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Dialysis Adequacy and Nutritional Status in Patients on Maintenance Hemodialysis

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ABSTRACT

Introduction

Dialysis adequacy and malnutrition are key factors contributing to high mortality and morbidity rate in maintenance hemodialysis patients. Previous studies from Nepal have reported very low mean single-pool Kt/V and very high malnutrition rates. However, contemporary data on these parameters are lacking in Nepalese patients. So, this study was done to assess the current status of adequacy of dialysis, nutritional status and to determine the association between them in dialysis population in a tertiary care center of Nepal.

Methods

A cross-sectional study was conducted among 118 maintenance hemodialysis patients at Tribhuvan University Teaching Hospital. Dialysis adequacy was measured using spKt/V and nutritional status was assessed using MQSGA, anthropometric measurements and serum albumin. Chi-squared test, t-test and logistic regression analysis were done to determine independent factors associated with inadequate dialysis.

Results

The mean spKt/V was 1.3 ± 0.36, with 59.3% of patients achieved adequate dialysis. MQSGA showed that 62.7% of patients had normal nutrition, while 37.3% had mild-to-moderate malnutrition and none had severe malnutrition. Mid arm circumference and mid arm muscle circumference were significantly higher in patients with adequate dialysis. On logistic regress analysis, mid arm circumference was found to be an independent risk factor associated with inadequate hemodialysis (p = 0.03). MQSGA, triceps skinfold thickness, biceps skinfold thickness and serum albumin did not show significant associations.

Conclusion

Despite improvements in dialysis adequacy and nutritional status over time, many patients continue to receive inadequate dialysis and have malnutrition. Dialysis adequacy is significantly associated with objective measures of muscle mass rather than subjective nutritional scores, highlighting the importance of incorporating simple anthropometric assessments into routine care.

Keywords: *Dialysis adequacy; malnutrition; maintenance hemodialysis; anthropometry*

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INTRODUCTION

Despite the advancement in dialysis treatment, the morbidity and mortality among dialysis patients remain high[1], largely due to inadequate dialysis and malnutrition. The adequacy of dialysis is measured by using single pool Kt/V (spKt/V)[2] with a target of 1.4 per hemodialysis session for patients treated thrice weekly and minimum of 1.2[3]. Studies have demonstrated that adequate dialysis is linked to improved survival rates, as seen in Tassin, France with a spKt/V >1.6, and in Minnesota, USA with a spKt/V >1.3[4,5]. Malnutrition is another strong predictor of patient survival in dialysis patients affecting about 20 to 50%[6]. Additionally, inadequate dialysis and malnutrition may be interrelated, as patients receiving insufficient dialysis are often uremic and anorexic. In Nepal, many isolated studies have been done in either dialysis adequacy or nutritional status, but data on correlation between these two critical factors are lacking. Previous studies over a decade ago, reported very low mean spKt/V and very high malnutrition rates[7–11]. Contemporary data and the analysis of the relationship between the two are necessary to evaluate the current state of dialysis in Nepal and to guide future interventions. Therefore, this study was done to assess the current status of adequacy of dialysis, nutritional status and to determine the association between them in dialysis population in a tertiary care center of Nepal.

METHODS

It was a cross sectional study done in 118 patients in dialysis unit undergoing maintenance hemodialysis in Tribhuvan University Teaching Hospital. Ethical approval was taken from Institutional Review Committee. After taking patient consent, data was collected using a proforma from 1st August, 2024 to 1st March, 2025. Demographic variables and clinical history variables were recorded. Nutritional status was measured using weight, height, body mass index (BMI), Triceps skinfold thickness (TSF), Biceps skinfold thickness (BSF), Mid arm circumference (MAC), Mid arm muscle circumference (MAMC), serum albumin and Modified quantitative Subjective global assessment score (MQSGA)[12]. All the patients underwent hemodialysis for 4 hours in each session using Fresenius 4008S machine with single use dialyzer of 1.6m^2 surface area. The blood flow ranged from 250-300ml/min with a fixed dialysate flow of 500ml/min. Dialysis adequacy was measured using spKt/V using the following formula[13].

spKt/V = -ln((Post BUN/Pre BUN)- 0.008 × t) + (4 - 3.5 × (Post BUN/Pre BUN)) × (UF/Weight)

Where, Post BUN= level of post-dialysis Blood Urea Nitrogen, in mg/dl, Pre BUN= level of pre-dialysis Blood Urea Nitrogen, in mg/dl, t = Duration of HD, in hours, UF = volume of removed ultrafiltrate, in liters (L), Weight = post-dialysis weight, in kilograms (kg), ln = logarithm with the base of 2 → the natural logarithm.

Blood Urea level post dialysis was taken as per the KDOQI guidelines. The ultrafiltration rate was first set to zero. Then, the blood pump was slowed to 100 ml per minute for 10–20 seconds, the blood pump was then stopped and sample was drawn from arterial blood line sampling port and sent for analysis. Anthropometric measurements were done 10–20 minutes after completion of hemodialysis. BSF and TSF were measured with a conventional caliper. MAC was measured using tape measure. BMI and MAMC were calculated using the following formulas.

Body mass index = post dialysis body weight (kg) / square of height (m) (kg/m2)

Mid arm muscle circumference= MAC (cm)-(0.3142* TSF (mm))

MQSGA score was calculated with seven components namely weight change, dietary intake, gastrointestinal symptoms, functional capacity, comorbidity, subcutaneous fat, and signs of muscle wasting. Each component had a score from 1 (normal) to 5 (very severe). Sum of all components ranged from 7 to 35. Patients were categorized into three groups: normal nutrition (score of 7–10), mild-to-moderate malnutrition (score of 11–20) and severe malnutrition (score of 21–35).

Statistical analysis was conducted using IBM SPSS Statistics version 26. Categorical variables were presented as percentages, while continuous variables were reported as mean ± standard deviation. The Chi-squared test and Student's t-test was done to assess association between categorical variables and continuous variables respectively. To

determine independent associations, logistic regression analysis was performed. A two-tailed p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 118 patients on maintenance hemodialysis were included in the study. Among them 78 (66.1%) were male and 40 (33.9%) were female. The mean age of the patients was 44.33 ± 15.53 years. Other demographic and clinical characteristics of the patients are shown in Table 1.

Table 1. Demographic and clinical characteristics of the patients

Patient characteristics	Count (percentage)
Number of Patients	118
Age	
Mean	44.33 ± 15.53 years
Range	18-76 years
Gender	
Male	78 (66.1%)
Female	40 (33.9%)
Cause of CKD	
Hypertension	89
Diabetes mellitus	18
ADPKD	1
Undetermined	10
Frequency of HD	
Once a week	1
Twice a week	74
Thrice a week	43
Dialysis vintage	
< 1 year	26
1-2 years	26
2-5 years	39
> 5 years	27

According to the MQSGA score, 74 patients (62.7%) had normal nutrition, 44 patients (37.3%) had mild to moderate malnutrition and none of the patients had severe malnutrition. The anthropometric parameters are shown in Table 2. The mean spKt/V was 1.3 ± 0.36. 70 patients (59.3%) had spKt/V of ≥ 1.2, showing adequate hemodialysis while rest of the patients (40.7%) had spKt/V of <1.2.

Table 2. Anthropometric parameters of the patients

Patient characteristics	Mean ± SD
Weight (kg)	54.15 ± 10.75
Height (cm)	156.37 ± 8.37
Body mass Index (kg/m^2)	22.16 ± 4.24
Triceps skinfold (mm)	6.0 ± 1.72
Biceps skinfold (mm)	3.20 ± 1.36
Mid arm circumference (cm)	23.58 ± 2.93
Mid arm muscle circumference (cm)	21.69 ± 2.92
Arm muscle area (cm^2)	37.63 ± 10.46
Serum Albumin (gm/L)	32.40 ± 4.82
MQSGA score	
Normal (7-10)	74 (62.7%)
Mild to moderate (11-20)	44 (37.3%)
Severe (21-35)	0
spKt/V	1.3 ± 0.36
Mean	48 (40.7%)
< 1.2	70 (59.3%)
≥ 1.2	

The association of spKt/V with all the nutritional, biochemical parameter and frequency of HD showed a significant association of spKt/V with mid arm circumference and mid arm muscle circumference (Table 3). Logistic regression analysis also showed mid arm circumference as an independent risk factor associated with inadequate hemodialysis (Table 4).

Table 3. Comparison of spKt/V with nutritional and biochemical parameters

Patient parameters		spKt/V		P value
		< 1.2	≥ 1.2	
Frequency of HD	Once a week	0	1	0.46
	Twice a week	28	46	
	Thrice a week	20	23	
Triceps skinfold (mm)		5.75 ± 1.38	6.18 ± 1.90	0.19
Biceps skinfold (mm)		3.18 ± 1.50	3.21 ± 1.27	0.90
Mid arm circumference (cm)		22.77 ± 2.18	24.13 ± 3.25	0.01
Mid arm muscle circumference (cm)		20.96 ± 2.14	22.19 ± 3.27	0.02
Serum albumin (gm/L)		31.53 ± 4.55	32.99 ± 4.94	0.10
MQSGA score		9.94 ± 1.64	10.16 ± 1.90	0.51

Table 4. Logistic regression analysis for factors with associated with inadequate hemodialysis

Patient parameters	P value	95.0% Confidence Interval	
		Lower Bound	Upper Bound
Triceps skin fold	0.33	-0.030	0.087
Biceps skin fold	0.67	-0.089	0.058
Mid arm circumference	0.03	0.002	0.064
Serum albumin	0.27	-0.008	0.030
MQSGA score	0.43	-0.030	0.070

DISCUSSION

Dialysis adequacy is a multifaceted concept that includes urea clearance, middle molecule removal, volume balance, nutritional status and overall quality of life. Inadequate dialysis is associated with increased risk of complications, higher rate of hospitalization and elevated mortality. This study evaluated the current status of dialysis adequacy and nutritional status using the subjective and objective measures in patients on maintenance hemodialysis. In our study, the mean spKt/V was 1.3 ± 0.36 and 59.3% patients had adequate dialysis. When compared to previous studies done in Nepal, our findings shows clear improvement of dialysis adequacy over time. For instance, a study done in 2009 by P. Sultania et al with only 14 patients, showed a lower mean spKt/V of 0.99, suggesting inadequate dialysis[7]. In another study, done by D.N. Manandhar et al (2009) also showed lower mean spKt/V of 0.95 in 60 patients[10]. Another study done in TUTH (2017) by Baral et al in 50 patients showed mean spKt/V of only 1.15[9]. This increase in spKt/v in our study compared to previous studies could be attributed to advancement in dialysis practices such as discontinuation of dialysis reuse, better patient monitoring and better expertise in the field of Nephrology and renal nutrition during this time to better handle and monitor complications.

Our study showed nutritional status as evaluated by MQSGA score to be normal in 74 patients (62.7%) and mild to moderate malnutrition in 44 patients (37.3%). Encouragingly, none of our patients showed severe malnutrition. When compared to previous studies, D.N. Manandhar et al (2009) reported malnutrition in more than 90% of patients with severe malnutrition in 7.7%[11]. Similarly, a study by A. Sedhain et al (2015) found malnutrition in 66.7% of patients and like in our study, it did not report any patients with severe malnutrition[8]. The lower rates of malnutrition in our study may reflect greater degree of awareness among patients, addition of nutritional support and dietary counselling in the dialysis centres and progressive improvements in dialysis practices over time.

Our study found that mid arm circumference and mid arm muscle circumference were

significantly associated with Kt/V ≥ 1.2 with p value of 0.01 and 0.02 respectively, suggesting that inadequate dialysis may contribute to muscle wasting. Since muscle mass is a key predictor of survival in dialysis patients, inadequate dialysis could lead to malnutritional and poor overall outcomes[14]. Both triceps and biceps skinfold thickness were not significantly associated with spKt/V, which may imply that dialysis adequacy may not have major impact on fat stores. The MQSGA score was also not significantly associated with spKt/V. This may imply that nutritional status in maintenance hemodialysis patient is multifactorial that is affected by systemic inflammation, oxidative stress, comorbid illnesses, anorexia, dietary intake, socioeconomic status and other factors, far beyond the effects shown by urea clearance[15]. Dialysis adequacy evaluated by spKt/V reflects a urea clearance of only a single session which may not tell us the whole picture. MQSGA on the otherhand, captures the chronic nutritional state with component such as weight change and functional state evolving over weeks to months. MQSGA has interobserver variability and depends on clinical judgement. So, the lack of association between MQSGA and dialysis adequacy in our study may be explained by inherent limitation of spKt/V and MQSGA. Additionally, the narrow distribution of MQSGA scores and absence of severe malnutrition in our study may have reduced the ability to detect sutble but significant differences. In study done in 65 patients, Agatha et al also did not find association between Malnutrition scores and Kt/V in patients in maintenance hemodialysis[16].

Logistic regression analysis showed that only mid arm circumference was an independent risk factor associated with inadequate hemodialysis. This finding highlights the need of inclusion of objective parameters such as MAC alongside subjective assessment when evaluating nutritional status of dialysis patients in resource limited setting where advanced body composition analysis may not be available.

This study has several limitations. It a cross-sectional study that does not show causal relationships and has a modest sample size from a single center that may limit generalizability. But the findings in our study gives an insight into the complex relationship between dialysis adequacy and nutritional parameters and highlights the need for larger, multicenter, longitudinal studies to better define the relationship between dialysis adequacy and nutritional status.

CONCLUSION

Despite improvements in dialysis adequacy and nutritional status over time, many patients continue to receive inadequate dialysis and have malnutrition. Dialysis adequacy is significantly associated with objective measures of muscle mass rather than subjective nutritional scores, highlighting the importance of incorporating simple anthropometric assessments into routine care.

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