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CORRELATION BETWEEN ANTHROPOMETRY, BIOCHEMICAL MARKERS AND SUBJECTIVE GLOBAL ASSESSMENT – DIALYSIS MALNUTRITION SCORE AS PREDICTORS OF NUTRITIONAL STATUS OF THE MAINTENANCE HEMODIALYSIS PATIENTS

Vanitha Rani N[1], S. Kavimani[2], Soundararajan P[3], Chamundeeswari D[4], Kannan Gopal[5]

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Authors details:
[1]Lecturer, Department of Pharmacy Practice, [4]Principal, Faculty of Pharmacy, Sri Ramachandra University Chennai, Tamilnadu, India
[2]Professor & Head, Department of Pharmacology, Mother Theresa Post Graduate and Research Institute of Health Sciences, Pondicherry.
[3]Professor & Head, Department of Nephrology, Sri Ramachandra Medical Center, Chennai
[5]Professor & Head, Department of Pharmacy Practice, Saastra College of Pharmaceutical Education and Research, Nellore

Corresponding author: N. Vanitha Rani
[1]Lecturer, Department of Pharmacy Practice, Faculty of Pharmacy, Sri Ramachandra University. Chennai, Tamilnadu, India
Email: vanithak9@rediffmail.com

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ABSTRACT

Background: Protein energy malnutrition is the major cause of poor prognostic outcome in patients on maintenance hemodialysis (MHD). The assessment of nutritional status in patients on maintenance hemodialysis should be done both subjectively and objectively by integrating clinical, biochemical and anthropometric measurements. A study was conducted to assess the possible correlations between the subjective global assessment-dialysis malnutrition score (SGA-DMS), anthropometric measurements, and biochemical parameters in hemodialysis patients. **Methods**: The study included 90 patients (55 males and 35 females; age range of 25 to 73 years; mean age 52.62 ± 11.7 years) undergoing twice/thrice weekly maintenance hemodialysis for six months and above in the dialysis unit of a tertiary care teaching hospital. The MHD patients were assessed by SGA -DMS, anthropometry and biochemical indicators (serum albumin, iron, ferritin and transferrin) of nutritional status. **Results:** According to the SGA-DMS 54.4 % were moderate to severely malnourished, 31% were mild to moderately nourished and 14.4% were well nourished. There was a highly significant negative correlation between SGA –DMS and serum albumin, iron, transferrin; positive correlation between SGA-DMS and ferritin (P<0.0001). Body mass index, upper arm circumferences, and skin fold thickness had a highly significant negative correlation with SGA-DMS (P<0.001), where as the lean body mass, total body water and the fat free mass had a significant negative correlation (P<0.05). **Conclusion:** SGA-DMS correlated with anthropometric and biochemical parameters that are indicative of nutritional status. SGA –DMS used in conjunction with other objective nutritional assessment methods may be of greater impact in determining nutritional status of hemodialysis patients.

INTRODUCTION

Protein energy malnutrition (PEM) is highly prevalent in patients on maintenance hemodialysis (MHD) and is strongly associated with poor clinical outcomes in these patients.[1] Dietary restriction, increased protein catabolism due to inflammatory cytokines, anorexia, uremic toxins and metabolic acidosis as well as a decrease in anabolic hormones, contribute to malnutrition in chronic hemodialysis patients. [2] Assessment of nutritional status is often ignored in many dialysis centers while periodical assessment of the nutritional status by simple methods could have a beneficial impact on the patients. Hence it should be part of the follow-up of dialysis patients, and is fundamental for preventing, diagnosing and treating PEM. Early detection and management of PEM plays a pivotal role in reducing complications and mortality in patients on MHD.[3] According to the National Kidney Foundation/Dialysis Outcome Quality Initiative Guidelines (National Kidney Foundation, 2002), the assessment of nutritional status in CKD patients on MHD should be made by integrating clinical, biochemical and anthropometric parameters. [4] The anthropometric measurements includes measurement of body mass index, lean body mass, skin fold thickness, mid arm circumference (MAC) and mid arm muscle circumference (MAMC). [5,6]

Subjective global assessment –Dialysis malnutrition score (SGA-DMS) is a fully quantitative reproducible instrument for assessing the nutritional status of dialysis patients. [7, 8] Among the biochemical markers serum albumin and transferrin have been proved to be useful indicators of PEM. [9] Several factors, such as altered protein synthesis, over hydration, reduced protein intake, bowel malabsorption and protein losses (as during nephrotic syndrome) influence plasma albumin concentrations, thus making hypoalbuminemia a marker of PEM. Transferrin, with a half-life of 7 – 8 days, rises in iron deficiency, whilst its decrease indicates iron overload or inflammation. Compared to serum albumin, serum transferrin is a more sensitive marker (due to its short half life) of nutritional status, and of the visceral protein pool. [10]
Serum ferritin is frequently used as a marker of iron status in patients on hemodialysis. According to National Kidney Foundation (NKF) Kidney Disease and Dialysis Outcome Quality Initiative guidelines, serum ferritin level >800 ng/ml in MHD patients may reflect iron overload. However, serum ferritin is an acute phase reactant and a better indicator of inflammation which is closely related to PEM in dialysis patients. [11, 12] This study was conducted to determine the prevalence of PEM in MHD patients using the SGA-DMS and to analyze possible correlations between SGA-DMS

and different indicators of nutritional status including the anthropometric measurements and biochemical markers of malnutrition.

MATERIALS AND METHODS

A **cross-sectional study** was conducted in 90 patients, aged above 18 years, diagnosed with stage V Chronic Kidney Disease, undergoing twice or thrice weekly maintenance hemodialysis for 6 months and above in the dialysis unit of a tertiary care teaching hospital, after obtaining the approval of the Institutional Ethics Committee and the informed consent of the patients. Patients with inflammatory diseases, smoking history, acute illness, long term therapy with steroids and immunosuppressant, known malignancies, patients on once weekly maintenance hemodialysis (MHD) and patients on enteral or parenteral nutrition were excluded from the study. On initiation, data including demographics, medical history and duration of dialysis was obtained from patients' cases records and direct history interview of the patients. The assessment of nutritional status was done by Subjective Global Assessment-Dialysis Malnutrition score (SGA-DMS).

SGA-DMS is a fully quantitative scoring system consisting of seven features: weight change, dietary intake, gastrointestinal symptoms, functional capacity, co morbidity, subcutaneous fat and signs of muscle wasting. Each component has a score from 1(normal) to 5 (very severe). Thus the malnutrition score (sum of all seven components) is a number between 7(normal) to 35 (severely malnourished). A lower score denotes normal nutritional status and a higher score is an indicator of the presence of malnutrition elements, that is the higher the SGA-DMS the stronger the tendency towards protein energy malnutrition. [7]

Anthropometric Indices:

The following measurements were performed between 10-20 minutes after termination of dialysis session.

1. Body mass index (dry body weight in kg/ height in m^2)[13] Dry body weight is the weight obtained by the end of dialysis without causing hypotension and /or cramps.
2. Mid arm circumference (MAC) was measured with a plastic tape on the non dialysis access arm for three times and average result of the three measurements was taken as final measurement [14]
3. Triceps skin fold thickness (TSF) was measured with a conventional skinfold caliper (Harpenden caliper) on the non-dialysis access arm using standard techniques for three times and average result of the three measurements was taken as final measurement [15]
4. Mid arm muscle circumference (MAMC) is a measure for muscle mass in the body measured together with the triceps skinfold assuming that the measured muscle circumference is representative for the rest of the body. It was calculated using the following equation [15] MAMC (cm) = MAC -3.1415 × triceps skin fold thickness
5. Mid arm muscle area (MAMA) is an estimation of the area of the bone and muscle portions of the upper arm. It was calculated using the formula [16]

MAMA = [Mid arm circumference (cm) – (3.14 × TSF cm)]^2 - 10 (males) or - 6.5 (females)

4π

6. Mid arm fat area (MAFA) [16]:
   MAFA = (MAC × TSF)/2 – π(TSF)^2/4
7. Lean body mass (LBM) is an estimation of difference between the total body mass (weight in kg) and weight of the body fat. LBM was obtained using the formula [17]
   LBM in kgs (men) = (1.10 × Weight (kg)) – 128 × (Weight ^{2}/ (100 × Height (m))^2)
   LBM in kgs (women) = (1.07 × Weight (kg)) – 148 × (Weight ^{2}/ (100 × Height (m))^2)
8. Ideal Body weight (IBW) was calculated using Devine formula [18]
   IBW in kgs (men) = 50 kg + 2.3 kg * (Height (in) - 60)
   IBW in kgs (women) = 45.5 kg + 2.3 kg *(Height (in) - 60)
9. Total body water (TBW) gives the Urea volume of distribution. It is calculated from the formula by Watson [19]
   Male TBW (liters) =2.447 - (0.09156 x age) + (0.1074 x height) + (0.3362 x weight)
   Female TBW (liters) = - 2.097 + (0.1069 x height) + (0.2466 x weight)

The biochemical parameters estimated for the study population after the dialysis session included serum albumin, iron, ferritin and transferrin by routine laboratory methods.

Statistical Analysis:

The analysis was performed using SPSS 16.0 version. Categorical variables were expressed as frequency and percentage and Continuous variables were expressed as mean ± standard deviation. The statistical analysis of differences in the anthropometric indices and the biochemical markers of the case population with respect to their nutritional status as per SGA-DMS were done using One way ANOVA with Tukey's Post-Hoc test. Pearson's correlation was done to assess the strength of association between the anthropometric indices, biochemical parameters and the SGA-DMS. A P value of < 0.05 was considered statistically significant.

RESULTS

The study was conducted in 90 patients (55(61%) males and 35(39%) females) undergoing twice/thrice weekly maintenance hemodialysis. The age range of the study population was 18 to 73 years and the mean age was 52.62 ± 11.7 years. Majority of the patients were in the age range of 46 to 55 (39%) and above 55 years (42%). The mean dialysis vintage of the study population was found to be 20.99 ± 12.08 months. The primary causes of renal disease in the study population were diabetic nephropathy in 43.3% patients, hypertensive nephropathy in 30%, polycystic kidney disease in 12.2 %, glomerulonephritis in 10% pyelonephritis in 3.4% and neurogenic bladder in 1.1% patients.

The overall mean SGA-DMS score was found to be 19.71 ± 7.5. Based on the SGA-DMS, 49 (54.4 %) patients were moderate to severely malnourished with a score range of

21 to 35 (mean score 25.55 ± 3.8), 28 (31%) patients were mild to moderately malnourished with a score range of 11 to 20 (mean score 14.50 ± 3.23) and 13 (14.4%) patients were well nourished with a score range of 7 to 10 (mean score 8.92 ± 1.15) .

The mean values of the anthropometric indices and the biochemical markers of the nutritional status of the study population based on the SGA-DMS are expressed in Table 1. There was a statistically significant difference in the mean body mass index, triceps skin fold thickness, mid arm circumference, mid arm muscle circumference, mid arm muscle area and mid arm fat area of the study population based on their nutritional status as per the SGA-DMS($P<0.05$). The mean body mass index, dry body weight, lean body mass, ideal body mass, total body water, fat free mass and the total body fat were also found to be higher in well nourished patients than the moderately and severely malnourished patients but the differences were not statistically significant. The mean values of serum albumin, iron and transferrin were found to decrease with respect to the increase in the SGA-DMS ($P<0.001$). The serum ferritin levels were found to increase with an increase in the SGA-DMS ($P<0.001$) reflecting the inflammatory status in malnourished patients.

There was a significant negative correlation between the anthropometric indices BMI, triceps skinfold thickness, mid arm circumference, mid arm muscle circumference, mid arm muscle area, mid arm fat area, lean body mass, fat free mass and the mean SGA - DMS. The anthropometric parameters were significantly lower for the patients with higher SGA-DMS values. The mean ideal body mass, total body water and total body fat had no correlation with the SGA - DMS. Serum albumin, iron and transferrin had a statistically significant negative correlation with SGA-DMS and serum ferritin had a highly significant positive correlation with SGA-DMS ($P<0.001$) (Table 2).

TABLE 1 - ANTHROPOMETRY AND BIOCHEMICAL MARKERS OF NUTRITIONAL STATUS AS PER SGA-DMS

Parameters	Mean ± SD			Significance P
	Well nourished (n=13)	Mild to Moderately malnourished (n=28)	Moderate to Severely malnourished (n=49)	
Dry body weight (kg)	57.71 ± 10.03	55.06 ± 8.02	51.87 ± 11.89	0.157
Body Mass Index (kg/m^2)	23.34 ± 3.39	22.11 ± 2.59	20.63 ± 3.59	0.02*
Mid arm circumference (cm)	22.25 ± 2.27	21.49 ± 1.94	18. 65 ± 4.27	< 0.0001**
Mid arm muscle circumference (cm)	18.46 ± 1.53	18.05 ± 1.47	15.82 ± 3.23	< 0.0001**
Triceps skin fold thickness (mm)	12.01 ± 2.67	10.96 ± 1.92	9.27 ± 3.47	0.004*
Mid arm muscle area (cm^2)	27.35 ± 4.5	26.09 ± 4.18	20.59 ± 8.23	< 0.0001**
Mid arm fat area (cm^2)	12.42 ± 3.89	10.99 ± 2.78	8.56 ± 4.79	0.004*
Lean Body mass (kg)	46.85 ± 6.31	45.68 ± 6.97	42.27 ± 9.17	0.141
Ideal body mass (kg)	55.04 ± 8.43	54.38 ± 9.33	53.71 ± 6.49	0.782
Total body water (L)	31.92 ± 3.87	31.89 ± 4.41	30.44 ± 5.46	0.381
Fat free mass (kg/m^2)	44.33 ± 5.37	44.29 ± 6.17	42.27 ± 7.58	0.385
Total body fat (kg)	10.36 ± 3.42	9.46 ± 2.18	8.24 ± 2.37	0.261
Serum albumin (g/dL)	3.44 ± 0.562	3.66 ± 0.34	3.26 ± 0.431	< 0.0001**
Serum iron (μg/dL)	88.92 ± 32.72	75.43 ± 24.40	64.84 ± 17.78	0.002**
Serum ferritin (ng/mL)	261.36 ± 72.95	277.5 ± 70.43	374 .19 ± 186. 08	0.003*
Serum transferrin (mg/dL)	237.69 ± 35.16	202. 29 ± 35.93	170.16 ± 39.09	< 0.0001**

** $P<0.001$- highly significant; *$P<0.05$- significant

TABLE 2- CORRELATION BETWEEN SGA-DMS AND ANTHROPOMETRY BIOCHEMICAL MARKERS OF NUTRITIONAL STATUS

Variable	Pearson Correlation (r)	P value
Body Mass Index (kg/m^2)	-0.463	<0.001**
Mid arm circumference (cm)	-0.597	<0.001**
Mid arm muscle circumference (cm)	-0.585	<0.001**
Triceps Skin fold thickness (mm)	-0.518	<0.001**
Mid arm muscle area (cm^2)	-0.586	<0.001**
Mid arm fat area (cm^2)	-0.529	<0.001**
Lean Body mass (kg)	-0.318	0.002*
Ideal body mass (kg)	0.059	0.58
Total body water (L)	-0.204	0.054
Fat free mass (kg/m^2)	-0.210	0.047*
Total body fat (kg)	-0.164	0.12
Serum albumin (g/dL)	-0.435	< 0.001**
Serum iron (µg/dL)	-0.428	< 0.001**
Serum ferritin (ng/mL)	0.618	< 0.001**
Serum transferrin (mg/dL)	- 0.486	< 0.001**

** P<0.001 - highly significant; *P<0.05 - significant

DISCUSSION

Nutritional assessment is a vital function of healthcare providers. The nutritional status of hospitalized patients can be assessed by a variety of methods. Subjective Global Assessment – Dialysis Malnutrition Score (SGA -DMS) is a fully quantitative nutritional status assessment tool which is widely used in patients on maintenance hemodialysis both in clinical practice and in research.

In the present study, based on the SGA-DMS, 31.1% of the patients were mild to moderately and 54.4% were moderate to severely malnourished. A study conducted by Janardhan et al, reported that 91% of patients on MHD were mild to moderately malnourished. [20] Similarity Faintuch et al, also reported severe malnutrition in 13% of their study population. [21]

In this study, SGA-DMS negatively correlated with anthropometric measurements such as body weight, body mass index, TSF and MAC and biochemical parameters such as serum albumin, iron and transferrin. Kalantar-Zadeh et al, found that SGA-DMS was significantly correlated with anthropometric parameters like MAMC, MAC, BMI, TSF and TIBC. A study done by Janardhan et al, also reported the same. [20]

Serum albumin has frequently been used as a marker of nutritional status. In the present study, like many other studies a statistically significant lower level of serum albumin was observed in HD patients with moderate to severe malnutrition and the albumin levels negatively correlated with the SGA-DMS. The systemic inflammatory response can present as an important cause of protein wasting in chronic renal disease by causing anorexia and increase protein catabolism. [22-26]

Most biochemical markers such as serum albumin or transferrin are useful in identifying patients with deteriorating nutritional state. Kalantar Zadeh et al, also suggested that transferrin values are superior to other biochemical markers in assessing nutrition and will supplement SGA criteria. They also suggested that serum ferritin may be useful as a predictor of inflammation associated PEM. [26] There are multiple causes of malnutrition in HD patients. An ideal protocol for early diagnosis of PEM in these patients has not yet been formed. Hence, a combination of valid complementary measures is to be adopted to assess the nutritional status in maintenance dialysis patients rather than any single measure alone to obtain a better clinical outcome.

Limitations of the study: Small sample size and cross sectional study design.

CONCLUSION

Patients on maintenance hemodialysis have moderate to severe protein energy malnutrition. The present study showed the correlation between SGA-DMS and some biochemical and anthropometric indices of malnutrition. Therefore, we conclude that SGA- DMS when used with objective methods may be of greater significance in determining nutritional status of hemodialysis patients.

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Conflict of Interest: Nil

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