Original Article

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Adequacy of dialysis among patients with end-stage renal disease undergoing maintenance haemodialysis in South-West Nigeria

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ABSTRACT

Background: Globally, Dialysis remains the most common form of Renal Replacement Therapy (78%) with HD being the preferred mode of Dialysis (89%). An Adequate dialysis is the dose that ameliorates the uraemic symptoms, prolongs life, and provides a quality of life close to normal and reduces the associated morbidity and mortality. **Objective**: This study assessed the adequacy of dialysis prescribed and delivered to patients on maintenance HD in South-West Nigeria. **Method**s: An observational cross-sectional study involving Adult ESRD Patients on Maintenance HD at four different units in South Western part of Nigeria. **Results**: Forty-one (41) patients with ESRD undergoing maintenance HD for ≥3months participated in the study. Their ages ranged between 19 and 84 years (mean ± SD: 49.6 ± 16.5) Males constituted 58.5% with a M:F of 1.4:1. The measures of adequacy of dialysis calculated from Pre- and Post- dialysis urea levels were Percent Reduction of Urea (PRU), Equilibrated Kt/V (eKt/v) and Standard Kt/V (stdKt/V) with mean (± SD) of 54.7 (± 10.8)%, 0.89 (± 0.21)and 1.31 (± 0.37) respectively. Of the 41 patients, 7 (17.1%) had PRU ≥65%, 10 (24.4%) had eKt/v ≥1.05 and 3 (7.3%) had stdKt/V ≥2.0 per week. **Conclusion**: Adequacy of dialysis using clinical and laboratory parameters in our ESRD patients were poor and did not attain levels recommended by available Clinical Practice Guideline and Recommendations. However, the two measures of adequacy, PRU and stdKt/V, correlated significantly.

Keywords: Haemodialysis, Adequacy of Dialysis, Maintenance Haemodialysis, End-Stage Renal Disease

INTRODUCTION

Chronic kidney disease (CKD) is kidney damage evidenced by structural or functional abnormalities or a persistent decline in glomerular filtration rate (GFR) to less than 60ml/min/1.73m^2 body surface area lasting ≥3 months. (1) It is a spectrum of pathophysiologic processes with multiple aetiologies, resulting in a progressive reduction in the Glomerular Filtration Rate (GFR), frequently leading to end-stage renal disease (ESRD) accompanied by signs and symptoms of kidney failure necessitating renal replacement therapy.(2) The definitive management of advanced CKD (ESRD) is renal replacement therapy (RRT).

Globally, 2·618 million people were estimated to receive RRT in 2010 with a projection that the number will more than double to 5·439 million (3·899-7·640 million) people by 2030.(3) Treatment options for RRT in ESRD include haemodialysis (HD), peritoneal dialysis (PD) and renal transplantation (RTx).

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HD removes solutes and fluid in total/ near-total loss of kidney function by machines utilizing extracorporeal blood lines and artificial kidney (‘dialyzer’)(1).

Globally, Dialysis remains the most common form of Renal Replacement Therapy (78%) with HD being the preferred mode of Dialysis (89%)(4) (5) (6)
In Sub-Saharan Africa, HD is the most common modality of RRT. Chronic ambulatory PD is limited by cost and a high rate of peritonitis while transplantation is limited by cost, donor shortages and

absence of brain-death laws.(7,8) In Nigeria, majority of patients with CKD requiring RRT are
HD, for the afore-mentioned reasons.(7) Also, poor and inadequate facilities for HD, insufficient manpower and the predominantly urban location of renal care centres are contributory.(9,10)
The therapeutic objective of RRT is restoration of functions of the failed kidney including excretion of nitrogenous wastes, maintenance of fluid, electrolyte and acid-base homeostasis, secretion of erythropoietin and metabolism of vitamin D. In practice, most aspects of normal renal function are very difficult to reproduce. HD and PD are unable to restore total renal function, but renal transplantation does.
Adequate dialysis is the dose that ameliorates the uraemic symptoms, prolongs life, and provides a quality of life close to normal and reduces the associated morbidity and mortality.(11)
Assessment of adequacy considers multiple objectives and measurable clinical parameters including patient well-being (physical, mental, and social), nutritional status (lack of malnutrition), small solute clearance (urea kinetic modeling [UKM]), adequacy of ultrafiltration, control of blood pressure, protein catabolic rate (PCR), control of anaemia, acidosis, and renal bone disease.(11,12)
Studies on dialysis adequacy led to the development of different Clinical Practice Guidelines (CPG) and Recommendations on HD adequacy.(13,14) These studies were undertaken in developed countries, where patients have access to optimal care at minimal or no cost and the HD facilities are readily available and up-to-date.
In Africa, Arogundade and Barsoum(11) worked on adequacy of maintenance HD in Egypt, comparing the different validated formulae for calculating the adequacy of small solute clearance. Their result was compared with the recommended formulae of National Kidney Foundation, Kidney/Disease Outcomes Quality Initiative. They concluded that the relatively simpler formulae for assessing adequacy using small solute removal correlated well with the recommended formulae of NKF-K/DOQI and can be adopted in developing countries. However, it was not stated whether these formulae were compared to the standard computerized Urea Kinetic Modeling.
In Nigeria, there is an increase in centres offering HD, but there are no Clinical Practice Guidelines and Recommendations on the minimum and target values for an adequate dialysis. The current Clinical Practice Guidelines and Recommendations in the developed world would be difficult to achieve, mainly due to the unaffordability of HD and ancillary supporting treatment modalities. Also, most units suffer interruptions due frequent breakdown of machines making it particularly difficult for patients to maintain regular therapy, those that do, are not compliant prescriptions.(15,16) This study assesses the adequacy of dialysis prescribed and delivered to patients on maintenance HD in South-West Nigeria. Its outcome will guide future practice of participating centres.

PATIENTS AND METHODS

Study Design: An observational cross-sectional study involving adults on maintenance HD.

Study Setting: The Renal Centre of Obafemi Awolowo University Teaching Hospitals' Complex (OAUTHC) Ile-Ife, St Nicholas Hospital, Dialyzer Medical Centre, Life Support Medical Centre, Gbagada General Hospital and Eko Hospital, all in Lagos

Exclusion Criteria: Patients on PD, not dialysis dependent, with active malignancy or evidence of infection. Also, patients with chronic liver or cerebrovascular disease, HIV with gastrointestinal involvement, those in class IV NYHA congestive cardiac failure or hospitalized Study Population: Patients with ESRD on maintenance HD for a duration ≥ 3 months.

Inclusion Criteria: Patients aged ≥ 18yrs with ESRD having creatinine clearance ≤ 15mls/min/1.73m2 (Cockcroft & Gault equation) undergoing 2 – 3 sessions of maintenance HD a week for ≥ 3 months. in the past 30 days.

Sampling Method: Purposive sampling; a non-probability sampling method.

Procedure: Patients were reviewed and their demographic data obtained. Physical examination was conducted. The dialysis was recorded to include the prescription and duration of dialysis. Body weight was measured before and after each dialysis session using a clinical weighing scale. Blood pressure (BP) was measured before and after the dialysis session in the

supine and standing positions after five minutes rest using standard mercury sphygmomanometer (Accusson, Germany). Phases I and V of the Korotkoff sounds were used to determine systolic and diastolic blood pressure respectively. Right arm of the patient was used for the BP measurements except where contra-indicated by the presence of an AVF. Samples were taken from the patients for serum electrolytes, urea and creatinine, uric acid, calcium, phosphate, serum proteins, packed cell volume just before commencement of the HD procedure. Samples were taken 30 minutes after the session for serum urea level.

Data Management: Data was analyzed using Statistical Package for Social Sciences (SPSS) version 17 and values expressed as mean with standard deviation. Adequacy of Hemodialysis was determined using Percent Reduction of Urea (PRU) and Equilibrated Kt/V. Values for PRU were calculated using the formula: PRU = (Upre - Upost) / Upre x 100

Equilibrated Kt/V was calculated using the second-generation natural logarithmic equation of Daugirdas(17),:eKt/V = –ln [Req – 0.008 × t] + [4 – 3.5 × Req] × UF/W

Where: Req is the ratio of post-dialysis BUN to predialysis BUN, t is time on dialysis in hours, UF is the volume of ultrafiltration in litres and W is the post-dialysis weight or patient's dry weight in Kilograms. Standard Kt/V was calculated using the Leypoldt equation.(18)

ETHICAL CONSIDERATION

Approval of the Ethics and Research Committee of the Obafemi Awolowo University Teaching Hospitals' Complex, Ile-Ife, was obtained to conduct study (Appendix VI). Informed consent was obtained from the patients after adequate explanation of study protocol by the lead author in the patient's best understood language. Interpreters were used in a few cases.

RESULTS

Forty-one (41) patients with ESRD undergoing maintenance HD for ≥3months participated in the study.

Demographics of Studied Sample

Their ages ranged between 19 and 84 years (mean ± SD: 49.6 ± 16.5); upon further grouping, 36.6% were young (mean±SD; 32.3±6.5), 41.5% middle aged (mean±SD; 53.1±7.7) and 22.0% elderly (mean±SD; 71.89±5.5). Males constituted 58.5% with a M:F of 1.4:1. The mean (± SD) age for males was 50.33 (±16.2) years while that for females was 48.65 (±17.39) years.

TABLE 1: Age-grouping and gender distribution of participants

	AGE-GROUPS			
	18-40YRS	41-65YRS	>65YRS	
GENDER				
MALE	9	10	5	24
FEMALE	6	7	4	17
TOTAL	15	17	9	41

Twenty-seven (65.9%) were married, 9 (22%) single, 4 (9.8) widowed and 1 (2.4%) divorced. Thirty-six (87.8%) belonged to either the upper or middle social class, while 5 (12.2%) were in the lower class. Most patients were recruited from centres in Lagos (Table 2).

Table 2: Patients' Distribution from the Different Renal Care Units

	Frequency	Percent
OAUTHC	4	9.8
St Nicholas Hospital	19	46.3
Dialyzer Medical Centre	7	17.1
Life Support Medical Centre	7	17.1
Gbagada General Hospital	2	4.9
Eko Hospital	2	4.9
	41	100

Clinical and Biochemical Profile of Maintenance Haemodialysis Patients

The systolic BP (SBP) ranged from 110 - 220mmHg, with a mean (± SD) of 159.0(± 22.7); while the diastolic BP (DBP) ranged from 70 - 120 mmHg, with a mean (± SD) of 91.3 (±14.7) mmHg. The mean arterial BP (MAP) ranged between 83.3- 140 mmHg, with a mean (± SD) of 113.9 (±15.1) mmHg. Twenty-seven (65.9%) had pedal oedema and 10 (24.4%) ascites. Pallor was present in 29 (70.7%) and asterixis in 24 (58.5%).

Baseline and pre-dialysis laboratory parameters assessed are shown in Table 3.

Table 3: Baseline Laboratory Parameters of Studied Patients

Parameter	Mean ± standard deviation	Median (Range)
Packed Cell Volume (%)	25.6 ± 5.93	25 (17 -42)
Sodium (mmol/l)	136.9 ± 5.21	138 (122-146)
Potassium (mmol/l)	4.47 ± 0.85	4.5 (3.3 – 6.8)
Bicarbonate (mmol/l)	23.0± 3.39	23 (14 – 32)
Chloride (mmol/l)	102.3 ± 3.79	102 (93 – 111)
Urea (pre-dialysis) (mmol/l)	43.5±19.1	43.9 (9.9 – 96.4)
Urea (post-dialysis) (mmol/l)	19.5±8.86	18.56 (4.5 - 35.7)
Creatinine (µmol/l)	789.8±418.4	742.6 (203.3-1980.2)
Calcium (mmol/l)	2.13±0.46	2.18 (0.66-3.28)
Phosphate (mmol/l)	1.30±0.41	1.21 (0.39-2.36)
Calcium – phosphate product ($mmol^2/l^2$)	2.86±1.15	2.68 (0.32-5.92)
Total Protein (g/l)	63.2 ± 9.6	62.5 (34-84)
Albumin (g/l)	32.9 ± 5.48	33.5 (17 -43)

The Dialysis Procedure

Only 14 (34.1%) had AVF access for dialysis. Five patients (12.2%) were dialyzed via jugular vein, 3 (7.3%) via subclavian vein, and 19 (46.3%) via the femoral vein. Thirty-one patients (75.6%) were on twice weekly HD and 10 (24.4%) were on thrice weekly HD. The mean duration (± standard deviation) on HD therapy was 19.07 (± 20.5) months with a median of 12(range; 4-110) months.

The measures of adequacy of dialysis calculated from Pre- and Post- dialysis urea levels were Percent Reduction of Urea (PRU), Equilibrated Kt/V (eKt/v) and Standard Kt/V (stdKt/V) with mean (± SD) of 54.7 (± 10.8)%, 0.89 (± 0.21)and 1.31 (± 0.37) respectively. Of the 41 patients, 7 (17.1%) had PRU ≥65%, 10 (24.4%) had eKt/v ≥1.05 and 3 (7.3%) had stdKt/V ≥2.0 per week.

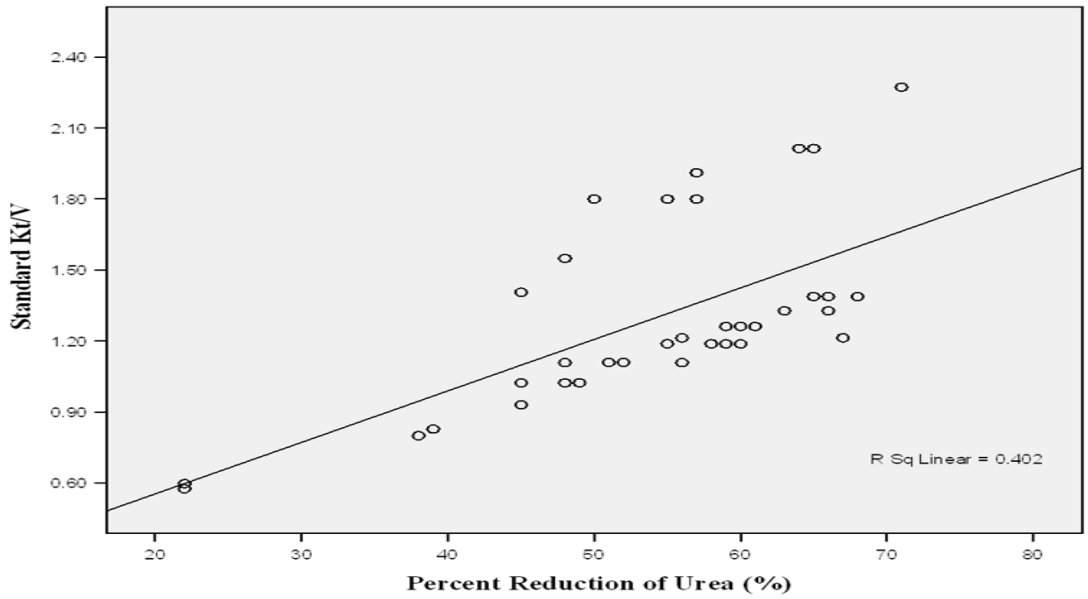
Table 4: Clinical Characteristics of Dialyzed Patients

PARAMETER	MEAN ± STANDARD DEVIATION	MEDIAN (range)
Pre-dialysis Systolic BP (mmHg)	162.3 ± 26.35	163 (110 - 224)
Pre-dialysis Diastolic BP (mmHg)	94.4± 16.12	90 (64 - 129)
Pre-dialysis Mean Arterial BP	117.0±17.73	114.67 (83.3 - 153.3)
Post-dialysis Systolic BP (mmHg)	159.9 ± 20.28	160 (122 - 217)
Post-dialysis Diastolic BP (mmHg)	93.3 ± 16.8	90 (63 - 131)
Post-dialysis Mean Arterial BP	115.5±14.4	116.7 (92.7 - 152.3)

Table 5: Adequacy of Haemodialysis in Dialyzed Patients

PARAMETER	MEAN ± STANDARD DEVIATION	MEDIAN (range)
Percent Reduction of Urea – PRU (%)	54.7 ± 10.8	57 (22 - 71)
Equilibrated Kt/V	0.89 ± 0.21	0.9 (0.37 - 1.31)
Standard Kt/V	1.31 ± 0.37	1.26 (0.58 - 2.27)

FIGURE 1: CORRELATION BETWEEN STANDARD Kt/V AND PERCENT REDUCTION OF UREA (r=0.607; p<0.001)



DISCUSSION

Haemodialysis is the most commonly available, accessible and utilized modality of RRT in ESRD.(5) The need to optimize HD to enhance patient survival, quality of life and cost effectiveness has been demonstrated by several studies. (19) Different recommended guidelines for an adequate dose of HD exist, but none specific to the Nigerian environment. This study assessed the dose and adequacy of HD in Nigeria using clinical and laboratory parameters.

In Nigeria, financing MHD is mainly out-of-pocket; 87.8% the patients were in the upper and middle social classes and could purchase this service or had employer's support. This implied that the lower socio-economic class could not afford to have regular maintenance dialysis, therefore not included in the study. (20)

The male preponderance is similar to that of other studies on maintenance HD in both developed and developing countries. (21) In s semi-structured interview conducted by Tong A et al, the responses by Nephrologists reasons for gender differences in accessing HD by Women included factors related to social norms, roles of caregiving responsibilities, disempowerment, lack of support, stereotyping by clinicians, and entrenched social and economic disadvantages (21)

Initially, there were recommendations that Dialyzing CKD patients with Hypertension should have systolic (BP) ≤ 130mmHg and 80mmHg diastolic. However recent studies shows that there are no widely accepted targets for Patients on MHD. (22) (23) The mean BP from our study showed a systolic of 159.0 ±22.7mmHg and a diastolic of 91.3 ±14.7mmHg. The MAP of 113.9 ± 15.1was also high. This poor BP control encountered is likely due to a combination of factors. Most MHD patients were instructed to discontinue anti-hypertensive medication before dialysis to prevent dialysis-induced hypotension. It could also be partly due to under-dialysis or inadequacy of HD with consequent fluid retention especially as quite a high percentage of the patients

had fluid retention. The high percentage of patients with clinical features of fluid retention, anaemia and asterixis clearly indicates sub-optimal dialysis with long inter-dialysis periods allowing for more fluid retention and features of uraemia.
The baseline haematological and biochemical parameters of patients were out of the range recommended by NKF-K/DOQI.(24) The mean PCV (25.6±5.93) and serum albumin (32.9±5.48) were lower than the NKF-K/DOQI range of 33-36% and 40g/l. (25) (26)

The calcium, phosphate and calcium-phosphate product were however, within the recommended range. This could be accounted for by the low incidence of the recognized risk factors for mineral and bone disorder both in the CKD and non-CKD patients in our environment. The relatively young age of our ESRD patients, the short duration on HD, the tropical weather and our local diet are some of the reasons for the low incidence of MBD in our setting. (27)

The frequency of dialysis was mainly determined by the ability to pay for the therapy. Thirty-one (75.6%) patients were on twice weekly HD, while 10 (24.4%) were on thrice weekly therapy. This is below the recommendations by the various practice guidelines in the developed world. However, improved survival of patients on twice weekly HD prescription compared to thrice weekly treatment has been demonstrated by several studies. (28) (29). The plausible explanation proffered was that the group of patients on twice weekly HD had greater residual renal function and better clinical profile.

The two biochemical measures of adequacy; PRU and Equilibrated Kt/V with a mean ± SD of 54.7 ± 10.8 and 0.89 ± 0.21 respectively, were clearly suboptimal and did not meet any available Clinical Practice Guidelines and Recommendations. Converted to standard Kt/V values using the modified Leypoldt equation which incorporates the values of eKt/V, frequency of HD per week and duration of treatment, the mean (± SD) of 1.31 ± 0.37 derived was still below the recommended value of ≥ 2.0per week.(24)

Based on these, very few patients had adequate dialysis as measured by small solute clearance. Many factors could account for this low dialysis dose. The major ones include the lack of a proper and individualized dialysis prescription, low blood flow rates, poor vascular access and long inter-dialytic periods. The other factors could be variations in the definition of outcomes and practices in delivering treatment.(30)

However, the good correlation between PRU, eKt/V and standard Kt/V suggest that the relatively simple method (PRU) could be used in busy units with huge patient load or units without access to computational software for deriving standard Kt/V.

LIMITATIONS OF STUDY

The small sample size and the observational design of the study may have reduced the ability of the study to detect minor differences in the measured and calculated parameters. Moreso, the measurements of adequacy of small solute clearance did not account for the effects of residual renal function, which could contribute to the total clearance in some patients.

CONCLUSION

Haemodialysis is the main RRT for the ESRD patients in Nigeria consisting mainly of young/middle-aged males within the economically active sector. The treatment is mainly self-sponsored with most patients using temporary vascular access.
Adequacy of dialysis using clinical and laboratory parameters in our ESRD patients were poor and did not attain levels recommended by available Clinical Practice Guideline and Recommendations. However, the two measures of adequacy, PRU and stdKt/V, correlated significantly.

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