Ethiopian Medical Journal 2023, 61 (1)
Open access articles distributed in terms of Creative Commons Attribution Licence [CC by 4.0]
ISSN 0014-1755 eISSN 2415-2420 Uduagbamen et al.

Original Article
Dialysis Prescription: Determinants and relationship with intradialytic complications and the dialysis dose. A prospective study.

Peter Kehinde Uduagbamen[1], Solomon Kadiri[2]

[1]Division of Nephrology and Hypertension, Department of Internal Medicine, Ben Carson (Snr) School of Medicine, Babcock University/Babcock University Teaching Hospital, Ilishan-Remo, Nigeria.
[2]Nephrology Unit, Department of Internal Medicine, University College Hospital, Ibadan, Nigeria

Corresponding author*: petr.uduagbamen@gmail.com

Abstract

Introduction: *Dialysis still remains the most common modality for the treatment of end stage kidney disease and it could be maneuvered to augment its dose, minimize complications and improve outcome. Dialysis prescription is a brief of how dialysis is to be given and involves adjustments in patients' characteristics, disease or dialytic procedure. This study aimed to assess the determinants of the prescribed dialysis and its relationship with intradialytic complications and the dialysis dose.*

Methods*: A prospective study in which 1248 sessions for 232 consented participants with end stage kidney disease on maintenance hemodialysis were studied from 2017-2020. Biodata was taken, participants were examined and blood samples were taken to determine electrolytes, urea/creatinine and hematocrit. Pearson's correlation was used to determine the strength of association between dialysis dose and some variables.*

Results*: Determinants of the prescribed dose were dialysis frequency (P<0.001), and predialysis systolic blood pressure (P<0.001) and packed cell volume (P<0.001). Dialysis sessions without significant intradialytic blood pressure changes were most likely to be completed, as sessions with intra-dialysis hypotension were most likely to be terminated. Participants dialyzed with high flux dialyzers, via an arterovenous fistula, higher blood flow and ultrafiltration rates had higher dialysis doses (P<0.001 in all instances).*

Conclusion*: Higher dialysis doses were achieved with higher blood flow and ultrafiltration rates. Intradialytic hypotension was common with dialysis termination, higher blood flow and ultrafiltration rates. Intradialytic hypertension was common with low flux dialyzers. An optimized dialysis prescription is needed to deliver an adequate dialysis dose and minimize complications.*

Keywords*: End stage kidney disease, intra-dialysis hypotension, intra-dialysis hypertension, prescribed dialysis*
Citation : *Uduagbamen PK, Kadiri S, Dialysis Prescription: Determinants and relationship with intradialytic complications and the dialysis dose. A prospective study. .Ethiop Med J 61 (1) 51 - 60*
Submission date : *13 October 2021 Accepted: 21 November 2022 Published: 1 January 2023*

Introduction

Despite advances in dialysis modalities, optimal dialysis delivery is still largely unattainable particularly, in low income nations (LINs). Agaba et al reported a urea reduction ratio (URR) of 45.3 ± 8.6% in Nigeria and attributed this low dose to socioeconomic factors and frequent breakdown of dialysis machines.[2] Amini et al in Iran, a developing nation, found a URR of 61.0 ± 11.8% and solute clearance (Kt/V) of 1.2 ± 0.4 and found similar limitations to effective dialysis delivery in LINs.[3] However Rafik et al in Morocco reported that increasing the blood flow rate (BFR) from 250 ml/min to 350 ml/min increased the mean URR from 75.41 ± 5.60 to 83.51 ± 6.12 and mean single pool Kt/V from 1.28 ± 0.25 to 1.55 ± 0.15.[4] Dialysis delivery is reported to be better in the developed nations due to better socioeconomic standards, government financing, reliable energy supply and a more enlightened population.[5] Suboptimal dialysis contribute to increased morbidity and mortality, more so in LINs. The dialysis prescription appears to be the final attempt at addressing these shortcomings, particularly in LINs.

The delivered dose is defined as adequate when the assessment measures, Kt/v or URR is at least 1.2 or 65% respectively. It is dependent on patients' prevailing clinical and laboratory parameters, the prescribed dose, dialysis facilities and personnel, and energy supply and is directly related to the blood pressure control and fluid balance. Adequate dialysis increases appetite and is associated with higher serum albumin and hematocrit. Inflammation in dialysis patients is partly attenuated with an adequate dialysis dose. [3-5].

Literature is scanty concerning the place of prescribed dialysis in improving treatment outcome in LINs. We studied the prescribed dialysis dose, its determinants, and its relationship with intradialytic complications and dialysis dose.

Methods

Study Design

This was a two-center hospital based prospective study conducted at the Federal Medical Centre, Abeokuta (FMCA) from January to December 2017 and Babcock University Teaching Hospital (BUTH), Ilishan-Remo, from August 2018 to December 2020, both cities in Southwestern, Nigeria, about 30 kilometers apart.

Study setting and population

Two hundred and thirty two participants with chronic kidney disease (CKD) in end stage according to the KDOQI 2012 criteria, ≥16 years, met the inclusion criteria and gave informed consent had 1248 sessions[6].Patients with kidney transplant, infections, and sessions less frequent than once weekly were excluded

Study Objectives

To assess the prescribed dose, its determinants and its relationship with intradialytic complications and the delivered dose.

Sample size estimation

Using a previous study's prevalence of 6.1% for patients on maintenance hemodialysis (MHD) for less than a year and on twice weekly treatment[7] (a common regimen in LINs). This gave an estimated sample size of 232 (after an attrition of 10%).

Data collection procedures

Retrieved were age, etiology of CKD, erythropoietin and dialysis frequency, intradialytic hypotension (IDH), intradialytic hypertension (IDHT) and dialysis termination. Unfractionated heparin 5,000 IU was used, alterations were documented. Dialysate buffer was bicarbonate based, where sodium profiling was done, it was documented.

Height and weight were measure bare-footed, on light clothing and without cap or head gear. After 5 minutes rest, vitals participants were examined to determine the oxygen saturation (SPO_2), temperature, pulse rate (PR) and blood pressure (BP), and dialysis was prescribed. These vitals were repeated half hourly throughout dialysis. Predialysis samples were taken, patient were connected, other pre-dialysis protocols were observed and dialysis was commenced.

Where the blood flow rate (BFR) or dialysate flow rate (DFR) was altered, the average was documented. At dialysis time zero, the dialysate flow was stopped, BFR was reduced to 100ml/min, five minutes later, blood flow was stopped and sample was taken from the arterial portal first for renal biochemistry, then for hematocrit.[8]

Dialysis dose was calculated using Daugirdas second generation logarithmic formula:

$Kt/V = -In(R - 0.008 \times t) + (4.35 \times R) \times UF/W$ [9].

The URR was calculated from the formula:

(differrence in urea/pre dialysis urea) X 100.

The URR and Kt/V were related by the equation,

Kt/V = In (1-URR), where In is natural log

The Ion Selective Electrode method was used to analyze the serum electrolytes. Serum albumin was analyzed using the bromocresol green method[9]. Hematocrit was determined using a hematocrit centrifuge. With increased risk of bleeding (deranged clotting profile), heparin dose was either reduced or withheld.

Study Definitions

Intra dialytic hypotension (IDH) was defined as ≥20 mmHg drop in systolic BP.[10]

Intra dialytic hypertension (IDHT) was defined as ≥10 mmHg rise in systolic blood pressure.[10]

Data processing and analysis

Data was entered into a data collection form, exported into SPSS 22 for cleaning, coding and analysis. Continuous variables were compared using t-test, categorical variables were compared using Chi square test or fisher's exact test. The P-value <0.05 was considered statistically significant. A multivariate logistic regression analysis was used to determine independent associates of the dialysis dose.

Ethical consideration

The Ethics Committees of the FMCA (FMCA/470/HREC/03/2017, NHREC/08/10-2015) and BUTH (BUHREC/723/19, NHREC/24/01/2018) have approved this study. The study protocol was read to participants, clarifications were given for enquiries and written informed consent were obtained. The research followed the tenets of the Declaration of Helsinki.[11]

Results

The mean age of the participant was 49.9 ± 4.6 years. Ninety (38.8%) of the participants had hypertension, all received antihypertensive drugs (**Table 1**). The overweight and obese made up 52.6% of the cohorts, had 56.6% of the sessions, but had 60.0% of sessions with Kt/V ≥1.2.

Table 1: Socio-demographic and clinical characteristics of participants

Variables	Frequency N=232 (%)	Dialysis session N=1248 (%)
Sex		
Males	143 (61.5)	818 (65.5)
Females	89 (38.5)	430 (34.5)
Age, years		
Less than 50	110 (47.4)	479 (38.4)
50 and above	122 (52.6)	769 (61.6)
Etiology of CKD		
Hypertension	90 (38.8)	585 (46.9)
Chronic glomerulonephritis	88 (38.0)	362 (29.0)
Diabetes	27 (11.6)	162 (13.0)
Others	27 (11.6)	139 (11.1)
Body mass index, m^2/kg	110 (47.4)	542 43.4)
<25.0	122(52.6)	706 (56.6)
≥25.0		
Predialysis Systolic BP, mmHg		
<140	45 (19.4)	201 (16.1)
≥140	187 (80.6)	1047 (83.9)
Predialysis Diastolic BP, mmHg		
<90	27 (11.6)	167 (13.4)
≥90	205 (88.4)	1081 (86.6)
Predialysis Oxygen saturation, %		
<95	207 (89.2)	1156 (92.6)
>95	25 (10.8)	92 (7.4)

Mean pre dialysis sodium was lower than the post dialysis (**Table 2**). The mean pre dialysis albumin was 34.7 ± 5.2 g/dl, it was higher in males (36.1 ± 4.4 g/dl versus 31.8 ± 3.7 g/dl).

Table 2: Laboratory results of participants

Variables	Pre-dialysis	Post-dialysis	t-test	P-value
Sodium	126.7 ± 4.7	134.24 ± 3.6	1.5	0.01
Potassium	5.76 ± 1.2	4.1 ± 1.1	5.5	0.001
Chloride	96.8 ± 7.6	102.4 ± 8.3	5.2	0.001
Bicarbonate	18.1 ± 4.4	20.1 ± 5.9	5.3	0.001
Urea	17.3 ± 2.7	8.1 ± 4.4	7.5	<0.001
Creatinine, u mol/l	526.6 ± 11.8	322.9 ± 11.4	7.9	<0.001
Glomerular filtration rate	5.2 ± 1.2	9.1 ± 1.6	5.8	<0.001
Hematocrit, %	23.5 ± 3.3	24.2 ± 4.8	1.1	0.

The dialysis dose (Kt/V) was adequate in 9.2% of the sessions and with URR, 13.8%. The mean Kt/V for all sessions was 1.02 ± 0.4, higher in males (1.10 ± 0.7 versus 0.94 ± 0.3), P=0.002 (**Table 3**). The mean URR was 55.8 ± 4.0 %. Participants on weekly, twice weekly and thrice weekly sessions, and erythropoietin had 264 (21.2%), 784 (62.8%) and 200 (16.0%), and 14.2%, 53.5% and 403 32.3% respectively.

The mean dialysis duration was 3.8 ± 0.6 hours, it was higher in males (3.8 ± 0.8 hours versus 3.8 ± 0.2 hours). Sessions with high flux dialyzers, AV fistula, higher BFR and UFV had higher dialysis doses (P<0.001 in all instances). The mean BFR and UFV were 306.8 ± 13.2 ml/min and 1.3 ± 1.0 L respectively. More men than women used the IJV access, P=0.8.

Table 3: Relationship between determinants and content of prescribed dialysis, and dialysis dose

Variables	Frequency N=1248 (%)	Kt/V <1.2 N=1133 (%)	Kt/V >1.2 115 (%)	X^2	P-value
Gender					
Males	818 (85.5)	736 (65.0)	82 (71.3)	3.4	0.002
Females	430 (34.5)	397 (35.0)	33 (28.7)		
Age, years					
Less than 50	479 (38.4)	443 (39.1)	36 (31.3)	5.4	<0.001
50 and above	769 (61.6)	690 (60.9)	79 (68.7)		
Etiology of CKD					
Hypertension	585 (46.9)	521 (46.0)	64 (55.6)	4.1	0.001
Chronic glomerulonephritis	362 (29.0)	333 (29.4)	29 (25.2)		
Diabetes	162 (13.0)	151 (13.3)	11 (9.6)		
Others	139 (11.1)	128 (11.3)	11 (9.6)		
Body mass index, kg/m^2					
Less than 25.0	541 (43.3)	495 (44.6)	46 (40.0)	3.9	0.002
25.0 and above	707 (56.7)	638 (55.4)	69 (60.0)		
Systolic BP, mmHg					
Less than 140	139 (11.1)	101 (8.9)	38 (33.0)	8.8	<0.001
140 and above	1109 (88.9)	1032 (91.1)	77 (67.0)		
Oxygen saturation, %					
Less than 95	864 (69.2)	897 (71.2)	57 (49.6)	8.2	<0.001
95 and above	384 (30.8)	326 (28.8)	58 (50.4)		
Erythropoietin/week					
1	434 (34.8)	417 (36.8)	17 (14.8)	7.9	<0.001
More than once	814 (65.2)	716 (63.2)	98 (85.2)		
Hematocrit, %					
Less than 33	865 (69.3)	844 (74.5)	21 (18.3)	10.3	<0.001
33 and above	383 (30.7))	289 (25.5)	94 (81.7)		
Albumin, g/dl					
Less than 35	1096 (87.8)	1063(93.8)	33 (28.7)	10.1	<0.001
35 and above	152 (12.2)	70 (6.2)	82 (71.3)		
Creatinine, umol/l					
Less than 130	33 (2.6)	2 (9.2)	31 (27.0)	7.1	<0.001
130 and above	1215 (97.4)	1131 (99.8)	84 (73.0)		

Variables	Frequency N=1248 (%)	Kt/V <1.2 N=1133 (%)	Kt/V >1.2 115 (%)	X^2	P-value
Dialysis frequency/week					
1	389(31.2)	380 (33.5)	9 (7.8)	9.1	<0.001
2 and above	859 (68.8)	753 (66.5)	106 (92.2)		
Vascular access					
Femoral	426 (34.1)	399 (35.2)	27 (23.5)	6.5	<0.001
Tunneled internal jugular	757 (60.7)	677 (59.8)	80 (69.6)		
Arterovenous fistula	65 (5.2)	57 (5.0)	8 (6.9)		
Dialysis duration, hours					
Less than 4	170 (13.6)	164 (14.5)	6 (5.2)	6.9	<0.001
4 or more	1078 (86.4)	969 (85.5)	109 (94.8)		
Blood flow rate, ml/min					
Less than 300	307 (24.6)	296 (26.1)	109 (9.6)	8.9	<0.001
300 and above	941 (75.4)	837 (73.9)	104 (90.4)		
Dialyzer area, m^2					
Low flux, 1.3/1.4	33 (2.6)	33 (2.9)	0 (0.0)	10.8	<0.001*
High flux 1.7/1.8	1215 (97.4)	1100 (97.1)	115 (100.0)		
Ultrafiltration volume, litres					
Less than 3	630 (50.5)	588 (51.9)	42 (36.5)	7.1	<0.001
3 and above	618 (49.5)	545 (48.1)	73 (63.5)		

IDHT was more common with AV fistulas as IDH was more common with TIJV catheters, P<0.001 (**Table 4**). Dialysis sessions without significant intra-dialytic BP changes were most likely to complete their treatment, sessions with IDH were more likely to be terminated.

IDHT were more common in males as IDH was in females 207 (67.9%) versus 145 (59.9%). The mean time for the detection of IDH was 64 ± 3.8 minutes while it was 146 ±7.1 minutes for IDHT. Dialysis was terminated in 8 (3.3%) of the sessions with IDH but in 1 (0.3%) session with IDHT, and intradialytic death.

Table 4: Relationship between the content of prescribed dialysis and intradialytic complications

Variables	All sessions N=1248 (%)	IDH 242 (%)	IDHT N=305 (%)		X^2	P-value
Access						
Femoral	426 (34.1)	72 (29.8)	132 (43.3)	7.6	<0.001	
Tunneled internal jugular	757 (60.7)	157 (64.9)	120 (39.3)			
Arterovenous fistula	65 (5.2)	13 (5.3)	53 (17.4)			
Dialysis duration, hour						
Less than 4	170 (3.6)	44 (18.2)	34 (11.1)		6.7	<0.001
4 and above	1178 (96.4)	198 (81.8)	271 (88.9)			
Blood flow rate, ml/min						
Less than 300	307 (24.6)	41 (17.0)	109 (35.7)		9.3	<0.001
300 and above	941 (75.4)	201 (83.0)	196 (64.3)			
Dialyzer area, m^2						
Low flux, 1.3/1.4	33 (2.6)	4 (1.7)	14 (4.6)	2.8	0.002	
High flux 1.7/1.8	1215 (97.4)	238 (98.3)	291 (95.4)			
Ultrafiltration volume, litres						
Less than 3	630 (50.5)	93 (38.4)	196 (64.3)		7.2	<0.001
3 and above	618 (49.5)	149 (61.6)	109 (35.7)			

From Pearson' correlation (**Table 5**), albumin and dialysis duration were very strongly positive and strongly positively correlated with dialysis dose.

Table 5: Pearson's correlation: Strength of association between dialysis dose and some variables

Variables	r	CI	P-value	Correlations
Age	0.12	0.10-0.20	0.06	Weakly positive
Males	0.09	0.06-0.11	0.08	Weakly negative
Body mass index	0.02	0.01-0.43	0.06	Weakly positive
Diabetes	0.09	0.05-0.12	0.06	Weakly negative
Systolic blood pressure	0.16	0.07-0.12	0.04	Strongly positive
Oxygen saturation	0.36	0.26-0.93	<0.001	Very strongly positive
Serum Albumin	0.34	0.26-0.81	<0.001	Very strongly positive
Hematocrit	0.11	0.09-0.19	0.05	Weakly positive
Arterovenous fistula	0.27	0.20-0.56	0.001	Strongly positive
Dialysis duration	0.20	0.11-0.39	0.003	Strongly positive
Blood flow rate	0.44	0.07-0.72	<0.001	Very strongly positive
Dialyzer surface area	0.18	0.13-0.51	0.04	Strongly positive
Ultrafiltration volume	0.34	024-0.72	<0.001	Very strongly positive

Multivariate regression analysis showed SPO_2 (OR-1.23, CI-0.55-3.73, P=0.002), catheter site (OR-2.04, 1.30-3.52, P=0.001), dialysis duration (OR-1.08, CI-1.01-2.84, P=0.04), albumin (OR-2.72, CI-2.12-5.94, P<0.001), BFR (OR-3.66, CI-2.46-8.84, P<0.001), UFV (OR-2.44, CI-1.07-6.38,P=0.001) predialysis creatinine (OR-1.14, CI-0.31-1.75, P=0.02) as predictors of the dialysis dose.

Discussion

We found the major predictors of dialysis dose to be patient's hemodynamics, CKD etiology, UFV, IDH, IDHT, and comorbidities. Males received higher doses than females, similar to findings in Egypt.[12]. Women, the malnourished and children, by virtue of their lesser weight have lower urea distribution volume (UDV), which has an inverse relationship with the dialysis dose, women should therefore have higher doses as reported by Somiji et al.[13] We attribute our findings to the combined effect of higher BFR, higher albumin levels, more frequent dialysis and EPO use in males, mitigating the relationship between weight and UDV.

The positive relationship between dialysis doses and BMI disagrees with previous findings that showed an inverse relationship between the BMI and dialysis dose. [14] A very large proportion of participants had relatively higher albumin level. Many of the dialysis patients were relatives of (or retired workers) of multinational organizations who had frequent dialysis and erythropoietin treatment. We infer that this pattern is behind the higher doses found in the aged who had hypertensive nephropathy, unlike chronic glomerulonephritis, which was more common in the young.[15] Infectious causes of kidney disease are common in the young in SSA.[15] Our findings agree with findings in the United States that found higher doses with advancing age, better living standard and access to medicare, common in these two groups most probably accounted for these findings.[16]

Diabetics had lower dose compared to those with hypertension and glomerulonephritis. We attribute this to the greater degree of atherosclerosis, autonomic neuropathy, cardiac systolic dysfunction in them.[17] Higher BP were associated with lower doses, similar to findings by Raikou et al[18] that hypertension was an impediment to dialysis adequacy. The positive relationship between bicarbonate and dialysis dose agrees with a previous study. Acidosis induces vasodilatation, peripheral pooling, thereby increasing the risk of IDH, however, bicarbonate buffers often minimizes the incidence and severity of IDH.[19]

Albumin was positively related to the dialysis dose. Normal serum albumin reflects dialysis adequacy, good nutritional balance, less edema and absence of protein energy malnutrition (PEM).[20] Lower pre dialysis creatinine gave higher dialysis dose. Narrow intradialysis osmotic gradient prevents excessive fluid shift hence lesser episodes of IDH, greater contribution of solute clearance to dialysis dose, and less ultrafiltration based solute removal.[21]

The positive relationship between the hematocrit and dialysis dose mirrors findings by El Shehkl et al.[12] Anemia frequently coexist with hypoalbuminemia, higher plasma volume and decreased effective oxygen transport, factors which separately and in combination lead to low dialysis dose and poor treatment outcome.

The AV fistula and the tunneled jugular access gave higher dialysis doses compared with the femoral access. The point of needle placement into the AV fistula can impact the dialysis dose and the recirculation time, which when high, leads to overestimation of dialysis dose commonly seen in low weight individuals. Tunneling with lesser intravascular fibrous tissue prevents luminal narrowing over time. Moreover, infections are more common in femoral than in tunneled access and AV fistula.[22]

Terminated sessions produced lower doses than completed ones. Higher ultrafiltration rates are seen within the first 2 intradialysis hours, followed by increased solute clearance. Removal of most middle and larger molecules is directly related to dialysis duration.[23] The significance of this is better appreciated knowing that middle and large molecules are largely responsible for most of the uremia symptomatology.[24] Ultrafiltration reduces the urea content of ultra-filtrate and urea generated intradialysis.[24]

Features of excessive UFV are made worse in the presence of a high BFR, high flux dialyzers, fever, excessive inter dialytic weight gain coupled with poor cardiac reserve associated with poor adrenegic response to fluid loss.[25] Recurrent UFV of up to 4 liters could be associated with IDH, myocardial stunning and increased mortality.[26]

The nephrologist's ultimate target in prescribing dialysis, is to give an optimal dose, with very few/no peridialytic events, improve QOL and prolong life. Rich et al[27] reported that death was common after the seventh day of stopping maintenance hemodialysis. The nephrologist would therefore prefer higher BFR, longer duration, high flux dialyzers, higher UFV, a tunneled access or an AVF. However, this "blinded" prescription often heightens the risk for IDH particularly with background dysautonomia.[26] When this blinded prescription becomes recurrent, despite good clinical and laboratory performance, it would often be associated with dialysis cachexia and PEM secondary to excessive intradialytic protein loss from high flux dialyzers.[27]

This study showed that lower BFR, low flux dialyzers, shorter dialysis duration and lower UFV, led to lower doses, a prescription pattern commonly given when the nephrologist anticipate possible intradialysis hemodynamic instability. Unfortunately, this prescription pattern could ultimately give lower doses associated with dialyzer blood clotting induced by stasis. When recurrent, it could lead to poor BP control, arrhythmias, acute and chronic coronary syndromes, reduced QOL, higher morbidity and mortali-

ty rates.[28] The nephrologist would therefore find a 'mid-point' prescription in which hemodynamic instability are minimized while attempting to give relatively higher doses.

It is worth noting that the dialysate fluid composition is also an important consideration for the nephrologist. Sodium profiling could be needed in conditions of IDH and IDHT as the case may be.[29] Water purification and delivery is also a priority to the nephrologist as infections cause vasodilatation and lower doses. Though the concentration of dialysate fluid was not altered in this study, it is worth stating that in patients with poor blood pressure control, high dialysate calcium could be detrimental as it could heighten the risk of tissue calcification, cardiovascular events and intra dialytic death.[30] While optimal doses are targets for nephrologists, often times, many prescriptions are given to reflect a balanced-point between the aggressive and cautious prescription patterns.

An implication of this study for clinical practice, is to emphasize the possibility of delivery an adequate dose while not subjecting patients to undue peridialytic stress.

We encountered some limitations. The contribution of the residual renal function to the delivered dose was not determined. The presence of some comorbidities that could be confounders could not be effectively ruled out. There were some irregularities with dialysis intervals and inability to control the choice of parameters for dialysis. The blood PH, the most reliable marker of MA, was not assessed on account of cost. The dry weight of participants could not be effectively assessed. Larger population studies are needed to formulate a comprehensive dialysis delivery program that will be applicable to all population groups.

The study is strengthened by its two center design and its relatively large sample size.

Conclusion: Despite efforts to improve dialysis delivery over the past decades, inadequate dialysis is still a very common finding in many LINs including Nigeria. Patient related factors, disease condition, socioeconomic deprivation and state of dialysis facilities play various roles in treatment outcome. The use of the AV fistula, tunneled jugular catheters, higher BFR and UFV, high flux dialyzers and longer dialysis duration were found to produce higher dialysis doses. Dialysis termination was more common with IDH than with IDHT.

We recommend that the content of the prescribed dialysis should therefore be carefully and intelligently individualized, and maneuvered to give dialysis patients an effective and optimal dose with minimal adverse consequences.

Authors' contribution

Conceptualization and design of paper: PKU.
Collection of data: PKU.
Implementation of research: PKU, SK
Data analysis and interpretation: PKU, SK
Preparation of manuscript: PKU, SK
The authors checked and approved the final manuscript before submission.

Acknowledgement:
The authors appreciate the contribution of the dialysis nurses and technicians of the two centers, and the study participants for participating in this study.

Consent for publication
Not applicable

Availability of data and material
The datasets supporting the conclusions of this article are included within the article. Additional material can be obtained upon reasonable request.

Conflict of interest:
The authors have no conflict of interest to declare.

Funding: None

References

1. Arije A, Kadiri S, Akinkugbe OO. The viability of haemodialysis as a treatment option for renal failure in a developing economy. Afr J Med med Sci 2000**;** 29: 311–314
2. Agaba EI, Lopez A, Ma I, Martinez R, Tzamaloukas RA, Vanderjagt DJ. Chronic hemodialysis in a Nigerian teaching hospital: practice and costs. Int J Artif Organs 2003; 26(11): 991-5.
3. Amini M, Aghighi M, Masoudkabir F, Zamyadi M, Norouzi S, Rajolani H et al. Hemodialysis adequacy and Treatment in Iranian Patients. A National Multicenter study. Iran J Kidney Dis 2011; 5(2): 103-9
4. Rafik H, Aatif T, El Kabbaj D. The impact of blood flow rate on dialysis dose and phosphate removal in hemodialysis patients Saudi J Kidney Dis Trans 2018; 29(4): 872-878
5. Brimble SK, Treleaven DJ, Onge JS, Carlisle. Onge J, Carhiale E.J. Risk factors for increased viability in dialysis delivery in hemodialysed patients. Nephrol Dial Transplant 2013; 18(10): 2112-17
6. National Kidney Foundation. KDOQI Clinical Practice Guideline for Diabetes and CKD: 2012 update. Am J Kidney Dis. 2012; 60(5): 850-886
7. Hanson JA, Hulbert-Shearon TE, Ojo AO, Port FK, Wolfe RA, Agodoa LYC et al. Prescription of Twice-Weekly Hemodialysis in the USA. Am J Nephrol 1999; 19: 625-633 doi.org/10.1159/000013533
8. Geddes CC, Traynor J, Walbaum D, Fox JG, Mactier RA. A new method of post-dialysis blood urea sampling: the `stop dialysate flow' method Nephrol Dial Trans, 2000; 15(4): 517–523

9. Daugirdas JT. Second generation logarithmic estimates of single-pool variable volume Kt/V: an analysis of error. J Am Soc Nephrol 1993; 4: 1205–1213
10. Agarwal R. How can we prevent intradialytic hypotension? **Curr Opin Nephrol Hypertens**. 2012; 21:593–599
11. World Medical Association Declaration of Helsinki. J Am Med Assoc 2013; 310: 20
12. El-Sheikh M, El-Ghazaly G. Assessment of hemodialysis adequacy in patients with chronic kidney disease in the hemodialysis unit at Tanta University Hospital in Egypt. Indian J Nephrol 2016; 26(6): 398-404.
13. Somji SS, Ruggajo P, Moledina S. Adequacy of hemodialysis and Its Associated Factors among Patients Undergoing Chronic Hemodialysis in Dares Salam, Tanzania. Int J Nephrol 2020; vol 2020: 9863065
14. Depner T. Dialysis dose and the effect of gender and body size on outcome in the HEMO Study. Kidney Int.2004; 65(4): 1386-94
15. Alebiosu CO, Ayodele OO, Abbas A, Olutoyin AI**:** Chronic Renal Failure at the Olabisi Onabanjo University Teaching Hospital, Sagamu, Nigeria. Afr J Health Sci 2006, 6(3)**:**132-138.
16. Collins AJ, Foley RN, Chavers B, Gilbertson D, Herzog C, Johansen K et al. United States Renal Data System 2011 Annual Data Report: Atlas of chronic kidney disease & end-stage renal disease in the United States. Am J Kidney Dis 2012; 59(1 Suppl 1): A7, e1-420.
17. Soleymanian T, Kokabeh Z, Ramaghi R, Mahjoub A, Argani H Clinical outcomes and quality of life in hemodialysis diabetic patients versus non-diabetics. J Nephropathol 2017; 6(2): 81-89
18. Raikou VD, Kyriaki D. The Association between Intradialytic Hypertension and Metabolic Disorders in End Stage Renal Disease. Int J Hypertension 2018; Volume 2018 |Article ID 1681056 | 9 pages | https://doi.org/10.1155/2018/1681056. Accessed 16/08/2018.
19. Meyring-Wosten, Zhang H, Kotanko A. Intradialytic hypoxaemia and clinical outcomes in patients on haemodialysis. Clin J Am Soc Nephrol (CJASN). 2017; 30: 464-72.
20. Teixeira NF, de Campos G, Xavier de Paula SM, Merchi VA, Portero-Mclellan KC, da Motta DG et al. Dialysis adequacy and nutritional status of haemodialyzed patients. Hemodial Int.2008; 12(1): 45-51
21. Ghondup T, Qian Q. Electrolyte and Acid-Base disorders in Chronic Kidney Disease and End stage kidney failure. Blood Purification. 2017; 43: 179-188.
22. Tentori F, Zhang J, Li Y, et al. Longer dialysis session length is associated with better intermediate outcomes and survival among patients on in-center three times per week hemodialysis: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). Nephrol Dial Transplant 2012; 27(11): 4180-8
23. Meyer TW, Sirich TL, Fong KD, Plummer NS, Shafi T, Hwang S et al Kt/V urea and non-urea small solute levels in the hemodialysis study. J Am Soc Nephrol 2016; 27: 3469–3478
24. Amira CO, Braimoh RW, Bello BT. Pattern of intradialytic complications at the Lagos university teaching hospital. Afr J Med Med Sci. 2012; 41(4): 411–6.
25. McIntyre CW. Haemodialysis-induced myocardial stunning in chronic kidney disease – a new aspect of cardiovascular disease. Blood Purif. 2010; 29((2)): 105–10.
26. Rich A, Ellershaw J, Ahmad R. Palliative care involvement in patients stopping haemodialysis. J. Palliative Med 2001; 15: 513-514.
27. Fernández P, Núñez S, De Arteaga J, Chiurchiu C, Douthat W, De La Fuente J. Inadequate doses of hemodialysis. Predisposing factors, causes and prevention]. Medicina (B. Aires) 2017; 77(2): 111-116
28. Chang KY, Kim SH, Kim YO, Jin DC, Song HC, Choi EJ. The impact of blood flow rate during hemodialysis on all-cause mortality Korean J Intern Med 2016; 31(6): 1131-1139
29. Donati G, Ursino M, Spazzoli A, Natali N, Schillaci R, Conte D et al. Sodium Prescription in the Prevention of Intradialytic Hypotension: New Insights into an Old Concept. In-depth Review. Blood purification 2018; 45: 61-70
30. Kovesdy CP, Regidor DL, Mehrotra R, Jing J, McAllister CJ, Greenland S et al. Serum and dialysate potassium concentration and survival haemodialysis patients. Clin J Am Soc Nephrol 2007; 2: 999-1007.