Malnutrition-Inflammation Score and Mortality Risk in Peritoneal Dialysis Patients

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Abstract

Background: Malnutrition is highly prevalent in peritoneal dialysis (PD) patients and is linked to increased morbidity and mortality. This study evaluated the association between the malnutrition-inflammation score (MIS) and mortality in PD patients.

Methods: This single-center, retrospective cohort study included 269 PD patients between January 2010 and December 2022. Patients were categorized by MIS levels: mild (Group A), moderate (Group B), and severe (Group C). Groups B and C received targeted nutritional interventions as part of routine care. Patients were followed until death, therapy transition, transplantation, or February 2025.

Results: Group B demonstrated the lowest mortality rate (17.8 per 100 person-years) and a significant survival advantage in Kaplan-Meier survival estimates and multivariable Cox regression after adjustment for confounders. Following interventions, 64% of Group B showed improvement in the MIS category, whereas 65% of Group C remained unchanged. Conversely, 60% of Group A (which received no intervention) experienced a worsening of the MIS category. Older age and diabetes were independent predictors of higher mortality.

Conclusion: Patients with moderate MIS achieved better survival than those with mild or severe MIS, likely driven by targeted interventions. The dynamic shifts across MIS categories underscore the critical need for regular, routine nutritional and inflammatory assessments followed by appropriate interventions.

Keywords: protein-energy wasting; PEW; survival; nutrition; nutritional impairment; outcome

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Received: 8 June 2026; Revised: 15 July 2026; Accepted: 26 July 2026
https://doi.org/10.63555/jnst.2026.289321

ความสัมพันธ์ระหว่างคะแนนภาวะทุพโภชนาการและการอักเสบกับความเสี่ยงต่อการเสียชีวิตในผู้ป่วยล้างไตทางช่องท้อง

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บทคัดย่อ

บทนำ: ภาวะทุพโภชนาการเป็นปัญหาที่พบได้บ่อยในผู้ป่วยล้างไตทางช่องท้อง และมีความสัมพันธ์กับอัตราการเจ็บป่วยและการเสียชีวิตที่เพิ่มขึ้น การศึกษานี้จึงมีวัตถุประสงค์เพื่อประเมินความสัมพันธ์ระหว่างคะแนนภาวะทุพโภชนาการและการอักเสบ (Malnutrition-Inflammation Score, MIS) กับอัตราการเสียชีวิตในผู้ป่วยล้างไตทางช่องท้อง

ระเบียบวิธีวิจัย: การศึกษานี้เป็นการศึกษาย้อนหลังในผู้ป่วยล้างไตทางช่องท้องจำนวน 269 ราย ระหว่าง เดือนมกราคม 2553 ถึง ธันวาคม 2565 โดยแบ่งผู้ป่วยเป็น 3 กลุ่มตามระดับคะแนน MIS ได้แก่ อาการน้อย (กลุ่ม A) อาการปานกลาง (กลุ่ม B) และอาการรุนแรง (กลุ่ม C) ซึ่งผู้ป่วยในกลุ่ม B และ C จะได้รับการให้คำแนะนำเพื่อปรับปรุงภาวะโภชนาการตามมาตรฐานการรักษา จากนั้นทำการติดตามผลจนกระทั่งผู้ป่วยเสียชีวิต เปลี่ยนวิธีการบำบัดทดแทนไตเป็นการฟอกเลือดด้วยเครื่องไตเทียม ได้รับการปลูกถ่ายไต หรือเดือนกุมภาพันธ์ 2568

ผลการวิจัย: ผู้ป่วยกลุ่ม B มีอัตราการเสียชีวิตต่ำที่สุด (17.8 รายต่อ 100 คน-ปี) และเมื่อวิเคราะห์ด้วย Kaplan-Meier และแบบพหุตัวแปรด้วย Cox regression พบว่ากลุ่ม B มีอัตราการรอดชีวิตที่ดีกว่าอย่างมีนัยสำคัญ ทั้งนี้หลังจากได้รับการดูแลให้คำแนะนำเพื่อปรับปรุงภาวะโภชนาการตามมาตรฐานการรักษาพบว่า มีจำนวนผู้ป่วยในกลุ่ม B ถึงร้อยละ 64 ที่มีคะแนน MIS ลดลงไปอยู่ในกลุ่ม A ส่วนผู้ป่วยกลุ่ม C ส่วนใหญ่ (ร้อยละ 65) ยังคงมีคะแนน MIS คงเดิมไม่เปลี่ยนแปลง ในขณะที่ผู้ป่วยกลุ่ม A (ซึ่งไม่ได้รับการให้คำแนะนำ) ร้อยละ 60 มีคะแนน MIS เพิ่มขึ้นเปลี่ยนไปเป็นกลุ่ม B หรือ C นอกจากนี้ยังพบว่าอายุที่มากขึ้นและโรคเบาหวานเป็นปัจจัยอิสระที่สัมพันธ์กับอัตราการเสียชีวิตที่เพิ่มขึ้น

สรุป: กลุ่มผู้ป่วยที่มีคะแนน MIS ระดับปานกลางมีอัตราการรอดชีวิตที่ดีกว่ากลุ่มคะแนนระดับน้อยหรือรุนแรง ซึ่งน่าจะเป็นผลมาจากการได้รับคำแนะนำเพื่อปรับปรุงโภชนาการอย่างตรงจุด การเปลี่ยนแปลงของคะแนน MIS เมื่อเวลาผ่านไปนี้สะท้อนให้เห็นถึงความสำคัญของการประเมินภาวะโภชนาการและการอักเสบของผู้ป่วยอย่างสม่ำเสมอ รวมไปถึงการดูแลให้คำแนะนำเพื่อปรับปรุงภาวะโภชนาการอย่างทันท่วงที

คำสำคัญ: ฟอกไต; อัตราการตาย; ขาดอาหาร; ขาดโปรตีนและพลังงาน; โภชนาการบกพร่อง

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Introduction

Malnutrition is a common and clinically significant problem among patients undergoing peritoneal dialysis (PD), contributing to infection, hospitalization, cardiovascular events, and mortality[1,2]. In Thailand, the "PD First Policy" under the Universal Health Coverage scheme, implemented from 2008 to 2022, positioned PD as the first-line kidney replacement modality nationwide and expanded access to dialysis for patients with end-stage kidney disease[3]. Although this policy has since shifted to a shared decision-making model, it significantly improved dialysis accessibility. Ensuring the quality of care remains a priority, particularly in the nutritional management of PD patients[4].

The Malnutrition-Inflammation Score (MIS) is a validated and practical tool that combines clinical, dietary, and biochemical parameters to assess both malnutrition and systemic inflammation in dialysis populations[5]. Despite its usefulness, MIS is not yet routinely implemented across all PD centers in Thailand. In the context of auditing PD care quality in Thailand, particularly as applied by the National Health Security Office (NHSO), serum albumin is a key performance indicator. However, structured tools like the MIS are not consistently included in routine audits or clinical protocols. Incorporating periodic MIS evaluation into this framework could support early identification of at-risk patients, guide individualized care plans, and improve long-term outcomes.

Furthermore, integrating inflammatory biomarkers such as the neutrophil-to-lymphocyte ratio (NLR) and the platelet-to-lymphocyte ratio (PLR) - which are simple and cost-effective - may enhance the predictive value of the MIS in identifying high-risk patients[6]. This study aimed to investigate the association between the MIS and all-cause mortality in PD patients and to explore the impact of individual baseline biochemical factors on the outcome.

Materials and methods

Subjects

We retrospectively reviewed data from patients undergoing PD at HRH Princess Maha Chakri Sirindhorn Medical Center, Nakhon Nayok, Thailand. Eligible participants were identified from the Database of Peritoneal Dialysis in Excel (DPEX) between January 2010 and December 2022. Inclusion criteria were patients aged 18 years or older who had been maintained on PD for at least six months and had documented MIS evaluations.

The MIS comprises 10 components, categorized into four sections: medical history (weight change, dietary intake, gastrointestinal symptoms, and functional capacity); physical examination (loss of subcutaneous fat and muscle wasting); body mass index; and laboratory parameters (serum albumin and total iron-binding capacity). Each component is scored from 0 (normal) to 3 (severe), yielding a total score of 0 to 30, with higher scores indicating greater severity of malnutrition and inflammation. Patients were classified according to their total MIS score as Group A (1–2), Group B (3–5), and Group C (≥6). The detailed scoring criteria for each MIS component are also provided in Supplementary **Figure 1**.

We excluded patients who had a history of malignancy, incomplete clinical or laboratory data, were lost to follow-up, were transferred to other PD centers, or experienced recovery of kidney function. The detailed flowchart of the study population selection is illustrated in **Figure 1**. This study protocol was approved by the Institutional Review Committee for Research in Human Subjects at Srinakharinwirot University (SWUEC-481/2563X).

Data collection

Baseline demographic and laboratory data at the initiation of PD were collected, including age, sex, education levels, types of health insurance, history of diabetes mellitus, dialysis vintage, serum creatinine, estimated glomerular filtration rate (eGFR), serum albumin, serum phosphate, hemoglobin level, NLR, and PLR.

Intervention

As part of routine care, patients in MIS groups B and C underwent evaluation for potential causes of malnutrition and received individualized nutritional education tailored to the identifiable causes.

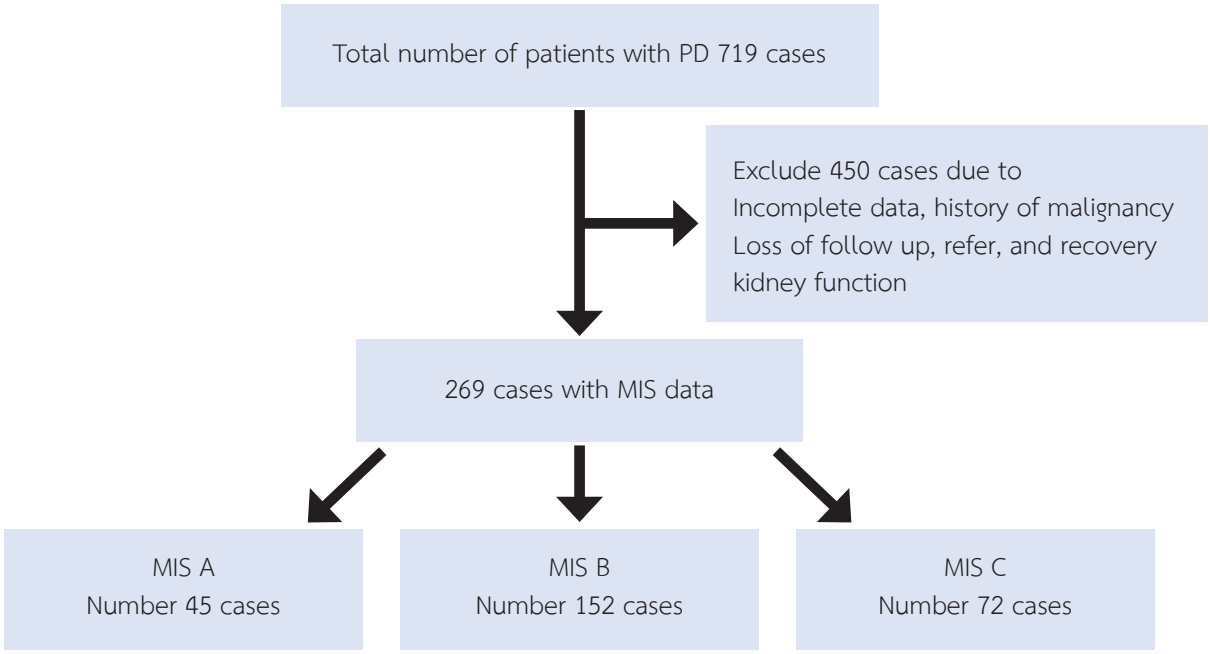

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Figure 1 Study flow diagram
PD, peritoneal dialysis; MIS, malnutrition-inflammation score

Follow-up and Outcome

Patients were followed until death or the end of February 2025. Transition to permanent hemodialysis or receiving kidney transplantation was treated as a censored observation.

Statistical analysis

All statistical analyses were performed using STATA version 18 (StataCorp, College Station, TX, USA). Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as means with standard deviations (SD). The 95% confidence intervals (CI) were estimated using the normal approximation to the binomial distribution.

Mortality rates were expressed per 100 person-years from the initiation of PD and calculated based on the Poisson distribution. Patient survival was analyzed using the Kaplan–Meier method. Risk factors for all-cause mortality were examined using a multivariable Cox proportional hazards model. Variables significant in univariable analysis, along with clinically relevant covariates from the literature, were included in a backward stepwise model. A two-sided p-value < 0.05 was considered statistically significant.

Results

Baseline biochemical parameters

Table 1 presents baseline characteristics, laboratory data, and outcomes for all patients, as well as stratified by the MIS groups. The number of patients across MIS groups A, B, and C was 45 (16.7%), 152 (56.5%), and 72 (26.8%), respectively. Most patients were covered by the universal health coverage scheme. Patients in the MIS group C had lower serum albumin and higher PLR levels compared to those in the MIS groups A and B. Death was most frequently observed in Group C, whereas kidney transplantation and transfer to hemodialysis were most common in Group A. There were no differences in educational level, health coverage, history of diabetes, serum phosphate, or NLR among the three groups. There was a tendency toward lower hemoglobin in groups B and C compared to group A (P=0.07), and longer PD vintage in group C compared to groups A and B (P=0.05).

Table 1 Baseline characteristics of all patients and by Malnutrition-Inflammation Score

Variables	All patients (N=269)	Group A (N=45)	Group B (N=152)	Group C (N=72)	P-value
Age at the start of PD	56.13 (16.7)	57.76 (14.1)	54.08 (17)	59.45 (17.2)	0.06
Male sex (N/%)	128 (47.6)	27 (60)	70 (46)	31 (43.1)	0.17
Education (N/%)					**0.46**
Illiterate and primary level	167 (62.1)	23 (51.1)	99 (65.1)	45 (62.5)	
Secondary level	71 (26.4)	14 (31.1)	37 (24.3)	20 (27.8)	
Bachelor's degree and higher	31 (11.5)	8 (17.8)	16 (10.5)	7 (9.72)	
Health scheme (N/%)					0.17
UC	163 (60.6)	24 (53.3)	94 (61.8)	45 (62.5)	
CSMBS	67 (24.9)	13 (28.9)	32 (21.1)	22 (30.6)	
SSS and others	39 (14.5)	8 (17.8)	26 (17.1)	5 (6.94)	
Diabetes (N/%)	137 (52.9)	28 (62.2)	72 (50.3)	37 (52.1)	0.38
Labs					
eGFR (mL/min/1.73 m^2)	4.78 (2.08)	4.87 (1.78)	4.41 (1.82)	5.51 (2.53)	0.001*
Albumin (g/dL)	3.17 (0.53)	3.69 (0.58)	3.13 (0.42)	2.9 (0.48)	<0.001*
Phosphate (mg/dL)	4.96 (1.94)	4.73 (1.46)	5.16 (2.13)	4.67 (1.75)	0.14
Hemoglobin (g/dL)	9.9 (1.79)	10.5 (1.53)	9.83 (1.66)	9.71 (2.14)	0.07
NLR	4 (2.3)	3.87 (2.09)	3.97 (2.21)	4.15 (2.61)	0.78
PLR	193 (113)	155 (92.1)	195 (111)	215 (122)	0.02*
Dialysis vintage (months)	45.41 (32.4)	35.62 (22.2)	48.82 (34)	44.34 (33.3)	0.05
Events (N/%)					0.03*
Death	208 (77.3)	32 (71.1)	110 (72.4)	66 (91.7)	
Transfer to HD	18 (6.69)	4 (8.89)	11 (7.24)	3 (4.17)	
Kidney transplantation	18 (6.69)	5 (11.1)	13 (8.55)	0 (0)	

Data are presented as mean (standard deviation) unless specified otherwise.

PD, peritoneal dialysis; UC, universal health coverage; CSMBS, civil servant medical benefit scheme; SSS, social security scheme; eGFR, estimated glomerular filtration rate; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; HD, hemodialysis

Changes in the Malnutrition-Inflammation category after intervention

As part of routine care, patients in MIS groups B and C were evaluated for potential causes of malnutrition and received nutritional education accordingly. One hundred ninety-two (85.7%) patients had inadequate protein intake, and 90 (40.2%) had inadequate energy intake. Ninety-seven (63.8%) patients in the MIS group B improved to group A. In contrast, 27 (60%) patients in the MIS group A experienced worsening of the MIS score. Forty-seven (65.3%) patients in the MIS group C showed no improvement **(Figure 2)**.

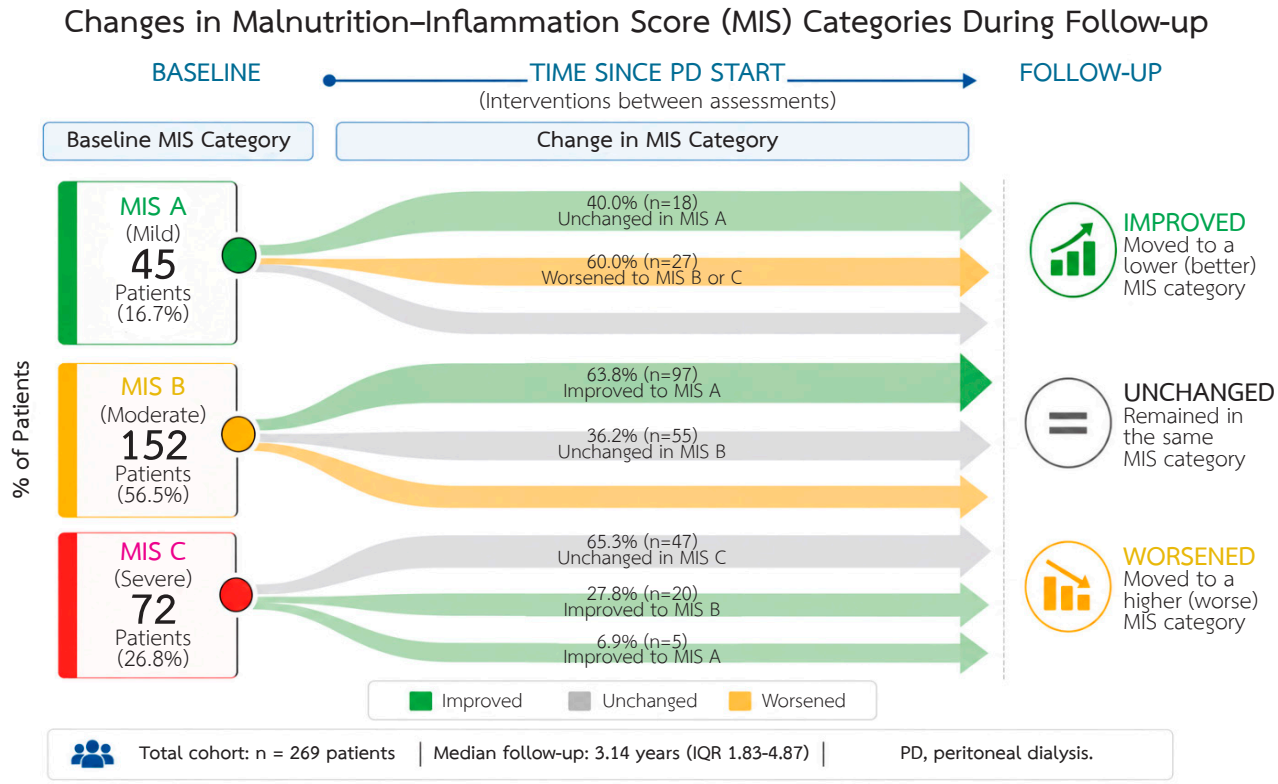

Figure 2 Changes in the Malnutrition-Inflammation category after intervention
MIS, malnutrition-inflammation score; PD, peritoneal dialysis

The median follow-up duration was 3.14 years (IQR: 1.83-4.87). There was an average of 20.4 deaths per 100 person-years. The highest mortality rate was observed in the MIS group C (24.8 deaths per 100 person-years), and the lowest in the MIS group B (17.8 deaths per 100 person-years) **(Figure 3a)**. Time-to-event analysis showed the highest survival rate in the MIS group B (p-value=0.013) **(Figure 3b)**.

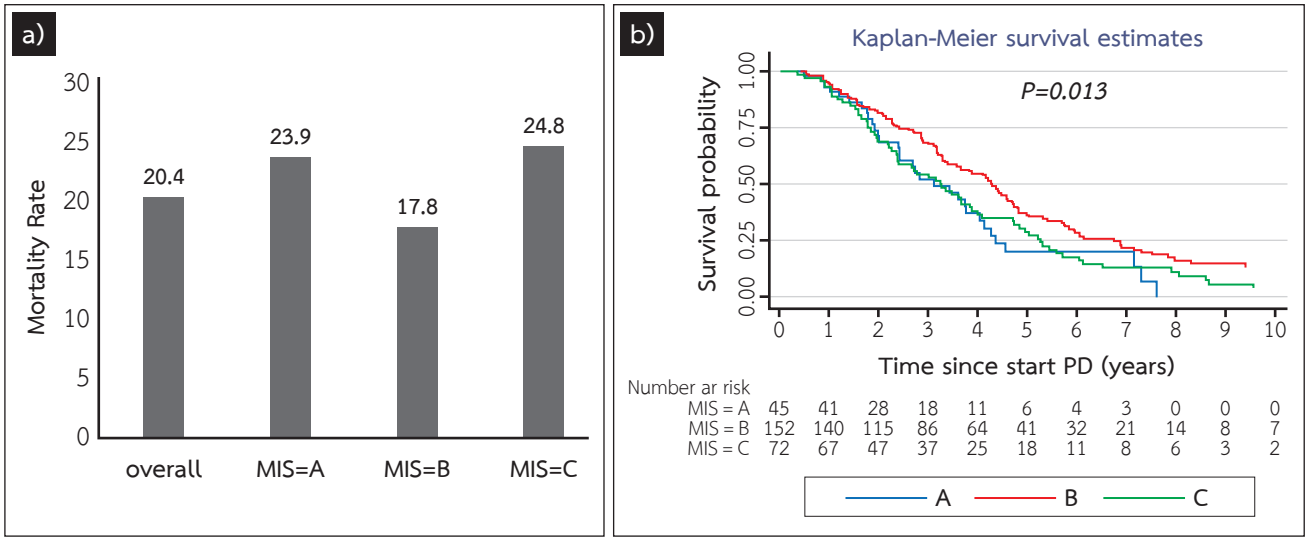

Figure 3 Mortality rate according to Malnutrition-Inflammation Score group
a) crude mortality rate (per 100 person-years); b) Kaplan-Meier survival estimates by MIS group PD, peritoneal dialysis; MIS, malnutrition-inflammation score; MR, mortality rate

Multivariable Cox proportional hazard regression analysis of baseline factors and mortality

Baseline demographic and laboratory data associated with mortality are shown in **Figure 4**. After adjustment for relevant confounders, patients in the MIS group B showed the lowest mortality risk. In addition, advanced age at the initiation of PD and diabetes were independently associated with increased mortality risk. There were no independent associations between NLR and PLR with mortality.

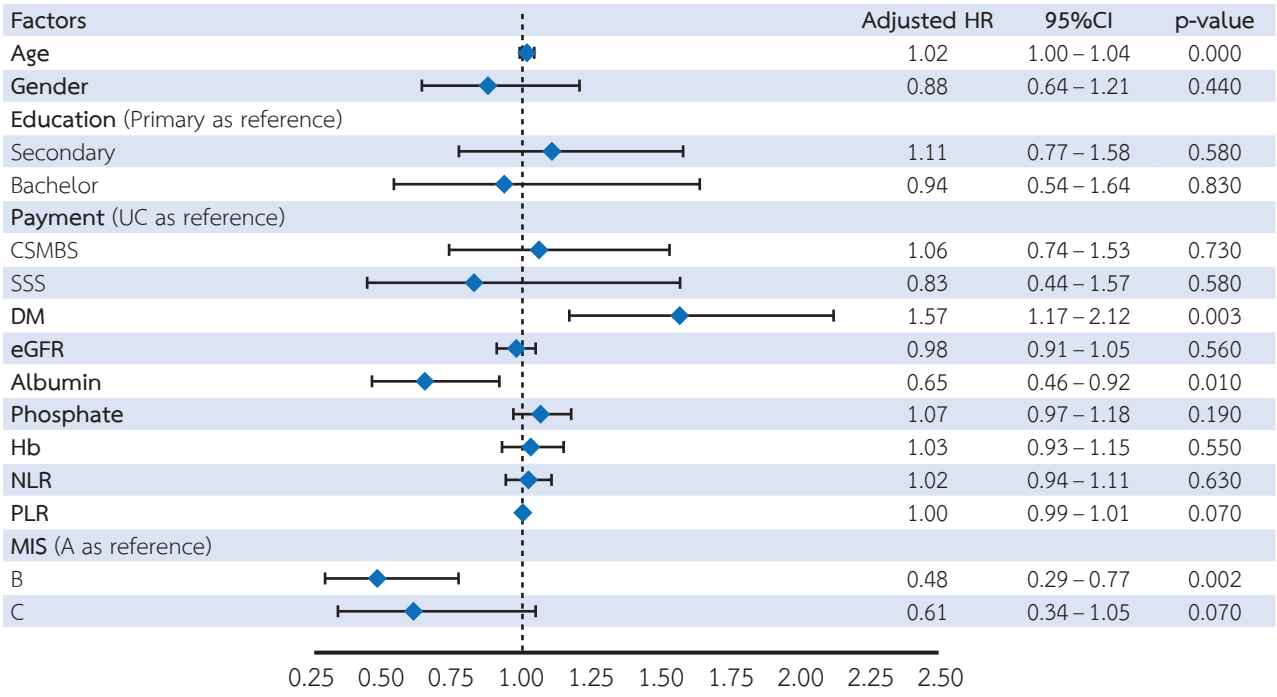

Figure 4 Adjusted hazard ratios of baseline demographic and laboratory data associated with mortality

The model was adjusted for age, gender, education levels, health coverage scheme, diabetes, eGFR, serum albumin, phosphate, Hb, NLR, PLR, and MIS groups. A multivariable Cox proportional hazards model was fitted using backward stepwise selection.

PD, peritoneal dialysis; HR, hazard ratio; CI, confidence interval; UC, universal coverage; CSMBS, civil servant medical benefit scheme; SSS, social security scheme; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; Hb, hemoglobin; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; MIS, malnutrition-inflammation score

Discussion

This study explored the association between MIS and mortality in PD patients. Kaplan-Meier estimates and multivariable Cox proportional hazards regression analysis demonstrated that patients in MIS group B had the lowest mortality risk. Following interventions, 64% of Group B showed improvement in the MIS category, whereas 65% of Group C remained unchanged. Conversely, 60% of Group A experienced a worsening of the MIS category. Older age and diabetes were independent predictors of higher mortality.

This finding aligns with prior research indicating that dialysis patients with severe MIS experience poorer outcomes[2, 5]. The superior survival observed in the MIS group B likely reflects the therapeutic benefits of timely clinical interventions triggered by initial MIS elevation. This interpretation is strongly supported by our data, which showed that a significant proportion of group B patients transitioned to the lower-risk group A following intervention. Conversely, a substantial number of patients initially categorized in group A progressed to higher-risk categories, underscoring the importance of routine reassessment—even for individuals initially deemed low risk. Meanwhile, the majority of group C patients

remained in their baseline category, highlighting the clinical difficulty of reversing advanced malnutrition and inflammation once established. Collectively, these findings emphasize the critical window for early detection and prompt nutritional intervention in PD patients. Furthermore, the observed association between MIS improvement and enhanced survival suggests that MIS should serve not only as a prognostic indicator but also as a dynamic treatment target[7].

In line with previous studies, older age and diabetes mellitus were significantly associated with increased mortality[8-11]. We also found that patients in the MIS group C had significantly higher PLR, supporting its utility as an additional inflammatory marker in this population[12,13]. Previous studies have demonstrated that PLR can enhance risk stratification and facilitate individualized nutritional management strategies; however, no independent association between PLR and mortality was observed in the present study[14]. Given their heightened risk profiles, more frequent monitoring may be warranted for elderly or diabetic patients[7].

PD plays a key role in enhancing equitable access to kidney replacement therapy[15] To maximize its impact, systematic nutritional assessment should be uniformly implemented across PD centers. Effective nutritional management is a vital component of comprehensive care, as it directly influences both clinical outcomes and quality of life in PD patients[16]. Currently, PD quality indicators monitored by Thailand's NHSO focus primarily on infection control—including peritonitis-related mortality—as well as one-year patient survival and serum albumin levels[17]. However, given that nutritional and inflammatory status significantly drive both mortality and cardiovascular risk, incorporating the MIS into national quality indicators could strengthen outcome-based monitoring and align local practices with global standards[18]. These system-level enhancements, if integrated into existing infrastructure and policy frameworks such as the PD Quality Assurance Programs, could significantly improve the overall quality of PD care in Thailand.

This study has several limitations. First, its retrospective, observational design precludes the establishment of definitive causal relationships between nutritional status and survival. Second, the relatively small sample size may have limited the statistical power to detect differences among smaller subgroups, particularly patients with severe malnutrition (MIS Group C). Third, the lack of a standardized MIS monitoring schedule restricted our ability to evaluate the specific impact of intervention timing. Fourth, as a single-center study, our findings may not be fully generalizable to settings with different clinical practices or distinct patient populations. Lastly, over half of the potential PD population lacked recorded MIS data, which introduces a risk of selection bias.

Future studies should aim to establish standardized MIS monitoring intervals and evaluate the long-term outcomes of structured nutritional interventions. Randomized controlled trials would be essential to confirm the causal relationship between MIS-targeted care and survival. In addition, implementation research is needed to evaluate the integration of MIS assessments into quality monitoring systems and to identify barriers and facilitators for adoption in diverse clinical settings.

In conclusion, this study demonstrates that PD patients with moderate malnutrition (MIS Group B) exhibit superior survival compared to those with lower or higher MIS scores. This paradoxically better outcome was likely driven by the timely implementation of targeted nutritional interventions within the moderate and severe cohorts (Groups B and C). The dynamic evolution of MIS categories over time underscores the critical importance of routine nutritional and inflammatory assessments in clinical care. Furthermore, older age and diabetes mellitus were confirmed as independent risk factors for mortality.

Acknowledgement

We acknowledge the dietitian and PD nurses at HRH Princess Maha Chakri Sirindhorn Medical Center for MIS evaluation and input data to DPEX, respectively.

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