within 30 days (OR = 1.93; 95% CI 1.12–3.32; $p = 0.017$). The findings of this study extend this evidence by showing that CONUT score is also associated with the incidence of recurrent hospitalizations within a one-year period in the hemodialysis population in Indonesia, particularly in Central Kalimantan.

In addition to nutritional status, this study found that SII was an independent predictor of recurrent hospitalization (OR = 1.097 per 100 units; 95% CI 1.041–1.156; $p = 0.001$). SII reflects the balance between inflammatory components (neutrophils and platelets) and the adaptive immune response represented by lymphocytes (Hu et al., 2014). An increased SII value reflects the dominance of systemic inflammatory activity that can contribute to complications in CKD patients. In hemodialysis patients, chronic inflammation is a complex process influenced by uremia, oxidative stress, immune system activation, and repeated exposure to the dialysis membrane (Stenvinkel et al., 2000). This condition can increase the risk of infection, cardiovascular disorders, and endothelial dysfunction, which are common causes of hospitalization in dialysis patients (Kalantar-Zadeh et al., 2003). Therefore, an increased SII may reflect a more active inflammatory condition and is associated with a risk of worse clinical outcomes.

The findings regarding the association of SII with clinical outcomes are also consistent with previous studies. In a large population-based cohort study involving 10,976 participants, Qin et al. (2022) reported that increased SII was associated with an increased risk of chronic kidney disease (OR = 1.29; 95% CI 1.05–1.58; $p = 0.014$) after adjusting for various confounding factors. A study by Liu et al. (2023) in 1,248 hemodialysis patients also found that high SII (highest quartile) was associated with an increased risk of cardiovascular mortality (HR = 1.82; 95% CI 1.21–2.74; $p = 0.004$) and all-cause mortality (HR = 1.58; 95% CI 1.13–2.21; $p = 0.007$). Although most previous studies have focused on mortality, the results of this study indicate that SII also has relevance in predicting recurrent hospitalizations, which is an important and often overlooked clinical outcome.

This study also found a positive correlation between CONUT score and SII ($R = 0.418$; $p < 0.001$). This relationship supports the concept of malnutrition-inflammation complex syndrome (MICS), a condition where malnutrition and chronic inflammation mutually reinforce each other (Kalantar-Zadeh et al., 2003; Stenvinkel et al., 2000). Inflammation increases protein catabolism and worsens nutritional status, while malnutrition leads to impaired immune function, increasing susceptibility to infection and complications (Stenvinkel et al., 2000). The interaction of these two mechanisms may explain why patients with higher levels of nutritional disorders and inflammation have a greater risk of recurrent hospitalization. This finding is consistent with a study by Kato et al. (2021) which reported that the combination of low albumin and elevated inflammatory markers (hs-CRP) synergistically increases the risk of hospitalization in hemodialysis patients.

This study simultaneously evaluated two key pathophysiological aspects of hemodialysis patients: nutritional status and inflammation. The combination of the CONUT score and the SII provides a more comprehensive picture than using either parameter alone, as both indexes complement each other in holistically reflecting the patient's clinical condition. Furthermore, both indexes are derived from routine laboratory tests (albumin, lymphocytes, total cholesterol, platelets, and neutrophils), making them relatively easy to implement in clinical practice without requiring complex additional tests or significant additional costs (de Ulibarri et al., 2005; Hu et al., 2014). This makes the combination of CONUT and SII a practical and applicable risk stratification tool, especially in healthcare facilities with limited resources, such as those in Central Kalimantan.

The prediction model in this study had good discriminatory ability with an AUC value of 0.842 (95% CI 0.773–0.912), which is included in the very good category based on the criteria of Hosmer et al. (2013). The Nagelkerke R^2 value of 0.412 indicates that the model is able to explain 41.2% of the variability in the incidence of recurrent hospitalizations, with the results of the Hosmer-Lemeshow test indicating good model fit ($p = 0.624$). This good discriminatory ability indicates that the combination of the CONUT score and SII has promising clinical potential for identifying hemodialysis patients at high risk of recurrent hospitalization. However, these results still require further validation through prospective studies with a larger sample size and involving several health care centers to ensure the generalizability of the model (Hosmer et al., 2013).

Limitations Study

This study has several limitations that need to be considered in interpreting the results. First, the cross-sectional design used makes it impossible to establish the temporal and causal relationships between the CONUT score, SII, and recurrent hospitalizations (Setia, 2016). Second, the use of medical record data has limitations related to data completeness and the possibility of confounding factors that have not been fully identified, such as smoking history, physical activity, and dietary adherence, which were not available in the medical records. Third, this study was conducted only at a single hospital in Central Kalimantan, so the results may not be fully generalizable to hemodialysis populations in other regions in Indonesia with different demographic characteristics and healthcare facilities. Fourth, the use of the CONUT score and SII, which were only measured at a single point in time, cannot capture the dynamics of changes in nutritional status and inflammation during the observation period. Further studies with prospective cohort designs are needed to evaluate changes in the CONUT score and SII over time and assess their impact on the incidence of rehospitalizations (Hosmer et al., 2013).

IV. CONCLUSION

Based on a study of 121 patients with stage 5 chronic kidney failure undergoing regular hemodialysis, it can be concluded that there is a significant relationship between the Controlling Nutritional Status (CONUT) score and the incidence of recurrent hospitalizations. Patients with a higher CONUT score, which reflects a more severe malnutrition status, tend to have a higher frequency of recurrent hospitalizations. The analysis results showed that the CONUT score had a correlation coefficient of 0.462 with a p value of 0.000, and in multivariate analysis it was proven to be an independent predictor with an odds ratio of 1.619 (95% CI 1.287–2.036; $p = 0.000$). This means that every one-point increase in the CONUT score increases the risk of recurrent hospitalization by 61.9%.

In addition, the Systemic Immune-Inflammation Index (SII) was also shown to have a significant association with recurrent hospitalizations. Higher SII values, indicating a predominance of systemic inflammation, were associated with an increased frequency of recurrent hospitalizations. The analysis showed a correlation coefficient of 0.389 with a p value of 0.000. In multivariate analysis, SII was also an independent predictor with an odds ratio of 1.097 (95% CI 1.041–1.156; p = 0.001), meaning that every 100-unit increase in SII increased the risk of recurrent hospitalization by 9.7%.

This study also found a significant relationship between CONUT score and SII with a correlation coefficient of 0.418 and a p value of 0.000.These findings support the concept of malnutrition-inflammation complex syndrome (MICS), where poor nutritional status is closely associated with increased systemic inflammation in patients with chronic kidney disease undergoing hemodialysis. These two conditions exacerbate each other, forming a pathological cycle that increases the risk of complications and recurrent hospitalizations.

Overall, the CONUT score and SII are simple predictive parameters, easily obtained from routine laboratory tests, and applicable in clinical practice to identify hemodialysis patients at high risk of recurrent hospitalization. The combination of these two indices provides better predictive value and has the potential to be used as a risk stratification tool for planning more effective preventive interventions.

AsSuggestions: CONUT score and SII can be considered as part of the routine evaluation of hemodialysis patients for risk stratification. Patients with high CONUT and SII require more intensive nutritional intervention and inflammation management. Further prospective cohort studies are needed to assess causal relationships, multicenter studies with larger sample sizes, and interventional studies to evaluate the effectiveness of CONUT and SII-based management in reducing recurrent hospitalizations.

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