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ASSESSMENT OF NUTRITIONAL STATUS OF END STAGE RENAL DISEASE (ESRD) PATIENTS ON DIALYSIS

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ABSTRACT **Background:** Protein energy malnutrition develops during chronic renal disease and is associated with adverse outcomes. Nutritional status considered major determinants of mortality and morbidity in patients with ESRD.

Objectives: To assess the nutritional status of ESRD patient on dialysis by subjective global assessment, anthropometric measurements and biochemical markers.

Methods: Sixty patients with ESRD, who initiated dialysis were prospectively recruited. Patients were assessed at baseline, 3 months and 6 months after dialysis. On each visit a detailed history, clinical examination, nutritional indices [anthropometry, a 3-day dietary diary, body mass index (BMI), mid-arm circumference, hand grip, nutrition risk index (NRI) and subjective global assessment (SGA)] and biochemical parameters were recorded.

Results: Sixty patients with ESRD were recruited. The mean age, weight, and BMI were 48.7±12.1 years, 57.7±14.8 kg, 22.0±4.4 kg/m^2 respectively. Thirty-seven patients (61.7%) were male and 50% were diabetic. At baseline, as per subjective global assessment 70% malnourished and 30% were normal. Mean hemoglobin at baseline was 8.9±1.8 gm%, serum albumin was 3.3±0.5 gm%. At end of 6 month of dialysis 30% of patients were normal in nutrition, 70% were mildly malnourished and none were moderate to severe malnourished. At the end of 6 months there were significant improvement in biochemical parameters of nutrition [hemoglobin (8.9±1.8 vs. 10.0±1.8, p=0.01), iron (50.2±14.5 vs. 108.8±10.0, p=0.000), serum albumin (3.3±0.5 vs. 3.5±0.6, p=0.06)].

Conclusions: Most of our patients were already malnourished and dietary counselling can have an important role in providing the recommended intake of nutrients and improving the nutritional status of ESRD patients.

KEYWORDS : chronic renal failure, end stage renal disease, malnutrition, subjective global assessment, nutritional risk index, albumin

Introduction

Chronic kidney disease (CKD) in major problem worldwide (United States Renal Data System. USRDS, 2013). Patient with CKD are having high chances of morbidity and mortality despite the improvement in the quality of dialysis therapy.

In a study by Ikizler T.A., et al (2013) showed that suboptimal nutritional intake is common in the population of CKD and end stage renal disease (ESRD) and poses a direct risk for protein malnutrition. Causes of suboptimal nutritional status related to multiple alterations including metabolic acidosis, bowel flora alteration and hormonal dysregulation, all of which could promote kidney disease progression and increase morbidity and mortality.

Numerous studies have shown that patients with ESRD with high resting energy expenditure. This is because of inflammatory state and various co-morbidity like cardiovascular disease, diabetes mellitus, hyperparathyroidism dims associated with ESRD (Wang A.Y. et al., 2013). Patients with renal failure require a higher amount of energy intake than healthy individuals. ESRD patients are, thus, susceptible to insufficient energy intake. Ikizler T.A. et al., (2002) observed that in the setting of suboptimal energy supply ESRD patients catabolize muscle to provide needed energy, leading to protein malnutrition.

The prevalence of malnutrition in previous studies varied between 28-65% depending on criteria used in diagnosis (Tayyem RF et al., 2008 Cianciaruso B et al., 1995, Lawson JA et al., 2001). In a study by Iseki K et al. (1993) observed that Serum albumin below 35 g/L [8] and serum prealbumin below 300 mg/L (Avram MM et al., 1995) have been shown to be independent predictors of increased morbidity and mortality. In another study Wolfson M et al. (1984) concluded that, virtually every study examining the nutritional status of dialysis patients indicates that such patients frequently manifest protein calorie malnutrition. The clinical evidence for malnutrition includes decreased relative body weight, skinfold thickness, arm muscle circumference.

There are few studies from India on malnutrition in ESRD and subsequent changes after dialysis. The purpose of this study was to see burden of malnutrition in ESRD and subsequent changes of nutritional indices after dialysis on cohort of patients at 3 and 6 months.

Material and methods:

Sixty patients with ESRD, who were started on dialysis (hemodialysis and/or peritoneal dialysis) from June 2016 to May 2017, were prospectively included in this study. Patients were assessed at baseline (before starting dialysis), 3 months and 6 months after dialysis. On each visit a detailed history and clinical examination were recorded for all patients. The nutritional indices of all patients were assessed by anthropometry which include weight, body mass index (BMI), mid-arm circumference, hand grip, nutrition risk index (NRI) and subjective global assessment (SGA). A patient's nutrient intake, e.g., calorie intake, protein intake, high biological value protein intake, carbohydrate intake, and fat intake, was calculated from the averages of a 3-day dietary diary at each visit. Biochemical parameters (hemoglobin, iron, creatinine, BUN, total protein, albumin, sodium, potassium, calcium, phosphorus and alkaline phosphatase) were also recorded as per protocol.

Body mass index was calculated according to the formula: weight in kilogram divided by the square of height in meters. Hand grip strength quantified by measuring the amount of static force that the hand can squeeze around a dynamometer. The force was measured in kilograms. The mean peak value for men is about 54 kg (ages 30–49), for women it is about 34.5 kg (ages 35–44). Mean values drop to about 44 kg for men and 28 kg for women in the age group 65–69 (Steiber N., 2016). Mid upper arm circumference (MUAC) is a useful tool for a fast assessment of the nutritional status. MUAC measured at the midpoint between the tip of the shoulder and the tip of the elbow (olecranon process and the acromion). MUAC considered normal if >23 cm in males, >22 cm in females (Velzeboer MI et al., 1983).

The nutritional risk index (NRI) was derived from the serum albumin concentration and the ratio of present to ideal body weight. NRI formula as follows: NRI = (1.519 × serum albumin, g/dL) + {41.7 × present weight (kg)/ideal body weight(kg)}. From these NRI values, we defined four grades of nutrition-related risk: i) major risk (NRI<83.5); ii) moderate risk (NRI 83.5–97.5); iii) mild risk (NRI 97.5–100); iv) No risk (NRI > 100) (Bouillanne O et al., 2005).

All patients also underwent Subjective Global Assessment (SGA), a valid estimate of nutritional status for patients treated with dialysis. The SGA was calculated according to the dialysis malnutrition score system of Kalantar- Zadeh et al (Klantar-Zadeh K et al., 1999). The assessment included taking a history of recent intake, weight change, gastrointestinal symptoms and a clinical evaluation. Patient were given score after assessment and classified as follow: (1) normal nutritional status (score of 7), (2) mild to moderate malnutrition (score of 8-14), and (3) severe malnutrition (score of 15- 35). The serum albumin of patients was measured during the same period, and patients were categorized into three groups: (1) normal nutritional status (more than 3.5 g/dL), (2) mild to moderate malnutrition (2.1-3.49 g/dL), and (3) severe malnutrition (less than 2.1 g/dL) (Iseki K, Kawazoe N et al., 1993).

After recruitment; each patient was given diet chart and counseling at beginning and then at 4 weeks and subsequently at 3 months and 6 months. Patient's calorie intake was assessed at baseline, 3 months and at 6 months. Hemoglobin, iron, creatinine, BUN, albumin, protein, calcium, phosphorus, alkaline phosphatase and electrolyte (sodium and potassium) were measured by an auto analyzer (Bayer RA-XT, Tarrytown, NY, USA), using kits manufactured by the same company.

This study was conducted at the Department of Nephrology, Sanjay Gandhi Postgraduate Institute of Medical Science, a tertiary-care institute in Lucknow, India. Informed consent was taken from patients before their inclusion in the study. Study was approved by Institutional Ethics Committee.

Statistics

Continuous variables were expressed as mean ± standard deviation and medians whichever was appropriate. Frequencies were used for categorical data. Distribution of variables was checked for normality. A chi-square test was used to compare the proportions of patients between different groups. Paired t-test and Mcnemar's chi-square test were used to compare variables before and after dialysis at 3 months and 6 months. Data was analyzed in the Statistical Package for Social Sciences software (version 20.0, IBM SPSS Statistics, Chicago, USA). $p<0.05$ was considered statistically significant.

Result:

We recruited 60 patients with ESRD for study. Thirty-seven patients (61.7%) were male. The mean age, weight, and BMI were 48.7±12.1 years, 57.7±14.8 kg, 22.0±4.4 kg/m2 respectively. In our study 50% patients were diabetic, 26.7% had hypertension and heart disease was present in 11.7% of the patients (Table 1).

Nutritional parameters were also studied in these patient at baseline and later followed up at 3 months and 6 months. At base mid arm circumference was 19.4±2.5 cm, calorie intake was 1127.06±335.9, calcium intake was 409.03±8.6 with high biological value of 24.8±10.2 (Table 2). In recruited patients at baseline, 85% were suffering from moderate to severe malnutrition while only 15% had normal nutrition as per nutrition risk index while as per subjective global assessment 70% were malnourished and 30% were normal. Mean hemoglobin at baseline was 8.9±1.8 gm%, creatinine was 7.2±2.3 mg%, serum albumin was 3.3±0.5 gm%.

Patients weight, BMI, mid arm circumference, handgrip and various calorie value (total calorie, high and low biological value, protein, calcium and fat intake) were studied at 3 months and 6 months. There was significant improvement in weight, BMI, mid arm circumference and handgrip at 3 months and 6 months (Table 3). Significant changes also noted in total calorie intake, protein fat, and calcium intake at 3 months and 6 months (Table 3).

At end of 6 month 30% of patients were normal in nutrition, 70% were mildly malnourished and none were moderate to severe malnourished. These changes were almost same at 3 months also (normal nutrition in 18%, mildly malnourished in 82% and none were moderate to severe malnourished). At end of 3 months there was significant improvement in hemoglobin (8.9±1.8 vs. 10.2±1.6, p=0.000), iron (50.2±14.5 vs. 73.7±14.2, p=0.000), serum albumin (3.3±0.5 vs. 3.5±0.5, p=0.04) and alkaline phosphatase (167.2±111 vs. 299.1±109.2, p=0.000), at the end of 6 months similar findings were noted, only serum albumin showed trend to improvement[hemoglobin (8.9±1.8 vs. 10.0±1.8, p=0.01), iron (50.2±14.5 vs. 108.8±10.0, p=0.000), serum albumin (3.3±0.5 vs. 3.5±0.6, p=0.06) and alkaline phosphatase (167.2±111 vs. 350.2.1±136.7, p=0.000)] (Table 3).

Other biochemical parameters like creatinine, BUN, sodium, potassium, total protein, calcium, phosphorus did not show any improvement at 3 months and 6 months as compared to baseline.

Discussion:

Mean age of patients in our study was 48.7±12.1 years and predominantly were males (61.7%). In this study, as per Subjective Global Assessment (SGA) of nutrition, most of our patients (70%) were already malnourished at the initiation of dialysis (hemodialysis or peritoneal). Of these patients, 46.7% had mild-moderate malnutrition, and 23.3% had severe malnutrition. While using other criteria (Nutritional Risk Index), percentage of malnourished were almost same.

The prevalence of malnutrition in previous studies varied between 28–65% with different criteria used in diagnosis (Tayyem RF et al., 2008 Cianciaruso B et al., 1995, Lawson JA et al., 2001). The prevalence of malnutrition in our ESRD patients appears to be very high compared with reports from other cross-sectional studies. However; like our study, Tayyem RF et al. (2008) reported 56.2% of patients on hemodialysis were moderately malnourished, and 5.6% were severely malnourished, similarly Naicker et al. (2002) reported a prevalence of malnutrition (76.2%) in their PD patients, with loss of appetite being an important etiological factor. A study by Prakash J et al. (2007) in which serum albumin, body mass index (BMI), triceps skin fold thickness (TST), mid-arm muscle circumference (MAMC), and subjective global assessment (SGA) scoring were used for assessment of nutritional parameters. They found overall, the prevalence of malnutrition was 65% which was like our study. Many multicenter studies also estimated that severe malnutrition ranged from 4% to 8%, and mild to moderate malnutrition from 33% to 55% (Cianciaruso B et al. 1995, Flanigan MJ et al., 1998).

Serum albumin is important predictor of nutrition and we have used in our study. The prevalence of malnutrition in our study also appears to be high, based on serum albumin. At the initiation of therapy, 58.4 % of our patients had a serum albumin level of less than 3.5 g/L. Though use of serum albumin as a marker of malnutrition in dialysis patient is controversial. Serum albumin is still one of the most commonly used nutritional marker in dialysis patients because albumin is both easy and inexpensive to measure. Cooper BA et al. (2004) showed that protein malnutrition and hypoalbuminemia as predictors of vascular events and mortality in ESRD. Another study by Thiane Gama-Axelsson et al. showed that serum albumin was correlated with age, diabetes, high-sensitivity C-reactive protein and urinary albumin excretion but less so with poor nutritional status (SGA). Gama-Axelsson T et al. (2012) showed that most importantly, serum albumin is a powerful predictor of outcome in dialysis patients. In this study, we also simultaneously used SGA as a nutritional marker, and there was a significant correlation between SGA and albumin level (r 0.28, p=0.03).

The reason for the high prevalence of malnutrition is unknown. Potential causes of an abnormal nutritional status that have been identified include an inadequate intake of protein or calories, an inability to activate the metabolic responses that are needed to achieve nitrogen and protein balance, or the presence of a disease that prevents activation of these metabolic responses or acts to stimulate the breakdown of body protein stores. In our country one of the important reason for high prevalence of malnutrition appears to be due to the late referral of patients with renal failure to the nephrologist and late start of renal replacement therapy (William E. Mitch et al., 1999).

In a study by Abraham G et al (2003) concluded that in developing countries many religious practices promote abstinence from meat, fish, and eggs. Both a vegetarian dietary pattern, which is being adopted by an increasing number of people, and the ingestion of inadequate protein and calories in the diet, lead to malnutrition.

We have observed that many time patients with ESRD are conservatively put on restricted diet with low protein for long term and this worsen the nutritional status of patients (Bergstrom J., 1999). In our study it was found that the mean daily calorie and protein intake was significantly lower than that recommended by the KDOQI (Nelson RG et al., 2007).

The various nutrient intakes appear to be very low in our patients (protein, calcium, fat and cholesterol). Similar low calorie and protein intake was observed in other studies also and those the actual protein intake of patients receiving maintenance hemodialysis (MHD) or peritoneal dialysis (PD) appeared to be approximately 0.95–1.0 g/kg/day (Dwyer JT et al. 1998) and the actual energy intake was approximately 23–28 kcal/kg/day (Kopple JD et al., 1989) suggesting an inadequate average protein and energy intake in dialysis patients. Complicating the problem is the concomitant increase in protein and energy requirements in advanced ESRD due to the combined catabolism-inducing effects of dialytic therapies and various metabolic alterations such as metabolic acidosis.

During the predialysis phase, low-protein diets which are rather unpalatable, together with uremic symptoms, predispose patients to exhibit various grades of malnutrition. In addition, several drugs and comorbidities may worsen anorexia and interfere with the absorption of specific nutrients in these patients initiating dialysis and already in a severely debilitated state. Lindholm B et al. (1989) showed that dialysis itself is associated with unique metabolic and nutritional problems. Similarly, Jones MR (1994) stated in a study that malnutrition at initiation of dialysis and subsequently has emerged as an important surrogate marker of adverse patient outcomes. This observation makes the assessment of nutritional status, and the prevention of malnutrition, important clinical priorities.

In our study the predominantly male patients are seeking treatment for ESRD, the main reason was cultural, reflecting male dominance in the society. Treatment facilities for ESRD are not available uniformly to all sectors of society. Women, children, and the elderly bear the brunt of such discrimination, and are often not offered dialysis. Males are thought to be the bread earners in the family and receive preferential treatment over females (Kher V., 2002).

Dietary management is an integral part of the management of ESRD patients on dialysis. In our study intensive dietary counseling and repeat counseling during follow-up visits lead to statistically significant improvement in the nutrient parameters (weight, BMI, SGA, mid arm circumference, hand grip, calorie intake, protein, calcium and fat intake, hemoglobin, and serum albumin) of these patients. This find confirm the confirmed the data from previous prospective studies (Williams AJ et al., 1999, Pollock CA et al., 1990).

Limitation of study was that low sample size, heterogenous distribution of patients' population and mixed of hemodialysis and peritoneal dialysis.

In conclusion, most of our patients were already malnourished and the calorie intake and protein intake of these patients were significantly lower than the recommended intakes. A detailed nutritional assessment and use of a broad panel of nutritional indicators, such as BMI, SGA, handgrip strength, mid arm circumference, waist circumference, serum albumin, and serum creatinine may be the best approach to provide useful information is essential at the beginning of the therapy. Dietary counselling can have an important role in providing the recommended intake of nutrients and improving the nutritional status of ESRD patients.

Table 1: Demographic data of participants at baseline (n=60)

Category	Mean ± std or number (%)
Age in yrs	48.7± 12.1
Gender	M 37 (61.7): F 23 (38.3)
Weight in Kg	57.7 ± 14.8
Height in cm	161 ± 8.3
BMI	22.0 ± 4.4
BSA	1.64 ± 0.21
Diabetes mellitus	30 (50)
Chronic isterstitial nephritis	14 (23.3)
Hypertension	16 (26.7)
Coronary artery disease	7 (11.7)
Dilated cardiomyopathy	2 (3.3)
Chronic liver disease	4 (4.7)
Cerebrovascular disease	2 (3.3)
Obstructive uropathy	2 (3.3)
Cancer	1 (1.6)

Table 2. Nutritional parameters at baseline (n = 60)

Parameters	Mean ± std/ n(%)
Mid Arm circumference	19.4 ± 2.5
Handgrip	25.2 ± 7.2
Nutritional Index	91.0 ± 8.4
Nutritional Index Normal Mild to moderate malnutrition Severe malnutrition	9 (15) 42 (70.0) 9 (15)
Subjective global assessment (SGA) Normal Mild to moderate malnutrition Severe malnutrition	18 (30) 28 (46.7) 14 (23.3)
Nutrition status as per serum albumin Normal Mild to moderate malnutrition Severe malnutrition	25 (41.7) 34 (56.7) 1 (1.7)
Calorie intake	1127.06 ± 335.9
High biological value	24.8 ± 10.2
Low biological value	24.4 ± 7.9
Protein intake in gm	49.7 ± 13.5
Calcium intake in gm	409.03 ± 148.6
Fat intake in gm	36.8 ± 8.6
Cholesterol intake in mg	148.8 ± 60.9

Table 3: Comparison of nutritional indices at baseline, 3 months and 6 months (n= 60)

Category	Mean ± std (at baseline)	Mean ± std (at 3 months)	P value	Mean ± std (at 6 months)	P value
Weight in Kg	57.7 ± 14.8	60.0 ± 14.8	0.000	61.1 ± 15.4	0.000
BMI	22.0 ± 4.4	22.8 ± 4.3	0.000	23.2 ± 4.6	0.000
Mid Arm circumference	19.4 ± 2.5	22.4 ± 2.5	0.000	25.2 ± 4.7	0.009
Handgrip	25.2 ± 7.2	29.6 ± 6.0	0.000	35.1 ± 6.5	0.000
Calorie intake	1127.0 ± 335.9	1379.6 ± 308.1	0.000	1341.2 ± 405.2	0.02
High biological value	24.8 ± 10.2	31.4 ± 12.0	0.000	38.1 ± 14.1	0.01
Low biological value	24.4 ± 7.9	33.9 ± 10.2	0.000	38.8 ± 15.1	0.001
Protein intake in gm	49.7 ± 13.5	60.9 ± 16.3	0.000	62.1 ± 15.6	0.000
Calcium intake in gm	409 ± 148.6	1395.7 ± 66.1	0.000	1413.7 ± 65.8	0.000
Fat intake in gm	36.8 ± 8.6	42.4 ± 10.5	0.000	47.9 ± 29.5	0.03
Cholesterol intake in mg	148.8 ± 60.9	187.3 ± 49.8	0.000	180.0 ± 64.3	0.05
Hemoglobin (gm%)	8.9 ± 1.8	10.2 ± 1.6	0.000	10.0 ±1.8	0.01
Iron (microgm/dl)	50.2 ± 14.5	73.7 ± 14.2	0.000	108.6 ± 10.0	0.000
Serum Albumin (gm%)	3.3 ± 0.5	3.5 ± 0.5	0.04	3.5 ± 06	0.06

Serum Alkaline phosphatase (IU/L)	167.2 ± 111.0	299.1 ± 109.2	0.000	350.2 ± 136.7	0.000

REFERENCES

1. United States Renal Data System. USRDS (2013) Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. National Institutes of Health; National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD 2013.
2. Ikizler T.A., Cano N.J., Franch H., Fouque D., Himmelfarb J., Kalantar-Zadeh K., Kuhlmann M.K., Stenvinkel P., TerWee P., Teta D., et al. (2013) Prevention and treatment of protein energy wasting in chronic kidney disease patients: A consensus statement by the International Society of Renal Nutrition and Metabolism. Kidney Int. 84:1096–1107.
3. Wang A.Y., Sea M.M., Tang N., Sanderson J.E., Lui S.F., Li P.K., Woo J. (2014) Resting energy expenditure and subsequent mortality risk in peritoneal dialysis patients. J. Am. Soc. Nephrol. 15:3134–3143.
4. Ikizler T.A., Pupim L.B., Brouillette J.R., Levenhagen D.K., Farmer K., Hakim R.M., Flakoll P.J. (2002). Hemodialysis stimulates muscle and whole body protein loss and alters substrate oxidation. Am. J. Physiol. Endocrinol. Metab. 282:E107–E116.
5. Tayyem RF, Mrayyan MT. (2008). Assessing the prevalence of malnutrition in chronic kidney disease patients in Jordan. J Ren Nutr. 18:202-9.
6. Cianciaruso B, Brunou G, Kopple JD, et al: (1995). Cross-sectional comparison of malnutrition in continuous ambulatory peritoneal dialysis and hemodialysis patients. Am J Kidney Dis 26:475-486.
7. Lawson JA, Lazarus R, Kelly JJ. (2001). Prevalence and prognostic signifcance of malnutrition in chronic renal insuffciency. Ren Nutr. 11:16-22.
8. Iseki K, Kawazoe N, Fukiyama K: (1993). Serum albumin is a strong predictor of death in chronic dialysis patients. Kidney Int 44:115– 119.
9. Avram MM, Mittman N, Bonomini L, Chattopadhyay J, Fein P: (1995). Markers for survival in dialysis: A seven-year prospective study. Am J Kidney Dis 26:209–219.
10. Wolfson M, Strong CJ, Minturn D, Gray DK, Kopple JD: (1984). Nutri¬tional status and lymphocyte function in maintenance hemodialysis patients. Am J Clin Nutr 39:547–555.
11. Steiber N. (2016). Strong or Weak Handgrip? Normative Reference Values for the German Population across the Life Course Stratified by Sex, Age, and Body Height. PLoS One. 24;11.
12. Velzeboer MI, Selwyn BJ, Sargent F, Pollitt E, Delgado H. (1983). The use of arm circumference in simplified screening for acute malnutrition by minimally trained health workers. J Trop Pediatr. 29:159–66.
13. Bouillanne O, Morineau G, Dupont C, et al. (2005). Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr. 82:777–83.
14. Klantar-Zadeh K, Kleiner M, Dunne E, et al: (1999). A modified quantitative subjective global assessment of nutrition for dialysis patients. Nephrol Dial Transplant 14:1732-1738.
15. Naicker S: (2002). Nutritional problems associated with ESRD in the developing world. Artif Organs 26:757-759.
16. Prakash J, Raja R, Mishra RN, Vohra R, Sharma N, Wani IA, Parekh A. (2007). High prevalence of malnutrition and inflammation in undialyzed patients with chronic renal failure in developing countries: a single center experience from eastern India. Ren Fail. 29:811-6.
17. Flanigan MJ, Bailia GR, Frankensfield DL, et al: (1998). Peritoneal Dialysis Core Indicator Study: report on nutritional indicators. Perit Dial Int 18:489-496.
18. Cooper BA, Penne EL, Bartlett LH, Pollock CA. (2004). Protein malnutrition and hypoalbuminemia as predictors of vascular events and mortality in ESRD. Am J Kidney Dis.43:61-6.
19. Gama-Axelsson T, Heimbürger O, Stenvinkel P, Bárány P, Lindholm B, Qureshi AR. (2012). Serum albumin as predictor of nutritional status in patients with ESRD. Clin J Am Soc Nephrol. 7:1446-53.
20. William E. Mitch, Bradley J. Maroni. (1999). Factors causing malnutrition in patients with chronic uremia. Am J Kidney Dis. 33:176-9.
21. Abraham G, Varsha P, Mathew M, et al: (2003). Malnutrition and nutritional therapy of chronic kidney disease in developing countries: the Asian perspective. Adv Ren Replace Ther 10:213-221.
22. Bergstrom J. (1999). Mechanisms of uremic suppression of appetite. J Ren Nutr. 9:129–132.
23. Nelson RG, Tuttle KR. (2007). The new KDOQI clinical practice guidelines and clinical practice recommendations for diabetes and CKD. Blood Purif. 25:112-4.
24. Dwyer JT, Cunniff PJ, Maroni BJ, Kopple JD, Burrowes JD, Powers SN, Cockram DB, Chumlea WC, Kusek JW, Makoff R, Goldstein DJ, Paranandi L. (1998). The hemodialysis pilot study: nutrition program and participant characteristics at baseline. The HEMO Study Group. J Ren Nutr. 8:11–20.
25. Kopple JD, Berg R, Houser H, Steinman TI, Teschan P. (1989). Nutritional status of patients with different levels of chronic renal insufficiency. Modification of Diet in Renal Disease (MDRD) Study Group. Kidney Int Suppl. 36(Suppl 27):S184–S194.
26. Lindholm B, Bergstrom J: (1989). Nutritional management of patients undergoing peritoneal dialysis. In: Nolph KD (ed): Textbook of peritoneal dialysis. 3rd ed. Boston, Kluwer, pp 230-260
27. Jones MR: (1994). Etiology of severe malnutrition: results of an international cross-sectional study in continuous ambulatory peritoneal dialysis patients. Am J Kidney Dis 23:412-420.
28. Kher V: (2002). End stage renal disease in developing countries (Nephrology Forum). Kidney Int 62:350-362.
29. Williams AJ, McArley A: (1999). Body composition, treatment time, and outcome in hemodialysis patients. J Ren Nutr 9: 157–162.
30. Pollock CA, Allen BJ, Warden RA, Caterson RJ, Blagojevic N, Cocksedge B, Mahony JF, Waugh DA, Ibels LS: (1990). Total-body nitrogen by neutron activation in maintenance dialysis. Am J Kidney Dis 16: 38–45.