

Major Barriers Responsible for Malnutrition in Hemodialysis Patients: Challenges to Optimal Nutrition

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Background: Nutritional barriers may contribute to malnutrition in hemodialysis (HD) patients. Higher rates of morbidity and mortality rates have been reported in malnourished HD patients. These patients are faced with different challenges affecting their nutritional status.

Objectives: The aim of this cross-sectional study was to identify most important barriers responsible for malnutrition in HD patients.

Patients and Methods: We randomly selected 255 of 800 stable HD patients from three HD centers with an age range of 18-85 years, who had been on hemodialysis for at least three months without any acute illness. Each patient was interviewed to evaluate malnutrition [subjective global assessment (SGA), malnutrition inflammation score (MIS)], and potential medical, behavioral and socioeconomic barriers. Body composition of patients was checked through bioelectrical impedance analysis (BIA). Routine clinical markers of malnutrition such as serum albumin and total protein were measured using standard automated techniques. Binary logistic regression model was used to find the association between nutritional markers and potential barriers.

Results: Patients with higher SGA had lower knowledge about general nutrition [odds ratio (OR), 1.3], potassium (OR, 1.89), difficulty chewing (OR, 1.16), and shopping (OR, 1.16). Those with greater MIS scores had poor appetite (OR, 1.3), depression (OR, 1.21), and difficulty with cooking (OR, 1.15). Lower BCM (body cell mass) was associated with poor appetite (OR, 0.92) and needed help for cooking (OR, 0.88). Patients with higher BFMI (body fat mass index) had insufficient general nutrition (OR, 1.15), and protein (OR, 1.27) knowledge, and needed help for shopping (OR, 1.14). Moreover, patients with higher SGA scores were those with older age and longer duration of HD.

Conclusions: Three medical barriers (poor appetite, depression and difficulty chewing), one behavioral barrier (poor total nutrition, protein, and potassium knowledge), and one socioeconomic barrier (needing help for shopping and cooking) were independently associated with nutritional markers.

Keywords: Malnutrition; Hemodialysis; Anorexia; Uremia

1. Background

Malnutrition in the form of protein energy wasting (PEW) is highly prevalent in maintenance hemodialysis (HD) patients and associated with adverse clinical outcomes, hospitalization, higher morbidity and mortality rates (1-4). A number of factors could disturb nutritional and metabolic status in these patients. Uremic state, inflammation, depression, inability to prepare food, low quality of life, unfavorable restricted diets, dialysis procedure itself and concurrent catabolic illnesses lead to anorexia in hemodialysis patients and finally poor nutrient intake (1, 5-8). Malnutrition and associated chronic inflammation are responsible for cardiovascular mortality in dialysis patients (9). The more severe the malnutrition is, the poorer the quality of life of HD patients would be (10). Nutritional status of HD patients could be assessed by different methods, such as subjective global assess-

ment (SGA), malnutrition inflammation score (MIS), markers of body composition measured by bioelectrical impedance analysis (BIA), predialysis serum creatinine, albumin (3, 11), and interdialytic weight gain (IDWG) (12). Compliance with fluid restriction and calorie and protein intake could be assessed by IDWG (12). Dialysis adequacy is an important factor in maintaining good nutritional status. Low-dose dialysis was associated with malnutrition (13, 14). Anorexia is a prevalent characteristic in HD patients (15, 16), which aggravates the disease due to higher inflammation (16). Nutritional education programs aimed to improve dietary knowledge could be useful in treating malnutrition and decreasing mortality in patients on hemodialysis (17). Depression is an important risk factor affecting mortality rate in HD patients in the same way of other medical risk factors (18). It has

been shown that nutritional status markers are strong predictors of health-related quality of life in HD patients; thus, identification of nutritional barriers and targeting them through nutritional strategies would result in better health outcomes (19, 20).

2. Objectives

This study aimed to identify different potential barriers including medical, behavioral, and socioeconomic ones in HD patients. These barriers are difficult to search in HD population. Therefore, we emphasized to evaluate the relationship between nutritional status and presence or absence of each of these barriers. Consequently, targeted interventions could improve nutritional status of HD patients after recognizing most important barriers.

3. Patients and Methods

3.1. Participants

This cross-sectional study was conducted from September 2012 to March 2013 at three referral hemodialysis centers. After screening all 800 patients under regular HD in these centers, 255 stable HD patients with an age range of 18-85, who had been on hemodialysis for at least three months without any acute illness, were selected using random number generator. An informed consent was obtained from all subjects to participate in this study. They underwent dialysis at least twice a week by high flux dialyzer with reverse osmosis purified water and bicarbonate containing dialysate. Patients with mental disorders and deafness were excluded from the study due to lack of communication. This study was performed in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines and was approved by the Ethics Committee of Shiraz University of Medical Sciences.

3.2. Patient Interview and Nutritional Status Assessment

After obtaining an informed consent, each patient was interviewed during the HD session by the investigator who was an experienced renal dietitian and four questionnaires (SGA, MIS, Beck Depression Inventory, and Nutritional Barriers) were filled out. SGA questionnaire is a useful tool to evaluate nutritional status in HD patients. It includes questions on physical examination (muscle and subcutaneous fat wasting, edema), and nutritional history (weight change in preceding two weeks and six months, appetite, food intake and gastrointestinal symptoms). The overall status was interpreted based on the sum of scores as follows (the score for each item from zero to Five). Scores less than 10 were considered as well-nourished, 10-17 mildly to moderately malnourished, and more than 17 as severely malnourished (21).

MIS (Malnutrition inflammation score) scoring system is more quantitative and comprehensive than SGA. It has

all similar parts explained earlier in SGA. It also includes two nutritional laboratory markers (albumin and transferrin). Each item scores from 0 to 3. The sum of scores of all 10 components could be a good indicator of nutritional status. The higher the score was, the more severe the malnutrition and inflammation was (22). Questions of these two questionnaires were read to each patient. The Beck Depression Inventory (BDI) scoring system was used to assess the severity of depression (23-25). This is a multiple-choice questionnaire assessing depression symptoms. The value of each component ranges from 0 to 3. At the end, the sum of scores was as follows: 0 to 9: no depression; 10 to 13: borderline; 14 to 19: mild depression; 20 to 28: moderate depression; 29 to 63: severe depression. Higher scores were indicative of more severe depression.

Nutritional barriers questionnaire was a tool to detect medical (poor appetite, inadequate dialysis, difficulty chewing and swallowing, depression and gastrointestinal disorders), behavioral (general nutrition knowledge and dietary compliance), and socioeconomic (having enough money to buy food, needing help for shopping and cooking) barriers related to nutritional status. Nutrition knowledge was evaluated by the correct number of potassium-rich, high phosphorus, and protein containing foods included in the questionnaire. Dietary compliance was determined by estimating patients' fluid intake through interdialytic weight gain. Flow sheets of the first 6 HD sessions of the enrollment month for each patient were checked over for the records of interdialytic weight gain and post-dialysis dry weight. Patients with a mean interdialytic weight gain less than 2.5% of their dry weight were considered as being dehydrated and having the barrier of low fluid intake. We also calculated Kt/V for each dialysis treatment according to pre- and post-dialysis urea values, amount of fluid removed and treatment duration. Patients with a mean Kt/V less than 1.2 in a 3-month period before the interview were dialyzed inadequately and had this barrier. Patients were asked whether they could afford purchasing food, and also if they needed additional help for shopping or cooking. Patients who said yes were considered to have this barrier. Answers were designed in a five point Likert scale and summarized in two groups of "yes" (patient had the barrier) or "no" (coded as 1 or 0 for each barrier), respectively. This questionnaire was developed according to the work developed by Sehgal et al. (26). We changed some items based on Iranian's culture and food habits. The reliability of this questionnaire was verified by test retest assessment on 35 patients interviewed at least twice with 2-7 days interval. The reliability of each item was in the range of 91% to 100%.

Nutritional status of all patients was checked by bio-electrical impedance analysis (BIA) for fat mass, lean mass, body cell mass (BCM), body mass index (BMI), body fat mass index (BFMI), and fat-free mass index (FFMI). BIA is a simple and noninvasive technique to determine

body composition and fluid status in HD patients (27). A multi-frequency bio impedance spectrum analyzer device (Bodystat, UK) was used to measure body composition. The measurement was performed for each patient 30 minutes after the end of midweek dialysis session. Four electrodes were placed on the right hand and foot or on the side contralateral to the arteriovenous fistula, of supine patients. Two runs of measurements were performed to recheck the accuracy of data.

Demographic data (age, gender, height, pre and post dialysis weight, cause of renal failure, marital status, education level, employment, and duration of HD) were obtained using medical records. Routine laboratory markers (Table 1) were assessed monthly for each patient using standard automated techniques. The mean value of measured factors in 90 days interval before the interview was used in our study.

3.3. Statistical Analysis

Statistical analyses were performed using SPSS version 18 (SPSS Inc., Chicago IL) statistical software package. We used binary logistic regression analysis to verify which potential barriers were independently related to nutritional status. This type of regression analysis yielded regression coefficients, odds ratios (ORs), and P values. Independent variables were nutritional status markers (serum albumin and total protein, SGA, MIS, BMI, BCM, BFMI and FFMI). Dependent variables were potential identified barriers categorized into two groups of Yes/No coded as 1/0. We also had separate analysis with serum albumin and SGA using the χ^2 test to detect the association between these two nutritional markers and patients' demographic characteristics. P values < 0.05 were considered statistically significant.

4. Results

From 800 patients in three hemodialysis centers, 255 were selected randomly based on the inclusion criteria. Demographic and clinical characteristics of patients were shown in Table 1. Of total patients, 42% were female and 58% male. Moreover, 47% of patients had renal failure due to diabetes. Nutritional status was assessed through different markers (serum albumin, total protein, SGA, MIS, BMI, BCM, BFMI and FFMI). The most important ones were SGA and serum albumin. According to the SGA classification, 71.4% of patients were moderately to severely malnourished (SGA score > 10). Regarding serum albumin, only 10.6% of patients had albumin values below 3.5 g/dL. The mean values of other nutritional markers are shown in Table 1.

All three types of potential barriers (medical, behavioral and socioeconomic) were found in patients; poor appetite (84.7%), inadequate dialysis (21.2 %), difficulty chewing (19.6%) and swallowing (9%), depression (73.7%), gastrointestinal problems (46.7%), poor total nutrition knowledge (88.6%), poor protein knowledge (92.9%), poor

Table 1. Patients' Demographic Characteristics ^{a,b}

Demographic Characteristics	Data
Age, y	55.76 ± 0.97
Female	42.4
Education	
Junior high school or less	69.4
High school graduate	23.6
Some college or college graduate	7.1
Cause of renal failure	
Diabetes	44.7
Hypertension	32.9
Polycystic kidney disease	3.5
Renal stone	1.3
Pyelonephritis	2.7
Other	14.9
Mean time since dialysis started, y	2.78 ± 2.06
Daily Kt/V	1.36 ± 0.01
BUN, mg/dL	49.62 ± 1.17
Creatinine, mg/dL	6.91 ± 0.42
Uric acid, mg/dL	4.91 ± 0.08
Albumin, g/dL	4.18 ± 0.03
Total protein, g/dL	7.12 ± 0.05
Hb, g/dL	12.38 ± 0.13
Calcium, mg/dL	8.89 ± 0.05
Phosphorus, mg/dL	5.13 ± 0.07
PTH, pg/dL	339.51 ± 18.71
Potassium, mg/dL	5.28 ± 0.04
Sodium, mEq/L	139.72 ± 0.21
FBS, mg/dL	116.43 ± 3.93
TG, mg/dL	155.11 ± 5.04
Total cholesterol, mg/dL	171.78 ± 2.62
HDL, mg/dL	36.86 ± 0.63
LDL, mg/dL	103.91 ± 2.32
AST, IU/L	15.49 ± 0.5
ALT, IU/L	17.62 ± 1.78
Alkaline phosphatase, IU/L	369.4 ± 18.61
Ferritin, ng/mL	554.97 ± 29.65
Total iron binding capacity, mg/dL	269.06 ± 3.99
Iron, mcg/dL	74.29 ± 2.12
Depression score	16.87 ± 9.06
BMI, kg/m²	24.05 ± 0.3
SGA score	14.01 ± 0.29
MIS	7.91 ± 0.26
BCM	27.41 ± 0.45
BFMI	6.87 ± 0.23
FFMI	17.19 ± 0.1

^a BUN, Blood Urea Nitrogen; PTH, Parathyroid; FBS, Fasting Blood Sugar; TG, Triglyceride; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; AST, Aspartate Aminotransferase; ALT, Alanine Aminotransferase; BCM, Body Cell Mass; BFMI, Body Fat Mass Index; FFMI, Fat Free Mass Index.

^b Data are expressed as mean ± SD or %.

potassium knowledge (94.9%), poor phosphorus knowledge (97.6%), low interdialytic fluid gain (27.5%), not having enough money to buy food (30.6%), need help for shopping (64.3%) and cooking (35.7%). The association between patients' demographic characteristics and two important categorized nutritional markers based on χ^2 square test is demonstrated in Table 2. No significant association was found between low albumin and any patients' demographic characteristics. Although high SGA was strongly associated with age and duration of hemodialysis, no significant correlation was observed for other demographic factors. Accordingly, based on SGA results, malnutrition was more prevalent in older HD patients than younger ones ($P = 0.004$). Moreover, patients on dialysis for a longer time were more prone to malnutrition ($P = 0.001$).

Identified barriers regarding nutritional status markers were poor appetite, difficulty chewing, depression, poor general nutrition knowledge, poor protein nutrition knowledge, poor potassium nutrition knowledge

and need help for shopping and cooking. Other potential barriers were not significantly related to any nutritional factors ($P > 0.05$). Results of binary logistic regression analysis were shown in Table 3. Patients with higher SGA values who were more malnourished had poorer general nutrition (OR, 1.3, $P = 0.01$) and potassium nutrition (OR, 1.89, $P = 0.002$) knowledge, and also more problems with chewing (OR, 1.16, $P = 0.001$) and shopping (OR, 1.16, $P < 0.001$).

Among malnourished patients with greater MIS scores, poor appetite (OR, 1.3, $P = 0.02$), depression (OR, 1.21, $P < 0.001$), and needing help for cooking (OR, 1.15, $P = 0.001$) were more frequent. BCM is another marker of malnutrition in HD patients. Lower BCM was associated with poorer appetite (OR, 0.92, $P = 0.005$) and more help for cooking (OR, 0.88, $P < 0.001$). Patients with higher BFMI had a greater risk for poor general nutrition knowledge (OR, 1.15, $P = 0.04$), poor protein nutrition knowledge (OR, 1.27, $P = 0.02$), and needing help for shopping (OR, 1.14, $P = 0.005$).

Table 2. The Relationship Between Demographic Characteristics and Nutritional Markers ^a

Characteristics	High SGA, No. (%)	P Value	Low Albumin, No. (%)	P Value
Age, y		0.004		0.40
< 55	66 (25.9)		4 (1.6)	
≥ 55	116 (45.5)		5 (2)	
Gender		0.31		1.00
Female	73 (28.6)		4 (1.6)	
Male	109 (42.7)		5 (2)	
Education		0.7		0.76
Junior high school or less	128 (50.2)		6 (2.4)	
High school graduate	2 (0.8)		0 (0)	
Some college or college graduate	52 (20.4)		3 (1.2)	
Causes of renal failure		0.43		0.43
Diabetes	85 (33.3)		6 (2.4)	
Hypertension	62 (24.3)		2 (0.8)	
Polycystic kidney disease	6 (2.4)		0 (0)	
Renal stone	2 (0.8)		0 (0)	
Pyelonephritis	5 (2)		1 (0.4)	
Other	22 (8.7)		0 (0)	
Years on dialysis		0.001		0.80
< 1	55 (21.6)		4 (1.6)	
1-3	59 (23.1)		3 (1.2)	
4-7	54 (21.2)		2 (0.8)	
> 8	14 (5.5)		0 (0)	

^a High SGA was defined as scores more than 10 and low albumin levels was interpreted as below 3 g/dL.

Table 3. Logistic Regression Models for Identifying Potential Barriers Related to Nutritional Status ^a

Variable	B	SE (B)	OR	95% CI	P Value
Medical barriers					
Poor appetite					
MIS	0.262	0.119	1.30	1.02-1.64	0.02
BCM	-0.084	0.030	0.92	0.86-0.97	0.005
Difficulty chewing					
SGA	0.151	0.044	1.16	1.06-1.26	0.001
Depression					
MIS	0.193	0.047	1.21	1.10-1.33	< 0.001
Behavioral barriers					
Poor general nutrition Knowledge					
SGA	0.268	0.112	1.30	1.05-1.62	0.01
BFMI	0.145	0.073	1.15	1.001-1.33	0.04
Poor protein nutrition Knowledge					
BFMI	0.242	0.108	1.27	1.03-1.57	0.02
Poor potassium nutrition Knowledge					
SGA	0.639	0.204	1.89	1.27-2.88	0.002
Socioeconomic barriers					
Need help for shopping					
SGA	0.15	0.038	1.16	1.07-1.25	< 0.001
BFMI	0.134	0.047	1.14	1.04-1.25	0.005
Need help for cooking					
MIS	0.147	0.043	1.15	1.06-1.26	0.001
BCM	-0.119	0.026	0.88	0.84-0.93	< 0.001

^a abbreviations: SE, standard error; OR, odds ratio.

5. Discussion

This study was the first to report potential barriers regarding nutritional status among HD patients in developing countries. Our findings showed that three medical barriers (poor appetite, depression and difficulty chewing), one behavioral barrier (poor total nutrition knowledge and lack of knowledge for protein containing and potassium rich foods), and one socioeconomic barrier (needing help for shopping and cooking) were independently associated with nutritional status in a logistic regression model. Other barriers (inadequate dialysis, gastrointestinal problems, difficulty swallowing, low interdialytic fluid gain, and poor knowledge of phosphorus containing foods and not having enough money) were not considered important statistically.

Some demographic characteristics like advanced age, low level of education, malnutrition based on SGA, and diabetes as the causes of renal failure existed in a large proportion of our study population. In addition, we found that two demographic factors (advanced age and

duration of HD) might affect nutritional status negatively for SGA. Some potential barriers such as anorexia, depression, lack of nutrition knowledge about protein, potassium, and phosphorus containing foods were present in a considerable number of patients. Our results suggested that patients on HD in a longer duration had higher SGA scores compared to those for less than one year. Furthermore, the prevalence of malnutrition based on SGA was higher in older patients than younger ones.

Only one similar study was performed in Cleveland by Sehgal et al. (26). Their results were somehow different from ours. Detected barriers regarding protein nutrition in this study were poor appetite, inadequate dialysis, comorbid conditions, and lack of knowledge of protein containing foods, low interdialytic fluid gain, and needing help for shopping and cooking. Sehgal et al. only assessed protein nutrition status by serum albumin and protein catabolic rate (PCR). No significant link was found between demographic factors and protein nu-

trition markers (26). Prevalence of low serum albumin among their patients was much higher than our study. Although a large proportion of patients in our investigation were categorized as moderately to severely malnourished based on SGA, only 10.6% of them had serum albumin levels less than 3.8 g/dL. Our findings were different from Sehgal et al. investigation.

In addition to routine clinical markers of malnutrition (albumin and total protein), other valid nutritional indicators such as SGA, MIS, BIA markers (BCM, BFMI, FFMI) were also used in our research. We asked patients' knowledge of potassium and phosphorus through naming correct number of foods in the questionnaire regarding the importance of their control in overall health of HD patients (28-30). Association of these markers with potential barriers was analyzed through logistic regression model, which is good enough to predict the most possible strong association. Most patients in our survey were compliant about fluid intake, though they knew little about other dietary recommendations regarding protein, potassium and phosphorus.

As mentioned earlier, poor appetite was an important nutritional barrier with a high prevalence in our study population. This problem is an issue of debate in HD patients and happens due to different clinical (uremic toxins and inflammation) (31, 32), biochemical (32) and gastrointestinal (food aversion, changes in taste and smell) (33) reasons. Anorexia contributes to malnutrition and protein energy wasting (PEW) through reduced food intake (16, 31). Therefore, patients with poor appetite who are more malnourished have lower quality of life (19, 31) and higher rates of morbidity and hospitalizations (34). Based on the findings of this study, depression was commonly encountered in patients and is considered to be another critical nutritional barrier affecting nutritional status (35).

There is a mutual link between depression and anorexia in HD patients (36). Depression leads to lower quality of life (37) and reduced survival (18, 38) in HD patients. Furthermore, a close significant association was found between depression and MIS (39), meaning that malnutrition was more severe in patients with depression undergoing peritoneal dialysis. Our results suggested that lack of nutritional knowledge especially about protein and potassium was an important problem associated with malnutrition. Evidence has shown that nutritional education could be effective in treating malnutrition and thus reducing mortality among HD patients (17). Increased dietary protein intake due to lack of knowledge in HD patients affects their health status and mortality through uremic toxicity, hyperphosphataemia and metabolic acidosis (40). In addition, dietary restriction of potassium is considered essential to prevent deleterious effects of hyperkalemia in HD patients (41). Both higher and lower serum levels of potassium could affect total well-being and mortality in patients with end stage renal disease (42); thus, tight control of serum potassium

would be warranted in these patients. A strength point of our work compared to similar studies was that we used various valid markers of malnutrition and then the association of each marker with potential barriers was investigated in the logistic regression model.

SGA as a valuable nutritional indicator predicts mortality among HD patients (4). MIS is also a valuable score to predict morbidity and mortality in HD patients (43). BIA has also been suggested as a good marker to evaluate hydration and nutritional status. Body size and body composition are important determinants of physical functioning, quality of life, hospitalization rate, and mortality in HD patients (27). This cross-sectional study presented a comprehensive report of HD patients from clinical and nutritional aspects. Although no causal association was proved, promising areas for monitoring, policy making, and interventions were clarified. A causal association between nutritional markers and survival would not be identified unless observing reduced mortality rate after overcoming barriers by appropriate interventions.

The results of this study could help policy makers in health care system, nephrologists, nurses and dietitians in renal units, and also psychologists and psychiatrists working in HD centers. In clinical practice, early identification of mentioned nutritional barriers and implementing appropriate interventions targeting these barriers may reduce hospitalizations, morbidity, mortality and health care system related expenses (44). Identifying patients with barriers needs a brief interview by experienced staff in HD centers. Besides, it is necessary to evaluate nutritional status of all HD patients routinely through valid anthropometric and clinical measurements. Despite the high prevalence of depression in HD patients, such symptoms remain undiagnosed by health care professionals. It seems that greater attention and work is needed in this field. Especial psychiatric interventions in accordance with psychological consult through periodic monitoring of depression symptoms in each facility could result in better quality of life (37, 45, 46). Regarding behavioral barriers, challenging tasks should be performed by experienced dietitians. Developing training nutritional programs for nurses and patients, and dietary counseling aimed to improve nutrition knowledge is urgently needed in HD centers. Considering the socioeconomic barrier of needing help for shopping and cooking, social policies should be established to provide patients with better home care facilities. Maybe, some special delivery systems should be organized to provide prepared healthy foods for such patients. We did not examine other measures of dietary compliance such as 24-hour dietary recall or food frequency questionnaire to estimate dietary protein, energy, potassium, and phosphorus intake of patients. In addition, we did not consider protein catabolic rate (PCR) as a marker of protein nutrition.

In conclusion, the most common nutritional barriers were determined among HD patients in an attempt to attenuate malnutrition. However, it is suggested to per-

form further studies to design targeted interventions for managing barriers and also to evaluate the efficacy of these strategies on nutritional markers, quality of life, morbidity and mortality rates.

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