Assessment of Nutritional Status and Biomarkers among Chronic Haemodialysis Patients

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ABSTRACT

Although biomarkers have significance on the nutritional status, there is little information about its relationship among patients on maintenance haemodialysis (MHD). The study was done to determine the significance of the relationship between nutritional status and biochemical markers among chronic haemodialysis patients. The study was done at Kenyatta National Hospital (KNH), Nairobi-a teaching and a referral hospital. This was a cross-sectional, prospective study among chronic haemodialysis patients. Fifty patients on chronic maintenance haemodialysis for 3 months and more were included in the study which was carried out May 2012. All eligible study subjects gave informed consent. Biochemical tests of albumin, electrolytes: sodium and potassium and urea were done and anthropometric measurements taken. The reagents for all biochemical analysis were provided by JAS INC., Court Miami Lakes Florida. The relationship between nutritional status and dietary intake, anthropometric status, primary diagnosis, co-morbid, socio-demographic factors and dialysis related factors were determined. Fifty subjects were recruited in the study. The consent for the study was sought at Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (KNH/UON ERC). Electrolytes mainly potassium were elevated. Sodium and albumin was low. There were significant correlations between albumin and hospital attendance, albumin and nutritional counseling and BMI with anthropometric parameters. The electrolyte levels of sodium and potassium are useful nutritional biomarkers for HD patients coupled with regular nutritional advice. Anthropometric parameters and BMI can be used for nutritional status assessment.

Key words: _Assessment, Nutritional status, Biomakers, Haemodialysis, Anthropometric measurements_

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Introduction

Hospitalized patients who are undernourished are more likely to develop clinical complications and have relatively poor outcomes, with increased length of stay (LOS) and higher mortality compared with well-nourished patients. Provision of adequate nutritional support reduces the complication rate and improves outcome (Shenkin, 2006). Poor nutritional status is a well-documented consequence of chronic kidney disease (CKD), even before dialysis became widely available. It is now recognized as a predictor of the prognosis for patients starting dialysis. An alteration in anthropometric parameters is found in 70% and severe malnutrition in 25% of dialysis patients (Davies, 2000). Prevalence of malnutrition in patients on haemodialysis of protein-energy-malnutrition (PEM) is more than 70%. Patients presenting with protein-energy malnutrition are hypoglycaemic because of diminished glycogen stores due to interconversion of biomolecules in the compensation of the deficient protein. Reduction in anthropometric measurements, low concentrations of visceral proteins such as serum albumin, abnormalities in plasma and muscle amino acid profiles are some of the indices of malnutrition that have been identified in these patients (Thomas, Kanso, Sedor, 2008).

Nutritional biomarkers (water, nitrogen, potassium, plasma vitamins, sodium) are constituents in the blood that are used to estimate nutrient intake or compare nutrient intake to that of estimated by dietary assessment (Thompson and Subar, 2001). Prealbumin, has a half-life in plasma of ~2 days, much shorter than that of albumin. Prealbumin is therefore more sensitive to changes in protein-energy status than albumin, and its concentration closely reflects recent dietary intake rather than overall nutritional status (Ingenbleek and Young, 2002). Because of this short half-life, however, the concentration of prealbumin falls rapidly as a result of the fall in its synthetic rate when there is a reprioritization of synthesis toward acute-phase proteins such as C-reactive protein (CRP), fibrinogen, or α_1-acid glycoprotein. Moreover, prealbumin concentration in plasma, like that of albumin, is affected by changes in transcapillary escape. Hence, interpretation of plasma prealbumin is difficult in patients with infections, inflammation, or recent trauma (Fleck *et al.*, 1985). The serum albumin level is a useful indicator of protein-energy nutritional status in maintenance dialysis patients. The extensive literature, in individuals with or without renal failure, relating serum albumin to nutritional status, and the powerful association between hypoalbuminemia and mortality risk in the maintenance dialysis population, strongly support this contention. The serum albumin correlates reasonably well with other measures of visceral proteins. A pre-dialysis or stabilized serum albumin equal to or greater than the lower limit of the normal range (Port *et al.*, 2002). Serum potassium (K) is altered in patients with chronic kidney disease (Iseki *et al.*, 1996).

Progression of chronic kidney disease is usually associated with worsening hyperkalemia that may require dialysis treatment (Hayes, McLeod and Robinson, 1967). However, intermittent haemodialysis may result in fluctuating serum K levels, which at the extremes can reach pathologically high or low concentrations. Predialysis hyper- and hypokalemia have been implicated as a correlate of death risk in maintenance haemodialysis (MHD) patients ((Iseki *et al.*, 1996). The high incidence and prevalence of cardiovascular disease and death—including sudden death—in MHD patients makes such an association clinically relevant, especially because significant electrophysiologic alterations may result from serum K variations. However, a confounding effect of other factors associated with the presence or the treatment of hyper- and hypokalemia is also possible.

Materials and Methods

The study was a cross-sectional prospective study. A total of fifty study subjects were recruited from the haemodialysis patients attending Kenyatta National Hospital Renal unit both outpatients and inpatients. The sample size was determined using Fisher *et al.*, (1998) formula;

$n = z^2 p (1-p)/d^2$.

Where n = desired minimum sample size; z = standard normal deviate value (1.96); p = known prevalence rate for the factor of interest under study (in these case proportion of patients undergoing haemodialysis at KNH renal unit (8%); and d= the level of desired precision (7.5%); Thus n = (1.96) (1.96) (0.08) (0.92)/ $(0.075)^2$ = 50.

Eligibility criteria included all the patients attending Renal Unit at KNH for haemodialysis with the following characteristics: patients with end-stage renal failure, patients who had never had kidney transplantation, on MHD for not less than 3 months and are able to participate in the study and giving informed consent. The patients who were pregnant; proved difficult to determine weight or height accurately and those on parenteral nutrition were excluded. All the HD patients fitting inclusion criteria were given a chance to participate in the study. The following anthropometric measurements and dietary data collection were done to determine recruitment: Dry weight (Wt.) was taken using electronic weighing chair. Weight was measured in all participants and taken to the nearest 0.1 kg. The scale was calibrated at the beginning and end of each examining day. The scale is checked using the standardized weights and calibration is corrected if the error is greater than 0.1 kg. The results of the checking and the recalibrations are recorded in a log book. Height (Ht.) was measured in all participants, with the patients bare footed and head upright using a measuring rod attached to the balanced beam scale. The height was reported to the nearest 0.5 cm (Eknoyan and Garabed, 2007). Desirable body weight based on body mass index (BMI) was used to assess the desired weight. The survival reference range of 23-24.9kg/m^2 was used in the patient recruitment (Leavey *et al.*, 2001; Bellizzi, Cioffi and Cianciaruso, 2000). The mid-point of this range (23.9) was used to calculate the desirable body weight for our subjects. Adjusted body weight (aBW) was used to calculate the energy and protein requirement for patients with BMI of >25, by using the following formula;

aBW = (ABW – IBW) x 0.25 + IBW.

Where: ABW = Actual body weight, IBW = Ideal or desirable body weight.

Mid-Upper Arm circumference (MUAC) was measured by using a Ross Inser-Tapetm fiberglass tape. At the dry weight, patient's right or non-access arm was bent at the elbow at 90° angle; palm up, to locate the arm's midpoint on posterior side of the arm. With the same arm hanging loosely by side, the tape was positioned at previously marked midpoint of upper arm and the circumference was obtained (Eknoyan and Garabed, 2007). Waist circumference (WC) was used in addition to BMI for a greater prediction of variance in health risk. WC was measured midway between the lower rib and the illiac crest (Eknoyan and Garabed, 2007). Dietary data collection methods were used for dietary data collection because they are less reactive. Twenty-four hour recalls, in which the previous day's intake was queried in detail (for instance, foods, amounts, preparation techniques, condiments) because they are easy for individuals to complete. The data collected was converted from foods to nutrients with the use of food composition tables. Since a single day is not representative of usual intake, multiple twenty-four hour recalls were used. Data was captured through structured serialized questionnaire on: demographic, nutritional status, diet history and medical history from the study subjects. Data collected was entered in spreadsheet and screened through physical counting, double entry and frequency runs. Data was analyzed using Statistical Package for the Social Scientists (SPSS) version 13.0 and was presented in tables and figures. Categorical values were presented in mode, mean and median. Ethical clearance for this study was given by Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (KNH/UON ERC).

Results

Study subject characteristics

The study subjects' gender was comparable: 52% men and 48% women. The youngest study subject was 12years and the oldest was 75years of age. Most of the participants (92%) had basic education. At least 62% of the participants had a steady income through employment (22%) and self-employment (30%). The majority (66%) had a monthly income of above KShs 30,000 equivalent of $362.72 at exchange rate of KShs 82.7 per dollar. Majority of them (70%) were married.

Table 1: Summary of social and demographic characteristics of the study participants

Measure	Categories	Percentage (%)
Age group	Below 12 years 13-22 years 23-45 years 46-60 years Above 61 years	2 8 44 24 22
Gender	Female Male	52 48
Education	University Tertiary Secondary Primary	8 30 34 28
Occupation	Employed Self employed Casual Retired Not employed Others	22 30 2 20 24 2
Marital status	Married Single Widow/widower Separated	70 22 6 2
Income	Below Kshs. 5,000 Kshs.6,000-10,000 Kshs.21,000-30.000 Above Kshs.30,000 Others	4 10 12 66 10

Nutrition status

Nutrition status was assessed through number of feeding per day, appetite assessment, diet counseling and diet monitoring.

Majority of the population (60%) fed 3-5 times per day but mainly took three meals-breakfast, lunch and supper. 22% fed 6-8 times and 22% took meals above 8 times as they took small frequent meals due to poor appetite, nausea and vomiting.

Appetite was assessed in terms of very good through very poor indexed as 1 through 5 respectively. The relationship between appetite and dietary intake in Haemodialysis patients was assessed by asking the respondents how the appetite was on the day of dialysis. Majority of them had poor appetite (42%), 28% had very poor appetite, 28% had fair appetite and 2% had good appetite which is rated subjectively. Evaluation of the patient appetite is an important component of the nutritional assessment procedure. This is particularly true for the renal patient with numerous medical, uremic and treatment issues contributing to the development of a poor appetite. Impaired food intake due to poor appetite is thought to play role in the development of malnutrition. Despite the importance of evaluating appetite, it is often given only a subjective rating such as very poor, poor, fair, good and very good/excellent.

Most of the respondents had received diet counseling (78%), and 22% had not received counseling because they were newly diagnosed.

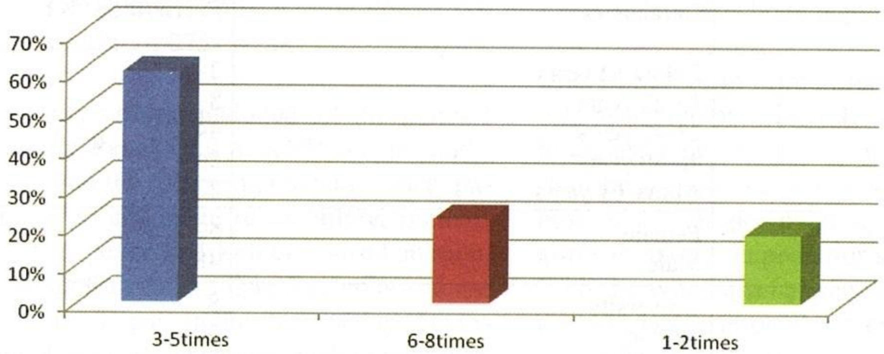

Figure 1: Daily number of feeding

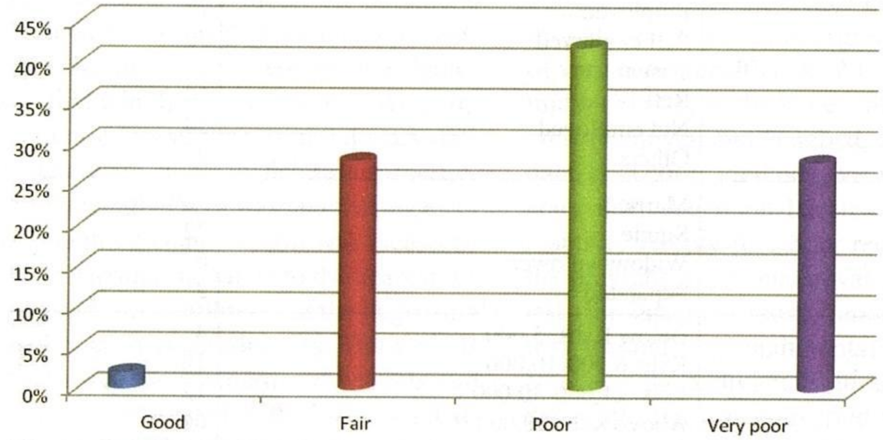

Figure 2:Appetite Assessment

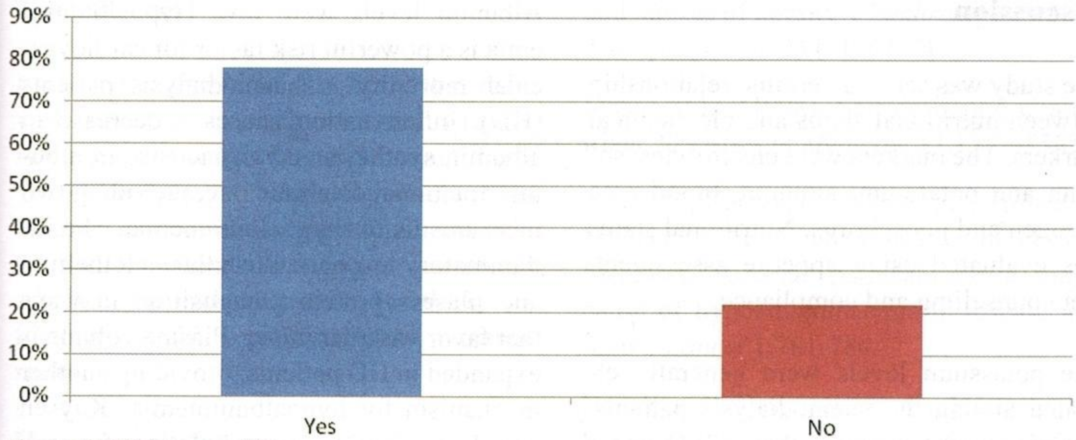

Figure 3: Diet counseling

Table 2: Biochemical Indicators for Malnutrition

Biochemical test (serum)	Reference range	Abnormal renal range (Range)	Percentage (%) abnormal results
Potassium	3.5-5.0mmol/L	≥ 6 mmol/L	60
Phosphorous	2.5-4.7mmol/l/L	>6.4 mmol/L	40
Calcium	8.5-10.5mmol/L	≤ 2.37 mmol/L	52
Creatinine	0.7-1.5mg/dl	≤ 2 or ≥ 15mg/dl	40
BUN	4-22mg/dl	60-120mg/dl	68
Hemoglobin	12-17mg/dl	≤ 8mg/dl	50
Sodium	135-145mmol/L	≤127mmol/L	20
Cholesterol	150-200mg/dl	≥ 200mg/dl	44
Albumin	3.3-5.0g/dl	≥ 3.5g/dl	32

Table 2: represents the patients with biochemical indicators of malnutrition. 60% of the patients showed serum potassium of ≥ 6, 40% serum phosphorus of >6.4mmol, 44% serum cholesterol >200mg/dl, while 50.0% has a serum cholesterol <3.9, 52% with serum calcium of ≤ 2.37mmo/l. Bread is the main starch item for breakfast that patients consume.

Discussion

The study was set to determine relationship between nutritional status and biochemical markers. The markers were electrolytes; sodium and potassium, albumin, blood urea nitrogen and phosphorus. Nutritional status was evaluated using appetite assessment, diet counselling and compliance.

The potassium levels were generally elevated among the haemodialysis patients. The elevation was more than +3SD upper reference range (5.75) in 60% of the study subject. This persistent hyperkalemia in dialysis patients is likely to be caused by excessive potassium intake, inadequate potassium elimination, or a combination of the two. Excessive potassium intake is most commonly caused by dietary noncompliance (Nanovic, 2005). Constipation has been reported to occur in up to 40% of HD patients and can predispose ESRD patients to hyperkalemia (Hammer *et al.*, 1998; Nanovic, 2005).

Sodium levels were low. Dialysis uses dialysate, a synthetic plasma water component, to remove soluble wastes from the blood by diffusion. The most abundant chemicals in dialysate are sodium chloride and water. Despite its universal use, no consensus on dialysate composition or tonicity exists. Presently, the average dialysate sodium concentration is approximately 135–145mmol, close to normal physiologic serum levels (Sam *et al.*, 2006). Sodium crosses dialysis membranes by means of 2 mechanisms: diffusion and convection. Therefore, sodium removal can be increased both by applying higher ultrafiltration volumes and by lowering dialysate sodium concentration (Nanovic, 2005).

Albumin levels were low. Hypoalbuminemia is a powerful risk factor for cardiovascular mortality in haemodialysis patients (HD). Inflammation causes a decrease in albumin synthesis and an increase in albumin fractional catabolic rate, providing two mechanisms for hypoalbuminemia. The inflammatory response alters the endothelium and plasma protein composition in ways that favor vascular injury. Plasma volume is expanded in HD patients, providing another mechanism for hypoalbuminemia (Kaysen and Don, 2003). Hypoabulminemia may have been contributed immensely by poor absorption. The correlation of albumin and total protein intake was statistically significant (pvalue = 0.001). similar p value was obtained when albumin was correlated with total energy intake. This is consistent with the hypoalbuminemia and protein absorption in HD patients. The calorie intake in HD patients is significantly reduced. Albumin correlation with blood urea nitrogen (BUN) was significant (p value = 0.001). The results were consistent with the hypoalbuminemia. The BUN is resultant of protien catalysis by the liver which is cleared from the body by the kidneys. The albumin correlated significantly with number of hospital visits (p value = 0.016) and hospital admission over the year (p value = 0.002). Blood urea nitrogen (BUN) was recorded elevated above the abnormal renal range up to 68% of study subjects. These results are consistent with levels of BUN levels in patients with renal insufficiency as is the case with HD patients. The BMI and anthropometric parameters: mid upper arm circumference (MUAC), admission days over the year and number of visits were statistically significant. The p values were less than 0.001. The results were expected among the study subjects due to consistent nutritional counselling and observation of diet.

Conclusion

It can be observed in this study that there was consistent hypoalbuminemia. Electrolytes: sodium was low and potassium high. The electrolytes: sodium and potassium and albumin can be used as nutritional biomarkers for HD patients with regular nutritional advice. The anthropometric variables and BMI are useful in assessment of nutrional status.

Recommendation

It is recommended that HD patients on nutritional counselling can be monitored the electrolytes: sodium and potassium and albumin through the treatment period. It is further recommended that studies to explain the causes and mitigation of hypoalbuminemia be done.

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