


**Research Article**

## Assessment of Nutritional Status and Its Association with Inflammation among Patients on Continuous Ambulatory Peritoneal Dialysis

Marjoa Humaira Mekhola<sup>1\*</sup>, Md. Ayub Ali Chowdhury<sup>2</sup>, Kazi Shahnoor Alam<sup>3</sup>, Sourav Saha<sup>4</sup>, Md. Shahadat Hossain<sup>5</sup>, Samira Mahjabeen<sup>6</sup>, Ayesha Samdani<sup>7</sup>, Nazma Azim<sup>8</sup>, A. K. M Shahidur Rahman<sup>1</sup>

### Abstract

Continuous ambulatory peritoneal dialysis (CAPD) is one of the therapeutic options in end stage renal disease (ESRD). Malnutrition is prevalent among patients on CAPD. This study was aimed to assess the nutritional status and its association with inflammation among patients on CAPD. This study was conducted at the Department of Nephrology, National Institute of Kidney Diseases and Urology (NIKDU), Dhaka, Bangladesh from July 2018 to June 2019. A total of sixty-nine (69) ESRD patients on CAPD were enrolled. Demographic profile, clinical history and nutritional status of each study patient were recorded. All relevant investigations were done accordingly. Their 24 hours urine and 24 hours effluent were collected for urea and creatinine levels to detect adequacy of dialysis, residual renal function and normalized protein catabolic rate (nPCR). Malnutrition inflammation score (MIS) was performed following standard procedure. In this study, malnutrition inflammation score (MIS) is higher among CAPD patients. It was observed that, 78.3% patients were malnourished. Serum albumin, serum pre-albumin, total iron binding capacity (TIBC) and body mass index (BMI) showed significant negative correlation with MIS; however high sensitive C-reactive protein (hsCRP) showed positive correlation with MIS. This study concluded that, malnutrition inflammation score (MIS) is related to inflammation in continuous ambulatory peritoneal dialysis (CAPD) patients.

**Keywords:** Continuous Ambulatory Peritoneal Dialysis (CAPD); End Stage Renal Disease (ESRD); Inflammation; Malnutrition; Malnutrition Inflammation Score (MIS).

### Introduction

Continuous ambulatory peritoneal dialysis (CAPD) is one of the therapeutic options of renal replacement therapy (RRT) in end stage renal disease (ESRD). CAPD is a treatment option used by about 11% of the world's dialysis population [1]. Because of its relative simplicity, patient freedom and better preservation of residual renal function (RRF), CAPD utilization is gradually increasing in the developing countries [1, 2]. Despite its potential benefits, CAPD is underutilized in low- and middle-income countries [2, 3].

Patients treated with haemodialysis/CAPD are often malnourished, as evident by low visceral protein levels, decreased anthropometric measurements and low scores of subjective global assessments (SGA) [4, 5]. Malnutrition is a common finding in patients on CAPD because of nutrient loss during dialysis, anorexia, protein catabolism and co-morbidities etc [3]. On the other hand, recent reports have shown that these patients tend to gain

### Affiliation:

<sup>1</sup>Medical Officer, Department of Nephrology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh

<sup>2</sup>Professor and Head of the Department (Former), Department of Nephrology, National Institute of Kidney Diseases and Urology (NIKDU), Dhaka, Bangladesh

<sup>3</sup>Professor and Head of the Department, Department of Nephrology, National Institute of Kidney Diseases and Urology (NIKDU), Dhaka, Bangladesh

<sup>4</sup>Associate Professor and Head of the Department, Department of Nephrology, Mainamoti Medical College and Hospital, Cumilla, Bangladesh

<sup>5</sup>Assistant Registrar, Department of Nephrology, National Institute of Kidney Diseases and Urology (NIKDU), Dhaka, Bangladesh

<sup>6</sup>Medical Officer, Department of Endocrinology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh

<sup>7</sup>Senior Medical Officer, Outpatient Department (OPD), BIRDEM General Hospital, Dhaka, Bangladesh

<sup>8</sup>Programmer, Management Information Systems (MIS), National Institute of Cancer Research & Hospital (NICRH), Dhaka, Bangladesh

### \*Corresponding author:

Dr. Marjoa Humaira Mekhola, Medical Officer, Department of Nephrology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

**E-mail:** mmekhola@gmail.com

**Citation:** Mekhola MH, Chowdhury MAA, Alam KS, Saha S, Hossain MS, Mahjabeen S, Samdani A, Azim N, Rahman AKMS. Assessment of Nutritional Status and Its Association with Inflammation among Patients on Continuous Ambulatory Peritoneal Dialysis. Archives of Nephrology and Urology. 6 (2023): 44-50.

**Received:** April 17, 2023

**Accepted:** April 24, 2023

**Published:** May 09, 2023

body weight and body fat in the first 2 years of CAPD and some of them may develop obesity [6]. The simultaneous existence of overweight and obesity as well as of protein-energy malnutrition (sarcopenia) is a particular nutritional pattern seen in CAPD [7]. To identify patients at high risk for negative outcomes, the Nutrition Kidney Disease Outcomes Quality Initiatives (K/DOQI) proposed a panel of the nutritional index that should be used in these patients [8]. The nutritional parameters recommended include- body weight (with empty peritoneal cavity), height, body mass index (BMI), waist circumference, skin-fold thicknesses, and mid-arm muscle circumference [9, 10]. Other nutritional measurements that should be assessed including serum albumin, pre-albumin, dietary interviews and diaries and the protein equivalent of nitrogen appearance (PNA) [8, 11].

Inflammation can be defined as a localised protective response elicited by injury or destruction of tissues that serves to destroy, dilute or sequester both the injurious agent and injured tissue [12]. Hence, it is a physiological response and in the form of an acute response to infections, trauma, or toxic injury, that helps the body to defend against any pathophysiological insults [13]. There are several factors that contribute to inflammatory condition in a patient on CAPD like: loss of residual renal function (RRF), peritoneal fluid and catheter, peritonitis, peritoneal membrane dysfunction and endotoxemia [11, 14]. However, if inflammation becomes prolonged and persistent in the form of the so called chronic acute-phase reaction, it may lead to adverse consequences, such as decline in appetite, increased rate of protein depletion in skeletal muscle, hyper-catabolism, endothelial damage, and atherosclerosis [12]. The inflammatory status seems to have a pivotal role in increasing the protein catabolism, as increased concentration of tumour necrosis factor- $\alpha$  (TNF- $\alpha$ ) and interleukin 6 (IL-6) can lead to anorexia, insulin resistance, activation of the ubiquitin-proteasome pathway and increased resting energy expenditure [15]. All these conditions are associated with decreased skeletal protein stores in CAPD patients [15]. Other factors associated with wasting in CAPD patients include aging, poor physical activity, genetic predisposition, diabetes mellitus and other co-morbidities [15]. There are several markers that can be measured to gauge the level of inflammatory burden, such as C-reactive protein (CRP), serum total iron binding capacity (TIBC) and serum albumin, serum pre-albumin [16].

Nutritional status of a patient with chronic disease could be measured by several tools [17-19]. But clinical condition of patients on CAPD is affected by both malnutrition and inflammatory condition and therefore, should be assessed in a combined way. Malnutrition inflammation score (MIS) significantly correlates with clinical, nutritional, inflammatory, anthropometric parameters and anaemia indices in CAPD patients [17-19]. MIS is a 4-point scale, quantitative nutrition screening tool, consists of four main parts, including -

patient's related medical history, physical examination, BMI and laboratory parameters [17-19]. Regular assessment of nutritional status and inflammatory condition of patients on CAPD may reduce mortality and morbidity and bring long-term better outcomes. There is scarce evidence that assesses nutritional status and inflammatory condition among CAPD patients. This cross-sectional study was undertaken to assess the nutritional status and inflammatory markers of CAPD patients by using malnutrition inflammation score (MIS).

## Methodology

This cross-sectional study was conducted at the Department of Nephrology, National Institute of Kidney Diseases and Urology (NIKDU), Dhaka, Bangladesh from July 2018 to June 2019. The study was approved by the institutional review board (IRB), NIKDU, Dhaka, Bangladesh. A total of sixty-nine (69) ESRD patients on continuous ambulatory peritoneal dialysis (CAPD) were enrolled by purposive sampling technique following selection criteria. Adult (age >18 years) ESRD patients on CAPD for more than 1 month were included. Patients having any episodes of peritonitis within last 1 month, patients with cognitive impairment and critically ill patients were excluded from the study. Demographic profiles and clinical history along with previous medical data of each study patient were recorded. All relevant investigations like- serum creatinine, blood urea, high sensitive C-reactive protein (hsCRP), fasting blood sugar (FBS), serum triglyceride (TG), serum cholesterol, serum high density lipoprotein cholesterol (S. HDL- C), serum albumin level, serum pre-albumin, serum calcium (S. Ca), serum phosphate (S. PO<sub>4</sub>), serum uric acid and total iron-binding capacity (TIBC) were measured. Their 24-hour urine and 24-hour effluent were collected for urea and creatinine levels to detect- adequacy of dialysis (Kt/v urea), residual renal function (RRF) and normalized protein catabolic rate (nPCR). Malnutrition inflammation score (MIS) was performed following standard procedure.

## Study procedures

After selection of the patients, the purpose and procedure of the study was explained. Informed written consent was taken from each study patient for enrollment in this study. The study subjects were advised to arrive at the place of study in the morning of the scheduled date with 12 hours fasting state. They were also asked to bring 24 hours' urine sample and 24 hours' effluent sample from each bag of last 24 hours. For anthropometric measurements of the patient's height and post-dialysis weight were taken. Then body mass index (BMI) was calculated using weight (in kilograms)/ height (in meters)<sup>2</sup> formula. Mid-arm circumference (MAC) was measured by using a flexible, non-stretchable, measuring tape. The biceps skin-fold (BSF) thickness and triceps skin-fold (TSF) thickness were measured by trained nutritionist using Harpenden skin-fold caliper on the right arm of study

patients. An overnight fasting blood sample (6 ml venous blood) from each study patient was collected for biochemical analysis. All biochemical parameters were measured by routine methods at the Department of Laboratory Medicine, NIKDU, Dhaka, Bangladesh. The demographic information, clinical examination findings and laboratory investigations reports were recorded in a predesigned data collection sheet.

### Malnutrition–Inflammation Score (MIS) [18]

The Malnutrition–Inflammation Score (MIS) is a scoring system used to evaluate malnutrition and inflammation of a patient with chronic disease. The MIS was created using the seven components of the conventional subjective global assessment (SGA) and combining them with three new elements: body mass index (BMI), serum albumin, and total iron-binding capacity (TIBC). The MIS is made up of ten components that are derived from a patient's medical history, physical examination, BMI, and laboratory parameters. Each component of the score is graded on a scale of 0 (normal) to 3 (severely abnormal). The total of the MIS's ten components ranges from 0 (normal) to 30 (severe malnutrition and inflammation).

### MIS scoring

The total score was calculated. The cut-off score derived from the highest sensitivity – (1-specificity) point and that was 5. This cut-off score was used to classify patients with nutritional risk where patients with score <5 were classified as normal nutrition status whilst patients with score ≥5 were classified as malnourished [19].

### Statistical analysis

Statistical analysis of the results was done by using computer-based statistical software (SPSS) version- 22. Quantitative data were presented as mean with standard deviation (SD) and qualitative data were presented by frequencies with percentages. The Pearson correlation test was performed to detect the correlation and unpaired 't' test was done to analyze quantitative variables. A p value less than 0.05 was considered statistically significant.

## Results and Observations

This cross-sectional study was conducted to evaluate the nutritional status and inflammatory condition among CAPD patients. A total of 69 patients were included in this study according to selection criteria. Out of 69 study patients; 39(56.5%) were male and rest 30(43.5%) were female (Figure- 1). Of them, 49.3% had diabetes mellitus (DM), 30.4% had glomerulonephritis (GN), 15.2% had hypertension (HTN), 2.9% had obstructive uropathy (OU) and 1.4% had polycystic kidney disease (PKD) (Figure- 2). Most of the study patients (78.3%) were found malnourished (Figure- 3).

It was observed that, mean age of the study patients was  $58.3 \pm 13.7$  years, mean body mass index (BMI) was  $26.1 \pm 4.0$

kg/m<sup>2</sup>, mean systolic blood pressure (SBP) was  $140 \pm 21$  mm of Hg and mean diastolic blood pressure (DBP) was  $83 \pm 11$  mmHg. Mean mid arm circumference (MAC) was  $25.94 \pm 3.99$  cm, mean waist size was  $91.99 \pm 8.92$  cm, mean hip size was  $99.06 \pm 8.04$  cm, mean waist-hip ratio (WH ratio) was  $0.93 \pm 0.08$ , mean biceps skin-fold thickness was  $3.83 \pm 2.62$  cm and mean triceps skin-fold thickness was  $9.74 \pm 5.14$  cm. Mean duration of dialysis was  $9.75 \pm 14.7$  months (Table- 1).

Regarding biochemical parameters of the study patients, mean haemoglobin (Hb) level was  $9.48 \pm 1.77$  g/dl. Mean serum creatinine and blood urea level was  $9.32 \pm 3.94$  mg/dl and  $86.8 \pm 35.7$  mg/dl. Mean high sensitive C-reactive protein (hsCRP) was  $23.73 \pm 26.67$  mg/dl. Mean fasting blood sugar (FBS), serum triglyceride (TG), serum cholesterol and serum high-density lipoprotein cholesterol (S. HDL-C) levels were-

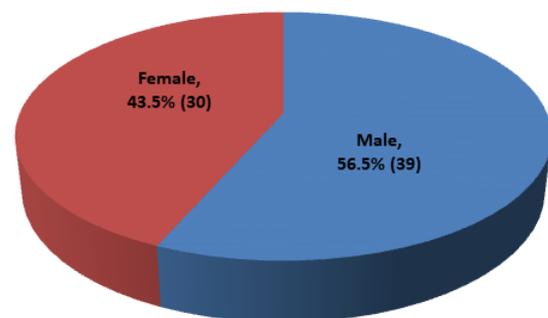


Figure- 1: Distribution of the study patients according to gender (N= 69)

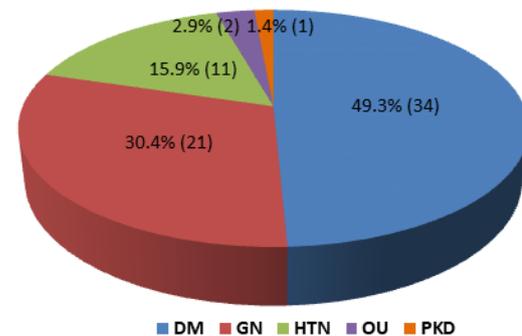


Figure- 2: Distribution of the study patients according to primary disease (N= 69)

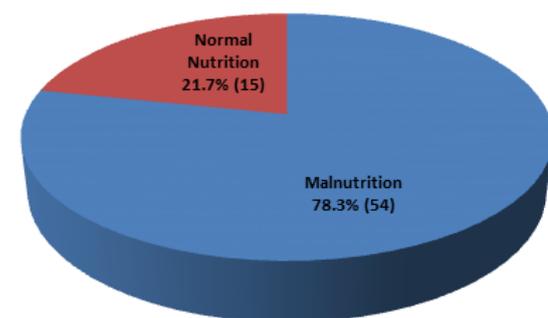


Figure- 3: Nutritional status of the study patients (N= 69)

**Table- 1:** Basic data of the study patients (N= 69)

Variables	Mean ± SD	Minimum – maximum
Age (year)	58.3 ± 13.7	19 – 89
BMI (kg/m <sup>2</sup> )	26.1 ± 4.0	14.4 – 35.0
Systolic BP (mmHg)	140 ± 21	100 – 180
Diastolic BP (mmHg)	83 ± 11	40 – 110
MAC (cm)	25.94 ± 3.99	11.00 - 32.00
Waist (cm)	91.99 ± 8.92	60.96 - 106.00
Hip (cm)	99.06 ± 8.04	71.12 - 121.92
WH ratio	0.93 ± 0.08	0.71 - 1.05
Bicep (cm)	3.83 ± 2.62	1.10 - 12.70
Tricep (cm)	9.74 ± 5.14	1.50 - 25.20
Duration of dialysis (months)	9.75 ± 14.7	0.5 – 88

**Table- 2:** Biochemical parameters of the study patients (N= 69)

Biochemical parameters	Mean ± SD	Minimum – maximum
Hb (g/dl)	9.48 ± 1.77	6.00 - 14.30
S Creatinine (mg/dl)	9.32 ± 3.94	4.03 - 23.17
Blood urea (mg/dl)	86.8 ± 35.7	31.2 – 240
hsCRP (mg/dl)	23.73 ± 26.67	0.79 - 142.00
FBS (mmol/L)	8.49 ± 4.53	3.80 - 22.50
TG (mg/dl)	286.73 ± 247.04	38.40 - 1027.10
Cholesterol (mg/dl)	179.48 ± 112.78	51.30 - 723.40
S. HDL- C (mg/dl)	35.81 ± 7.53	17.30 - 57.50
Serum albumin (mg/dl)	3.11 ± 0.60	2.00 - 4.50
Serum pre-albumin (mg/dl)	0.30 ± 0.11	0.04 – 0.54
S. Ca (mg/dl)	8.78 ± 1.80	4.27 - 13.46
S. PO <sub>4</sub> (mg/dl)	4.64 ± 1.90	1.85 - 11.63
Serum uric acid (mg/dl)	6.27 ± 1.33	2.98 - 9.00
TIBC (mcg/dl)	165.8 ± 59.5	24 – 298

**Table- 3:** Malnutrition inflammation score (MIS), normalized protein catabolic rate (nPCR) and Kt/V urea of the study patients (N= 69)

Variables	Mean ± SD	Minimum – maximum
MIS	11.2 ± 4.7	4 – 30
nPCR	1.93 ± 1.12	0.30 – 6.69
Kt/V urea	1.36 ± 0.59	0.64 – 4.04

**Table- 4:** Comparison of demographic, anthropometric and biochemical parameters among well-nourished and malnourished CAPD patients

Variables	MIS score <5	MIS score ≥5	p-value
	(n=15)	(n=54)	
	Mean ± SD	Mean ± SD	
Age (year)	52.73 ± 14.48	59.85 ± 13.28	0.076
BMI (kg/m <sup>2</sup> )	27.79 ± 4.21	25.65 ± 3.87	0.067

Systolic BP (mmHg)	134.67 ± 15.06	141.51 ± 22.22	0.267
Diastolic BP (mmHg)	76.67 ± 13.97	84.81 ± 9.90	0.013
MAC (cm)	27.43 ± 2.40	25.53 ± 4.25	0.102
Waist (cm)	92.65 ± 10.61	91.81 ± 8.50	0.75
Hip (cm)	101.46 ± 7.15	98.40 ± 8.21	0.195
WH ratio	0.91 ± 0.10	0.93 ± 0.07	0.376
Bicep (cm)	3.92 ± 1.57	3.80 ± 2.86	0.877
Tricep (cm)	10.50 ± 3.26	9.53 ± 5.56	0.523
Duration of dialysis (Months)	10.73 ± 10.37	9.46 ± 15.82	0.771
Serum albumin (mg/dl)	3.74 ± 0.41	2.94 ± 0.52	<0.001 <sup>s</sup>
Serum pre-albumin (mg/dl)	0.39 ± 0.10	0.28 ± 0.10	<0.001 <sup>s</sup>
CRP	14.36 ± 11.66	26.33 ± 29.07	0.125
nPCR	2.14 ± 1.19	1.88 ± 1.12	0.43
Total KT/V urea	1.48 ± 0.67	1.34 ± 0.57	0.432

Unpaired t test was done, s= significant

8.49 ± 4.53 mmol/L, 286.73 ± 247.04 mg/dl, 179.48 ± 112.78 mg/dl and 35.81 ± 7.53 mg/dl respectively. The mean serum albumin level was 3.11 ± 0.60 mg/dl and mean serum pre-albumin level was 0.30 ± 0.11 mg/dl. Mean serum calcium (S. Ca), serum phosphate (S. PO<sub>4</sub>) and serum uric acid levels were- 8.78 ± 1.80 mg/dl, 4.64 ± 1.90 mg/dl and 6.27 ± 1.33 mg/dl respectively. Mean total iron-binding capacity (TIBC) of the study patients was- 165.8 ± 59.5 mcg/dl (Table- 2).

Data analysis revealed that mean malnutrition inflammation score (MIS) of 69 study patients was 11.2 ± 4.7, mean normalized protein catabolic rate (nPCR) of the study patients was 1.93 ± 1.12 and mean Kt/V urea of the study patients was 1.36 ± 0.59 (Table- 3).

We compared demographic, anthropometric and biochemical parameters among well-nourished and malnourished CAPD patients. That revealed serum albumin and serum pre-albumin was found significantly lower in patients with higher MIS-score (>5) (Table- 4).

Pearson’s correlation analysis revealed that; body mass index (BMI), serum albumin, serum pre-albumin, serum total iron binding capacity (TIBC) had showed significant negative correlation (p<0.001) with malnutrition inflammation score (MIS); but high sensitive C- Reactive protein (hsCRP) had showed significant positive correlation to malnutrition inflammation score (MIS) (p<0.001) (Table- 5).

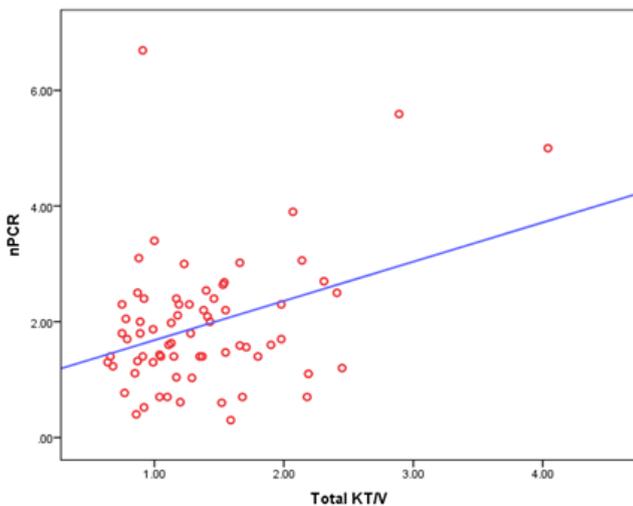
In this study we observed that normalized protein catabolic rate (nPCR) had a significant positive correlation with total Kt/v urea (r= 0.356 and p= 0.003) (Figure- 4).

But there was no significant correlation observed between KT/v urea with malnutrition inflammation score (MIS) in this study (r= 0.056 and p= 0.648) (Figure- 5).

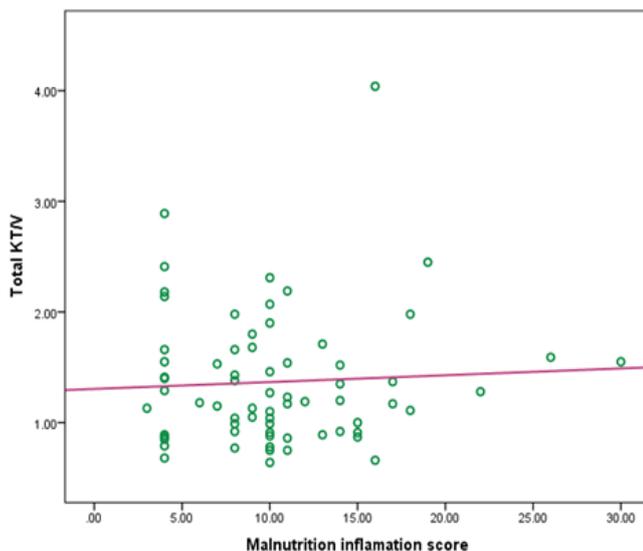
**Table-5:** Correlation of malnutrition inflammation score (MIS) with BMI, serum albumin, serum pre-albumin, TIBC, hsCRP, nPCR, serum creatinine and haemoglobin (Hb) levels (N= 69)

Variables	r value	p value
Body mass index (BMI)	-0.487	<0.001 <sup>s</sup>
Serum albumin	-0.447	<0.001 <sup>s</sup>
Serum pre-albumin	-0.591	<0.001 <sup>s</sup>
Total iron binding capacity (TIBC)	-0.6	<0.001 <sup>s</sup>
High sensitive C- Reactive protein (hsCRP)	0.322	<0.001 <sup>s</sup>
Normalized protein catabolic rate (nPCR)	-0.067	0.733
Serum creatinine	-0.221	0.07
Haemoglobin (Hb)	0.198	0.122

Pearson's correlation test was performed, s= significant



**Figure- 4:** Scatter diagram displaying the correlation of total KT/v urea with nPCR among the study patients (N=69)



**Figure- 5:** Correlation of total KT/v urea with malnutrition inflammation score (MIS) among the study patients (N=69)

## Discussion

Inflammation and inflammatory factors play an important role in malnutrition among patients with chronic kidney disease (CKD). The malnutrition inflammation score (MIS), a nutritional scoring system, has been verified in chronic kidney disease (CKD), particularly in dialysis patients [17-19]. We examined the nutritional status and inflammatory markers of sixty-nine (69) patients on continuous ambulatory peritoneal dialysis (CAPD) and observed the correlation of MIS with several nutritional variables and inflammatory markers like hsCRP, TIBC, pre-albumin, albumin and BMI. In this study, among 69 CAPD patients, 56.5% was male and 43.5% was female which indicates a male predominance. In accordance, Singh *et al.* also found male predominance in a related study [20].

In this study analyzing the primary causes of CKD revealed that; 49.3% study patients had diabetes mellitus (DM), 30.4% had glomerulonephritis (GN), 15.2% had hypertension (HTN), 2.9% had obstructive uropathy (OU) and 1.4% had polycystic kidney disease (PKD). In this series, one previous study showed primary causes of CKD were unknown in 41% patients, followed by DM 33%, HTN 11% and 14% was other causes [20]. So, there were more diabetic patients who developed CKD and ESRD underwent CAPD, even percentage of GN is also higher as primary disease in our study.

In this present study, we explored the possible cut-off score for defining malnutrition with the malnutrition inflammation score (MIS). MIS score of <5 obtained for all patients indicated normal nutritional status whilst scores of  $\geq 5$  indicated presence of malnutrition [19]. According to this cut-off value we found 78.3% of our study patients were malnourished. This finding was consistent with related previous studies [20, 21]. It was reported that prevalence of malnutrition among CAPD population was much higher (74%-90%) [17, 20, 21]. The plausible reason could be patients on chronic dialysis may experience malnutrition due to inadequate dietary intake, significant losses, elevated protein catabolism, and acidosis.

In this study the mean age of the patients was  $58.3 \pm 13.7$  years, that was comparable with couple of related previous studies [20, 21, 22]. The mean body mass index (BMI) of the study patients was  $26.1 \pm 4.0$  kg/m<sup>2</sup>. This finding was supported by a similar previous study [22]. However, another study showed the mean BMI of the study patients was  $21.8 \pm 5.2$ , which was much lower than our study [21].

In this study the mean value of malnutrition inflammation score (MIS) was  $11.2 \pm 4.7$ . In this context, Afsar *et al.* reported that mean MIS of 50 CAPD patients was  $8.1 \pm 5.0$  [22]. In comparison to that study our CAPD patients were higher MIS scorer. Normalized protein catabolic rate (nPCR) is a rate which correlates with normalized dietary protein

intake. The mean normalized protein catabolic rate (nPCR) of the study patients was  $1.93 \pm 1.12$ , which was comparable with similar previous studies [21, 22]. The mean Kt/V urea of our study patients was  $1.36 \pm 0.59$ . In accordance Prasad *et al.* showed mean weekly Kt/V urea was  $1.8 \pm 0.5$  in their study, which was consistent with our study [21].

In this current study, BMI showed significant negative correlation with MIS which was consistent with a related previous study [20]. High sensitive C-reactive protein (hsCRP), which is an inflammatory marker, we found mean hsCRP was  $23.73 \pm 26.67$  mg/dl in this study and that had showed a significant positive correlation with MIS. In this context, Afsar *et al.* also found a similar result [22]; but Singh *et al.* found a negative correlation of CRP with MIS [20]. Albumin, which is a negative acute-phase protein, is an important marker of nutrition in the dialysis population. We found mean serum albumin level was  $3.11 \pm 0.60$  mg/dl in our study patients, which had showed a negative correlation with MIS. This finding was in a line of similar previous studies [20-22]. Serum pre-albumin, like albumin, is also a negative acute-phase protein which reflects the presence of ongoing or resolving inflammatory condition that may influence the patient's nutritional state. In this current study, the mean serum pre-albumin level was  $0.30 \pm 0.11$  ng/ml, and we found a negative correlation between MIS and serum pre-albumin. In accordance Afsar *et al.* also showed similar results [22]. In this study, mean total iron-binding capacity (TIBC) level was  $165.8 \pm 59.5$  mg/dl and that had showed a significant negative correlation with MIS. This finding was supported by a couple of previous study [20, 22].

It was reported that nPCR was significantly correlated with dialysis adequacy including Kt/V [23, 24]. Our study also showed a significant positive correlation between nPCR and Kt/V urea ( $r = 0.356$ ,  $p = 0.003$ ). But in this study, there was no significant correlation observed between MIS and Kt/V urea ( $r = 0.056$  and  $p = 0.648$ ), which means that to detect dialysis adequacy only solute clearance or Kt/V is not sufficient. MIS should be performed among patients on CAPD. Nutritional status and inflammatory markers are important indicators to assess adequacy and to predict the outcome of CAPD.

In this study different clinical and laboratory parameters were compared between well-nourished and malnourished patients like age, BMI, MAC, waist-hip ratio, biceps skin-fold thickness, triceps skin-fold thickness, duration of dialysis, serum albumin, pre-albumin, hsCRP, nPCR, Kt/V urea, out of which albumin and pre-albumin showed significant difference. Malnutrition inflammation score was higher among CAPD patients in our country. There was also a significant negative correlation of albumin, pre-albumin, BMI and TIBC with MIS. But hsCRP had a significant positive correlation with MIS. So, MIS can be used as a useful tool to detect malnutrition and inflammatory conditions among patients on CAPD.

## Conclusion

This study demonstrated that malnutrition inflammation score (MIS) is significantly higher in patients on CAPD. Serum albumin, serum pre-albumin, BMI and TIBC has significant negative correlation with malnutrition inflammation score, whereas hsCRP have significant positive correlation with malnutrition inflammation score. Comparison to clinical and laboratory parameters with different variables in CAPD patients revealed that the malnutrition inflammation score (MIS) is related to inflammation in continuous ambulatory peritoneal dialysis (CAPD) patients. As MIS is a reliable tool to predict malnutrition and inflammation status in chronic dialysis patients, therefore MIS could be used for prevention of fatal outcomes among CAPD patients.

## Limitations of the study

There were some limitations in this study. The sample size was relatively small, which may have a lower statistical power. The present study was conducted over a short period of time.

## Recommendation

Further studies with larger sample size could be done over longer duration.

## Conflict of interest

The authors declared no conflicts of interest related to the research, authorship or publication of this article.

## References

- 1 Jain AK, Blake P, Cordy P, et al. Global trends in rates of peritoneal dialysis. *Journal of the American Society of Nephrology*23(3) (2012):533-44.
- 2 Krautzig, S., & Brunkhorst, R. *Nephrology Dialysis Transplantation*. Oxford University Press. September 11 9(1996): 1911–1912.
- 3 Katirtzoglou A, Oreopoulos DG, Husdan H, et al. Reappraisal of protein losses in patients undergoing continuous ambulatory peritoneal dialysis. *Nephron*26(5) (1980):230-3.
- 4 Kopple JD. National kidney foundation K/DOQI clinical practice guidelines for nutrition in chronic renal failure. *American journal of kidney diseases*37(1) (2001):S66-70.
- 5 Fouque D, Kalantar-Zadeh K, Kopple J, et al. A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease. *Kidney international*73(4) (2008):391-8.
- 6 Heimbürger O. Obesity on PD patients: causes and management. *Contributions to Nephrology* 140(2003):91-7.
- 7 Avesani CM, Heimbürger O, Stenvinkel P, et al.

- Nutritional aspects of adult patients treated with chronic peritoneal dialysis. *J Bras Nefrol*28(4) (2006):232-8.
- 8 Clinical Practice Guidelines for Nutrition in Chronic Renal Failure. K/DOQI, National Kidney Foundation. *Am J Kidney Dis*35(2) (2000):S1-140.
  - 9 Lapidus L, Bengtsson C, Larsson BO, et al. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow up of participants in the population study of women in Gothenburg, Sweden. *Br Med J (Clin Res Ed)*289(6454) (1984):1257-61.
  - 10 Heimbürger O, Qureshi AR, Blaner WS, et al. Hand-grip muscle strength, lean body mass, and plasma proteins as markers of nutritional status in patients with chronic renal failure close to start of dialysis therapy. *American journal of kidney diseases*36(6) (2000):1213-25.
  - 11 Pupim LB, Ikizler TA. Assessment and monitoring of uremic malnutrition. *Journal of Renal Nutrition*14(1) (2004):6-19.
  - 12 Cho Y, Hawley CM, Johnson DW. Clinical causes of inflammation in peritoneal dialysis patients. *International journal of nephrology*2014(2014).
  - 13 Hurst SM, Wilkinson TS, McLoughlin RM, et al. Il-6 and its soluble receptor orchestrate a temporal switch in the pattern of leukocyte recruitment seen during acute inflammation. *Immunity*14(6) (2001):705-14.
  - 14 Kalantar-Zadeh K, Kopple JD. Relative contributions of nutrition and inflammation to clinical outcome in dialysis patients. *American journal of kidney diseases*38(6) (2001):1343-50.
  - 15 Stenvinkel P, Ketteler M, Johnson RJ, et al. central factors in the altered cytokine network of uremia—the good, the bad, and the ugly. *Kidney international*67(4) (2005):1216-33.
  - 16 Hurst SM, Wilkinson TS, McLoughlin RM, et al. Il-6 and its soluble receptor orchestrate a temporal switch in the pattern of leukocyte recruitment seen during acute inflammation. *Immunity*14(6) (2001):705-14.
  - 17 Naeni AE, Poostiyan N, Teimouri Z, et al. Assessment of Severity of Malnutrition in Peritoneal Dialysis Patients via Malnutrition Inflammatory Score. *Advanced Biomedical Research*6(1) (2017):128.
  - 18 Kalantar-Zadeh K, Kopple JD, Block G, et al. A malnutrition-inflammation score is correlated with morbidity and mortality in maintenance hemodialysis patients. *Am J Kidney Dis* 38 (2001):1251-63.
  - 19 Harvinder GS, Swee WC, Karupaiah T, et al. Dialysis malnutrition and malnutrition inflammation scores: Screening tools for prediction of dialysis-related protein-energy wasting in Malaysia. *Asia Pacific journal of clinical nutrition*25(1) (2016):26-33.
  - 20 Singh P, Shankar H, Singh TB, Singh S. NUTRITIONAL PARAMETERS IN CHRONIC KIDNEY DISEASE PATIENTS. *Indian Journal of Preventive & Social Medicine*47(1-2) (2016):7-17.
  - 21 Prasad N, Sinha A, Gupta A, et al. Validity of nutrition risk index as a malnutrition screening tool compared with subjective global assessment in end-stage renal disease patients on peritoneal dialysis. *Indian Journal of Nephrology*26(1) (2016):27.
  - 22 Afşar B, Sezer S, Ozdemir FN, et al. Malnutrition–inflammation score is a useful tool in peritoneal dialysis patients. *Peritoneal Dialysis International*26(6) (2006):705-11.
  - 23 Harty J, Faragher B, Venning M, et al. Urea kinetic modeling exaggerates the relationship between nutrition and dialysis in CAPD patients.(The hazards of cross-sectional analysis). *Peritoneal dialysis international*15(2) (1995):105-9.
  - 24 Combe C, Chauveau P, French Study Group Nutrition in Dialysis, et al. Influence of nutritional factors and hemodialysis adequacy on the survival of 1,610 French patients. *American Journal of Kidney Diseases*37(1) (2001):S81-8.