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An Assessment of Haemodialysis Adequacy Among Patients on Maintenance Haemodialysis in a Tertiary Hospital in South-West Nigeria

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ABSTRACT

Background: kidney replacement therapy (dialysis and kidney transplantation) is the definitive treatment for end-stage kidney disease (ESKD). We set out to assess the adequacy of haemodialysis of our patients and how this relates with the occurrence of complications during dialysis.

Methodology: The study was an observational, single arm, paired survey. At the end of a month of dialysis on a specified prescription: URR and Kt/V were calculated for each patient. The data obtained from this study was analyzed using SPSS version 20.

Results: The mean age of study participants was 42.9(±11.5) years, with a male preponderance of 63.9%. The mean urea reduction ratio (URR) was 54.2(±18.3)%, 67.2% had URR less than 65%. The mean Kt/V was 0.9(±0.5), 75.4% had Kt/V < 1.2.There is a positive correlation between URR and Kt/V (r=0.87,P<0.001).

Conclusion: Our findings suggestthat many of our patients are inadequately dialyzed. Also, a direct positive correlation URR and Kt/V was noted as well as the occurrence of more intradialytic complications in patients with inadequate dialysis.

INTRODUCTION

The global occurrence of new cases of end-stage kidney disease is estimated to be 6% per year and the rate of rise approaches epidemic proportions[1].A feasible approach to reducing the high mortality rate associated with ESKD involves optimizing the adequacy of haemodialysis[1]. Several studies have reported that inadequate dialysis is associated with increased hospitalization and mortality[2]. Studies have shown that inadequate haemodialysis may promote atherosclerosis, infection, malnutrition, and failure to thrive in the paediatric age group[3].

Most of our patients on maintenance dialysis are unable to get or sustain adequate HD in South-West Nigeria[4]. Kidney replacement therapy is a capital intensive project, and therefore, without government support /subsidy or an appropriate health insurance scheme, the majority of patients in resource-poor settings would not be able to pay for it[4]. Kidney transplantation is also out of reach for many patients, as a large lump sum of money is needed to get the surgery done, in addition to the cost of post-transplant care, which includes hospitalization and immunosuppressive medications[5].

Considering the burden of chronic kidney disease (CKD) and ESKD in Africa, the exorbitant cost of accessing care and the paucity of data on the quality of dialysis delivered to our patients, it is necessary that a study like this be conducted.Several methods have been designed to assess haemodialysis adequacy including urea reduction ratio and Kt/V.

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The objectives of this study were to determine adequacy of dialysis of patients on maintenance haemodialysis using different methods: URR and Kt/V; to determine the association between adequacy of haemodialysis and occurrence of intradialytic complications.

METHODOLOGY

The study was conducted at the Owena Dialysis Center, University College Hospital (UCH), Ibadan. The study population consisted of patients on maintenance haemodialysis at UCH, Ibadan.The sample size of 66 was determined using Krejcie and Morgan formula[6], which is appropriate for calculation of required sample size for finite populations such as dialysis population. The study was designed as an observational, single arm, survey of subjects with ESKD on maintenance haemodialysis at UCH, Ibadan.

Inclusion criteria included: Patients who were 18 years or older; Patients with ESKD, on maintenance haemodialysis in UCH; patients that can afford at least a session per week and patients who have consented to participate in the study. The exclusion criteria included: patients with acute kidney injury (AKI), post-renal transplant patients, ESKD patients who cannot afford or procure scheduled haemodialysis and Patients who refused to give their consent to participate in the study. Consecutively presenting ESKD patients for haemodialysis at the Owena Dialysis Centre, UCH, Ibadan were enrolled in the study between May 2018 to January 2019. Written informed consent was obtained from all participants.Ethical approval for this study was given by the joint University College Hospital and University of Ibadan Ethical Review Committee.

Data Collection

A structured pretested interviewer-administered questionnaire was applied to all participants; information obtained included biodata, duration and aetiology of ESKD, time interval between diagnosis of CKD and commencement of haemodialysis, dialysis prescription, frequency and duration of hemodialysis and dialyzer type, medications and lifestyle. All patients were fully examined clinically at enrolment and at the end of the month. In the interdialytic period, participants were advised to comply with recommended CKD management strategies like low salt and low protein diet, fluid restriction, phosphate binders and vitamin D supplements. Patients continued their normal clinic schedule fortnightly and were not followed up after the study period.

Anthropometric parameters done were weight (in kilograms), height (in meters) and body mass index [BMI (in kg/m^2)]. Height was measured only at enrolment. The weight measurement was done at enrolment and also immediately before and after each haemodialysis session. Body Mass Index was estimated by dividing weight at enrolment (kg) by height^2 (m^2)[7]. The hip circumference was measured from the maximum perimeter of the buttocks at enrolment[7]. The waist circumference was taken as the plane between the umbilical scar and the inferior rib border at enrolment[7]. The waist/hip ratio was calculated by dividing waist circumference by hip circumference[7].

Patients who met the inclusion criteria (as above) were dialyzed as follows for one month following enrolment: Blood flow rate was 200-300ml/min, and dialysate flow rate at 500ml/min; Ultrafiltration goal was calculated as weight gain in the interdialytic period, duration of dialysis was 4 hours. Bicarbonate-based dialysate was used, dialyzer was polysulfone hollow fiber dialyzer with a surface area of 1.8m^2. A maximum tolerable ultrafiltration rate of 6 litres was applied to patients whose interdialytic weight gain exceeded 6 litres. Each patient had haemodialysis by this regimen for one month. There was no reuse of dialyzer. Ultrafiltration was adjusted for fluids infused or consumed by patient intradialysis to maintain the dry weight of the patient. Parameters monitored intradialysis included: vital signs (temperature, blood pressure, respiratory and pulse rates), fluid infused, or blood transfused and intradialytic complications.

Ten (10) ml of venous blood was collected at enrolment under aseptic conditions immediately before the first session of haemodialysis for full blood count, albumin, phosphate, calcium, urea and creatinine (as indicators of morbidity). This gives a baseline assessment of the haematological and nutritional status of study participants and the presence or absence of mineral bone disease. Pre dialysis samples were collected immediately before haemodialysis prior to infusion of saline or other diluents[8] while post dialysis samples were collected

from the dialyzer inflow port (arterial circuit) using a slow-flow method in which the blood flow rate is reduced to 100ml/min for 15 seconds before sample collection is done[8]. Samples were stored at -20 ^{O}C in a LG chest freezer with solar and inverter power back up and centrifuged using a uniscope laboratory centrifuge (Surgifriend Medicals, England) and analyzed using a landwindautochemistry analyzer (Accurex Biomedical, India).Haemodialysis adequacy mathematically calculated using formulae for urea reduction ratio and Kt/V at the end of one month of haemodialysis.The Daugirdas formula was used to calculate Kt/V[9]. The occurrence of complications encountered during each session of haemodialysis were noted.

Data Management

Data analysis was done using Statistical Package For Social Sciences Software (SPSS), version 20.Categoricaldata were presented in the form of tables. Quantitative variables were summarised using mean and standard deviation. The relationship between two quantitative variables were shown by product moment correlation. Fishers' exact test was used to show the association between two qualitative variables. A 95% confidence interval was used and a P value < 0.05 was regarded as statistically significant.

RESULTS

The socio-demographic characteristics of study participants are shown in Table 1.The most common symptoms reported pre-dialysis were vomiting (23.8%) and shortness of breath (21.3%). The most common symptoms reported post-dialysis were leg swelling, feeling tired and decreased interest in sex, each seen with 12.5% of study participants respectively. The mean BMI was 18.7(±0.6) kg/m^2 while the mean height of patients was found to be 6.7 (± 2.9) m. In addition, the mean waist circumference was 72.8 (± 8.3) cm while the hip circumference was 82.5 (± 8.2) cm. The mean pre-dialysis weight was 64.3(± 8.9) kg, while mean post-dialysis weight was 61.5 (± 8.5) kg. Similarly, the mean systolic and diastolic blood pressure pre-dialysis were 156.0 (± 34.2) mmHg; 95.0 (± 21.2) mmHg respectively while that of post-dialysis were 146.0 (± 31.7) mmHg; 91.8 (± 18.0) mmHg respectively. The mean haemoglobin was 10.0 (± 2.9) g/dl, while haematocrit among patients was found to be 31.4 (± 8.8)% . The mean WBC was 5.5 (± 2.2) x 10^3/cm while the mean platelets was 211.2 (±68.3) x 10^3/cm.The mean serum creatinine was 9.9(±5.3)mg/dl. Mean serum Albumin was 3.2(±1.1)g/dl. The mean concentration of serum calcium and phosphate was found to be 6.9 (±2.1)mg/dl and 8.2 (± 5.3) mg/dl respectively. Mean urea concentration was 124.9 (± 71.8)mg/dl while mean uric acid concentration was 6.9 (± 3.0)mg/dl.Urea reduction ratio was < 65% in 67.2% and e" 65% in 32.8%.The percentage of study participants with Kt/V e" 1.2 was 24.6%, while those with Kt/V < 1.2 were 75.4%. Figure 1is aline graphs that shows the relationship between Kt/V and URR, using Pearson correlation analysis. Table 2 shows the extent of correlation between Kt/V or URR and other parameters. Table 3 shows the occurrence of intradialytic complications observed among study participants.

Table 1: Socio-demographic Characteristics of study participants

Socio-demographic Characteristics	Frequency	Percentage %
Age (years)		
20-29	9	14.8
30-39	11	18.0
40-49	21	34.3
50-59	15	24.6
60 and above	5	8.2
Mean ± SD	42.9± 11.5	
Sex		
Male	39	63.9
Female	22	36.1
Occupation		
Employees	15	24.6
Entrepreneurs	34	55.7
Student	7	11.5
Clergy	5	8.2
Marital Status		
Single	14	23.0
Married	47	77.0
Religion		
Christianity	35	57.4
Islam	26	42.6
Income(Naira)/year (to nearest 1000 naira)		
0-100,000	4	6.6
101,000-200,000	18	29.5
201,000-300,000	11	18.0
301,000-400,000	5	8.2
401,000-500,000	7	11.5
501,000 and above	16	26.2

Key: SD is standard deviation

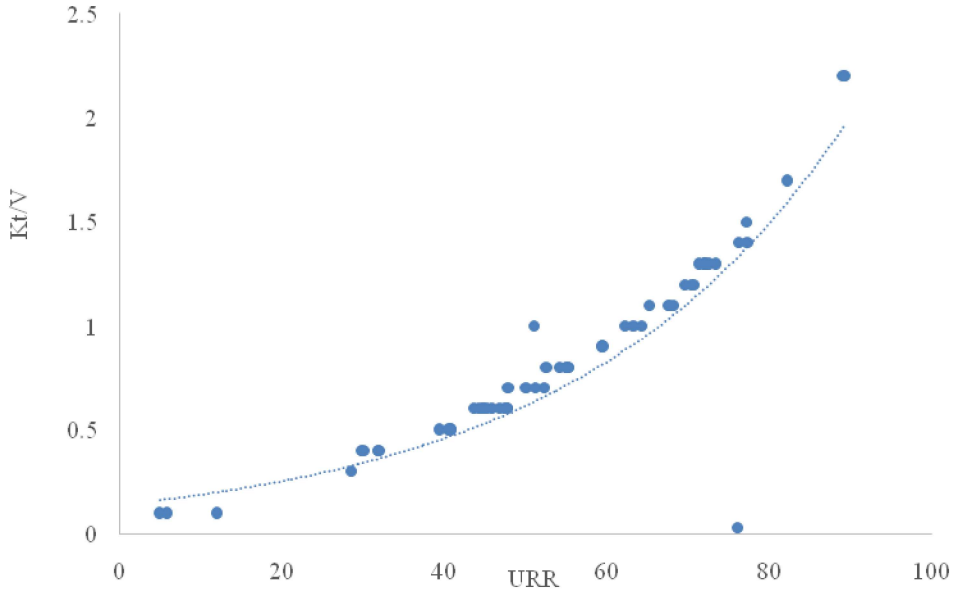

Figure 1: *Curvilinear relationship between URR (%) and Kt/V*

Table 2: Correlation between Kt/V; URR and other parameters

Parameters	**Kt/V ≥ 1.2**		**URR ≥ 65%**	
	rho	**p-value**	**rho**	**p-value**
Haemoglobin	0.31*	0.02	0.31*	0.02
Systolic BP predialysis	0.17	0.22	0.19	0.15
Diastolic BP predialysis	0.17	0.20	0.24	0.07
Systolic BP postdialysis	0.17	0.22	0.26*	0.04
Diastolic BP postdialysis	0.19	0.15	0.20	0.12
BMI predialysis	-0.73	0.48	-0.65	0.55
No. of days	0.01	0.98	0.08	0.56
Time interval	0.13	0.37	0.03	0.83

rho – correlation coefficient ; URR – urea reduction ratio; Kt/V – an index of urea clearance

Table 3: Intradialytic complications and adequacy of haemodialysis

Complications	**Marker of adequate dialysis Kt/V ≥ 1.2**		**p-value**
	Adequate	**Inadequate**	
Hypotension	**0 (0.0%)**	**3(19.9%)**	**0.13**
Abdominal pain	**1 (6.7%)**	**2 (13.3%)**	**0.69**
Muscle cramp	**0(0.0%)**	**2 (13.3%)**	**0.04***
Hypertension	**1 (6.7%)**	**1(6.7%)**	**0.54**

DISCUSSION

Majority of study participants were less than 50 years old. This suggests that in our setting, CKD tend to affect young patients. This is supported by a study done in Ghana with a mean age of 43(±17.8) years among CKD patients and 82.3% of their study participants were aged below 60 years[10]. In many regions of Africa, CKD affects mainly young adults, and so reduces their economic productivity[11]. The high occurrence of CKD among the young (economically active) pose a source of anxiety and untold outcomes for individual families and the country[10].There is a male preponderance among the study participants. This can be explained by the fact that males tend to have financial independence and better health seeking behavior. Also, hypertension and smoking are commoner in males, thus increasing their risk of CKD. The male preponderance demonstrated among patients in this study is also shown in several studies, for example, a study done in Spain and United States of America showed a percentage male preponderance of 60.1% and 61.2% respectively[12,13]. Also, another study done in Nigeria showed a male preponderance of 65.3%[14] The study was conducted in a Yoruba dominated society, accounting for 95.1% of study participants being Yorubas. The higher proportion of Christians among study participants may be an incidental finding among the cohort of patients.

Most of the study participants were low income earners, earning below 500,000 naira per annum which approximates to a monthly income of < 42,000 naira. With this income most of our patients cannot afford haemodialyis as the average cost of a session of haemodialyis is $90, excluding cost of vascular access, treatment of anaemia or mineral bone disease and cost of anti-hypertensives. The cost implications of haemodialysis per month is between $360-$1080 depending on number of sessions done weekly. This makes haemodialysis unaffordable and patients not having dialysis as scheduled.

The anthropometric parameters suggest that most of the study participants were malnourished, evidenced by a low mean BMI. This may be due to the patient's low socioeconomic state and the dietary restrictions patients are placed on. Nutritional status is a major determinant of morbidity and mortality in patients on maintenance haemodialysis[15]. In a study done in Nepal, mild to moderate malnutrition was found in two-thirds of patients on maintenance haemodialysis[16]. Malnutrition in dialysis patients can be attributed to increase catabolism and acidosis[17]. The anaemia seen among study participants was normochromic normocytic and can be explained mainly by erythropoietin deficiency, poor nutrition, multiple venipunctures and intradialysis blood loss among other reasons.

Majority of the study participants had URR below 65% and a Kt/V <1.2, suggesting inadequate dialysis. There is a strong positive correlation between urea reduction ratio and Kt/V (r=0.87, P<0.001). This means that to a very large extent, patients with adequate haemodialysis as measured by URR will also have adequate haemodialysis if measured by Kt/V. A line graph of URR vs Kt/V showed a curvilinear relationship between the two variables suggesting that the relationship between the two markers is not entirely linear as Kt/V tends to detect more patients with inadequate dialysis that would otherwise be categorized as having adequate dialysis if only URR was used.

The finding of low urea reduction ratio seen in most patients in this study was also demonstrated by several other studies. A study done in Sokoto, Nigeria, revealed a mean URR of 57.83(±0.83)%[18], this study also showed male preponderance of 73.6%[18]. Other studies done in Nigeria on URR showed mean URR of 45.3(±8.6)%[19]; and 41.8%[20]. Studies done outside Nigeria also corroborated low URR in their dialysis populations: 55.3(±7.05)[21]; 61(±11.8)[22]; 62.6(±12.8)[23]. Contributory factors to low URR include poor socioeconomic status of patients which results into late presentation to the hospital, repeated blood transfusion and inability to sustain the recommended thrice weekly haemodialysis prescription due to poor finances. The finding of Kt/V < 1.2 in this study was also supported by a study done in USA with a mean Kt/V of 1.13(±0.32)[24]. The strong correlation between URR and Kt/V will suggest that in resource poor countries, URR can be used as a simplified means of assessing adequacy of intermittent haemodialysis and delivery of small solute clearance. The bottle neck to this is that the NKF/KDOQI 2015 guideline suggests that URR should be phased out in favour of more precise options[8].

We also noted a direct correlation between Kt/V $\geq$ 1.2 and rise in haemoglobin levels; a similar observation was also noted for URRe"65%. This suggests that mean haemoglobin levels were higher in those with adequate dialysis than those with

inadequate dialysis. A similar finding was reported in a study done in Jordan[25]. In another study, adequacy of dialysis was found to reduce requirement of erythropoietin[26].

Intradialytic complications were commoner in study participants with inadequate dialysis than those with adequate dialysis. The occurrence of a severe intradialytic complication especially hypotension, may cause premature termination of an haemodialysis session which may result in inadequate dialysis.The incidence of intradialytic hypotension is significantly associated with increased risks for myocardial infarction, hospitalization for heart failure or fluid overload[27].

Limitations

This study involved only a single center, therefore results may not entirely represent the situation in other centers. Also, the sample size is small and therefore results obtained may not be generalized. Another limitation is that most of our patients cannot afford the recommended thrice weekly haemodialysis schedule

CONCLUSION

The findings from this study demonstrated that majority of our patients are unable to achieve adequate haemodialysis using markers of small molecule clearance. The marker Kt/V detected more patients with inadequate dialysis than URR. There is a direct positive correlation between urea clearance and middle molecule clearance. Adequacyof haemodialysis may enhance higher haematocrit levels in patients on maintenance haemodialysis. Intradialytic complications were commoner in patients with inadequate dialysis.

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