Tropical Journal of Nephrology Vol.12 No 1, June, 2017 15 - 24

HAEMODIALYSIS AT A PRIVATELY-RUN, STAND-ALONE DIALYSIS UNIT: A ONE-YEAR RETROSPECTIVE REVIEW OF THE CLINICAL AND LABORATORY PARAMETERS AND OUTCOMES OF INCIDENT PATIENTS

Bello BT[1], Oyedeji OA[2] and Buraimo OO[3]

[1.] Department of Medicine, College of Medicine, University of Lagos, Idi-Araba, Lagos.
[2.]Department of Haematology and Blood Transfusion, College of Medicine, University of Lagos, Idi-Araba, Lagos.
[3.]Vedic Lifecare Hospital, Lekki, Lagos

ABSTRACT

Background: There has been a recent and rapid rise in the number of privately-run dialysis units in Lagos with attendant concerns about the quality of careprovided. This study describes patient characteristics and outcomes at one such unit.

Methods: This was a retrospective review of 152 consecutively presenting patients who were dialyzed at a privately-rundialysis unit in Lagos. Patients' biodata, the source of the referral, type of kidney disease, co-morbid conditions present, clinical and laboratory parameters prior to the first dialysis session. Continuous and categorical variables are presented respectively as means and percentages. Student's t-test and chi-square test were used to compare means and percentages respectively.

Results: The mean age of the study population was 48.6 + 6.7years, 65 (42.8%) were females, 117 (77.0%) had CKD while 35 (23.0%) had AKI. 38.8% were referred from general hospitals, 32.2% from private hospitals while 10.5% were walk-in patients. 35.5% had previously been dialyzed at another facility prior to presentation tothe centre. Anaemia (98%), hypertension (65.1%), hyponatremia (63.2%), leukocytosis (39.5%) and hyperkalaemia (36.8%)were the most common abnormalities noted.The 152 patients received a total of 1,278 sessions of dialysis during the period under review. Intradialytic complications requiring intervention occurred during 28(2.2%) of the sessions with hypotension (60.7%), hypertension (28.6%) and hypoglycaemia (10.7%) responsible for all 28 episodes. In six of the cases, the session of dialysis had to be terminated early due to failure of hypotension to respond to fluid resuscitation and/or inotropic support during dialysis.

Conclusion: Privately-run dialysis centers provide services to patients with a wide range of co-morbid conditions and high rates of pre-dialysis clinical and laboratory abnormalities. Intradialytic complications leading to termination of dialysis sessions appear to be relatively infrequent.

Keywords: *Dialysis, complications, acute kidney injury, chronic kidney disease*

Corresponding Author: Dr. B.T Bello, Department of Medicine, College of Medicine, University of Lagos. **Email:** taslimbello@gmail.com

INTRODUCTION

In many parts of Africa, renal care is often out of the reach of majority of patients who require them because of a combination of factors including lack of facilities and manpower, high cost of care and out-of-pocket healthcare financing arrangements.The available dialysis facilities tend to be located in city centers or state capitalsgenerally within government-funded tertiary hospitals and many patients from rural areas make long journeys to access them.[1 – 5]. In addition, patients often face challenges accessing dialysis in these government-funded facilities as they tend to be bedeviled by bureaucratic and operational challenges such as elaborate registration requirements, frequent breakdown of dialysis machines and erratic power supply, in addition to recurrent industrial dispute and close down of the facilities.

Lagos is the commercial capital of Nigeria. Its unique combination of a cosmopolitan population and a relatively high literacy level and per capita income has driven significant improvements in overall availability of healthcare facilities.[6] This has resulted in a recent and rapid increase in the number centers offering haemodialysis in the state, majority of which are privately run, many being stand-alone units.[7] These units are thought to serve majority of the dialysis population in Lagos because services tend to be more regular, there are less delays due to bureaucratic bottlenecks, and they are generally more patient-friendly. In addition to the ease of access that these units offer, provision of dialysis care at units not attached to tertiary hospitals has been shown to be associated with improved patient outcomes.[8]

These benefits notwithstanding, questionscontinue to be raised about the quality of care received by patients at these privately-run units due to concerns about adequacy of qualified personnel (nephrologists,and dialysis nurses), adherence to internationalbest practices, [9–12] and ability to appropriately respond to intradialytic complications, [13] should they occur.This study describes the clinical and laboratory characteristics of patients presenting for haemodialysis in one such center highlighting the comorbid conditions as well as the abnormalities in the clinical and laboratory parameters of the patients at presentation.

STUDY DESIGN AND METHODS

This was a retrospective review of the hospital records of 152 consecutively presenting patients who were dialyzed between 1st January and 31st December 2015 at a privately-run, stand-alone dialysis unit located in Lagos, Southwest Nigeria. The unit offers haemodialysis to all patients with renal failure requiring dialysis provided they are seronegative for Hepatitis B surface antigen (HBsAg)and anti-Hepatitis C virus antibodies. The policy of excluding patients with evidence of hepatitis B abd C virus infections was because the unit did not have the resources to provide dialysis for HBsAg-positive patients in a separate room, using separate machines, equipment, instruments, andsupplies as well as ensuring that staff members caring for HBsAg-positive patients do not care for HBV-susceptible patients at thesame time as required by current guidelines.[14,15] All patients who had at least one session of haemodialysis in the unit during the period under review were included in the study. The unit is manned by a team consisting of one medical officer, two nurses, one of whom has formal dialysis training and one dialysis technician. In addition, there is access to a nephrologist who could be contacted in emergency situations.

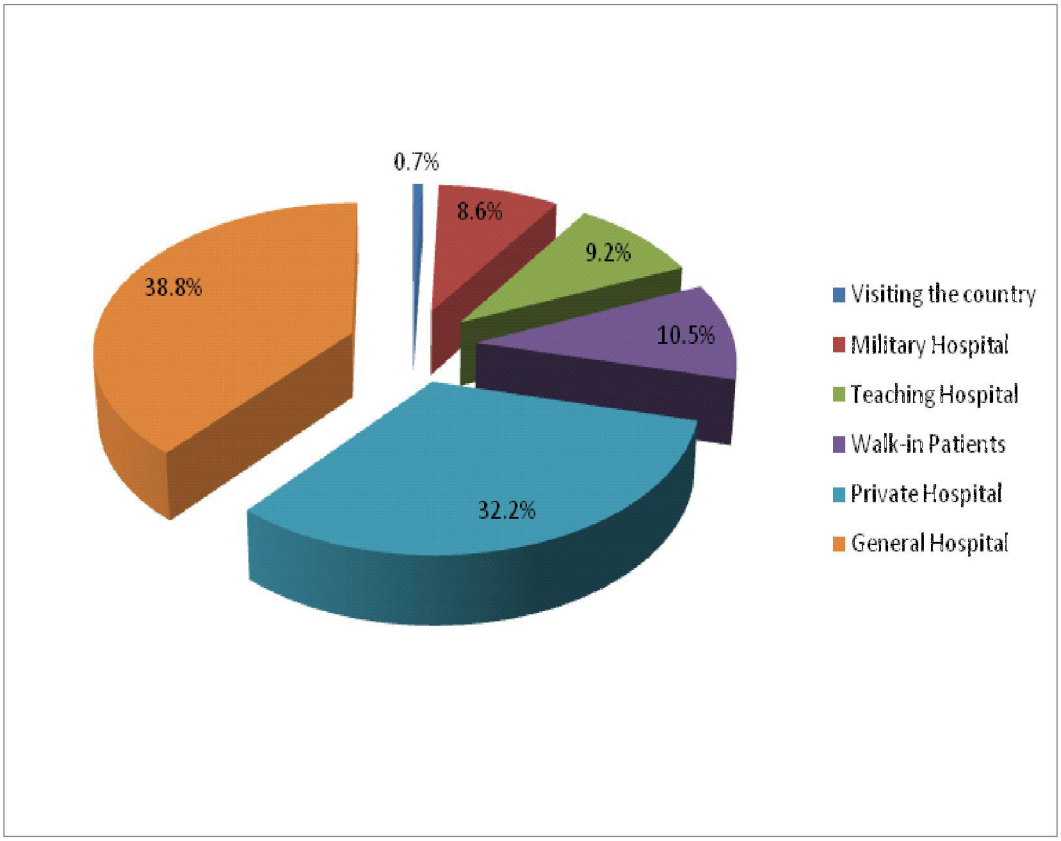
All incident patients undergo a venous blood sampling for evaluation of their serum electrolytes, urea and creatinine prior to dialysis. Where a patient presents a dialysis prescription from the referring physician, dialysis is carried out accordingly. For patients presenting without a dialysis prescription, dialysis was offered according to one of two standard regimens, taking into consideration whether or not the patient had received dialysis previously. Patient who had previously been dialyzed were offered dialysis over 4 hours with a blood flow rate of 300 – 350ml/min and a dialysate flow rate of 500ml/min. Those who had not previously been dialyzed received dialysis over 2.5 – 3 hours with a blood flow rate of 250 – 300ml/min and a dialysate flow rate of 500ml/min. Anticoagulation is with intravenous unfractionated heparin at a dose of 5,000 units at commencement of dialysis. Patients with haemoglobin concentration less than 7g/dl (haematocrit <21%) were transfused with blood intra-dialysis to achieve a haemoglobin concentration of at least 7g/dl.

Data retrieved included patients' biodata, the source of the referral, type of kidney disease, a history of prior dialysis during the current illness, and co-morbid conditions present in the patient. The dates of the first and last sessions of dialysis during the period under review were documented. The patients' blood pressure at the time of initial presentation as well as the results of haematologicand biochemical testsprior to the first session of dialysis were also documented.The current status of the patient was determined via the contact phone number provided by the patient at the time of registration with the units. Patients who had not been seen at the unit in the 6 weeks following the last session of dialysis and could not be reached on phone were presumed to be lost to follow-up.

Retrieved data were entered into an Excel® spreadsheet and analysed using Epi Info™statistical software version 7.2.1.0. Continuous variables are presented as means and standard deviations while categorical variables are presented as proportions. Comparison of means was done using student's t-test while comparison of percentages was done using the chi-square test. The level of statistical significance was set at a p-value less than 0.05.

RESULTS

Of the 152 patients included in the study, 65 (42.8%) were females,117 (77.0%) had CKD while 35 (23.0%) had AKI and98 (64.5%) were incident dialysis patients while 54 (35.5%) had received at least one prior session of haemodialysis at another facility.Figure 1 shows the source of patient referrals for dialysis. Majority of the patients were referred from Lagos State General Hospitals and private hospitals. Fourteen (9.2%)of the patients was made up of walk-in patients who presented for dialysis without formal referral letters from another facility and one patient who was on maintenance dialysis in the United Kingdom was visiting the country. With the exception of the patients visiting the country, none of the patients had a written dialysis prescription from the referring physician. In one case, a pre-dialysis electrolytes, urea and creatinine panel revealed that there was no indication for dialysis in the patient.



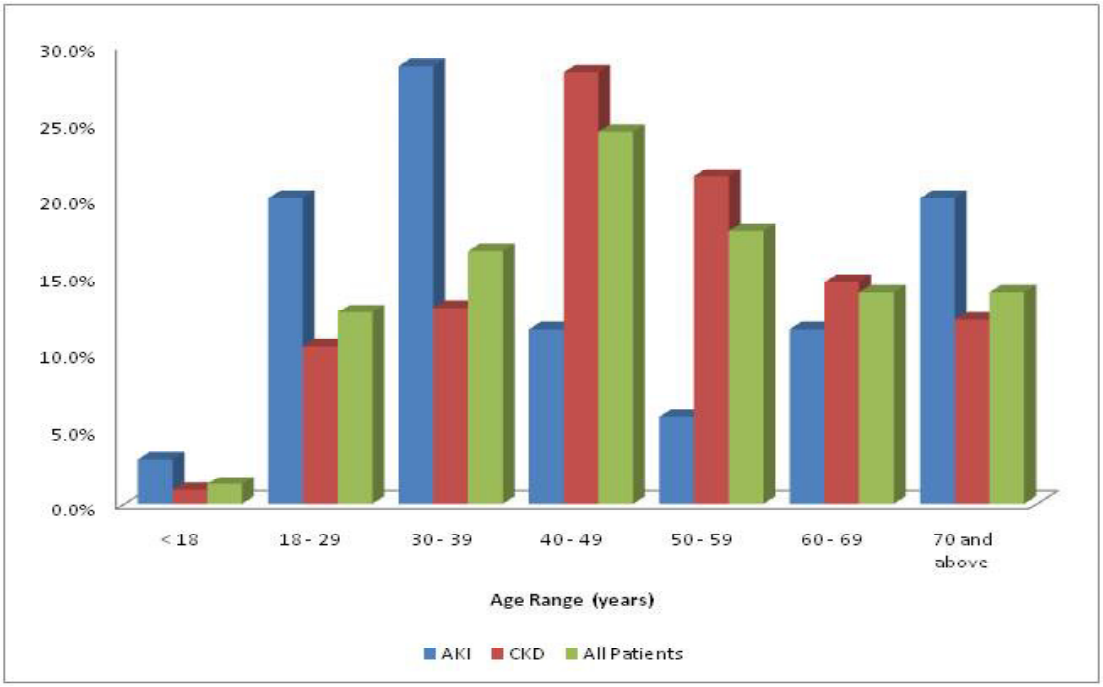


Table 1. Baseline characteristics of the study population stratified according to gender.

S/N	Characteristics	All Patients	Male	Females	P-value
		152	87 (57.2%)	65 (42.8%)	
	CKD	117 (77.0%)	67 (77.0%)	50 (76.9%)	0.99
	Prior Dialysis	54 (35.5%)	32 (35.6%)	23 (35.4%)	0.97
	Antibodies to HIV	24 (15.8%)	12 (13.8%)	12 (18.5%)	0.44
	Mean age (years)	48.6 ± 6.7	51.1 ± 17.2	45.2 ± 15.5	0.03[m]
	SBP (mmHg)	154.9 ± 36.8	153.4 ± 34.3	156.9 ± 40.0	0.56
	DBP (mmHg)	93.0 ± 23.2	91.9 ± 21.0	94.5 ± 25.9	0.50
	HbConc (g/dL)	8.2 ± 1.9	8.3 ± 2.0	7.9 ± 1.7	0.18
	MCV (fL)	70.1 ± 11.3	70.1 ± 11.6	69.9 ± 11.0	0.91
	MCH	24.8 ± 4.8	25.0 ± 5.3	24.4 ± 4.2	0.45
	MCHC	34.1 ± 5.6	34.6 ± 5.5	33.6 ± 5.8	0.28
	WBC (X 10^9)	14.7 ± 16.3	14.9 ± 18.0	14.4 ±13.8	0.86
	Platelets (X 10^9)	268.0 ± 139.5	270.0 ± 145.6	265.2 ± 132.1	0.83
	Na^+Conc (mmol/L)	130.6 ± 8.4	130.9 ± 8.2	130.3 ± 8.7	0.68
	K^+Conc (mmol/L)	5.2 ± 1.1	5.1 ± 1.2	5.2 ± 1.1	0.77
	Urea (mg/dL)	239.0± 147.2	247.4± 155.0	227.8 ± 136.4	0.42
	Creatinine (mg/dL)	11.7 ± 7.8	11.7 ± 8.2	11.7 ± 8.4	0.98

CKD = Chronic Kidney Disease; HIV = Human Immunodeficiency Virus; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; HbConc = Haemoglobin Concentration; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin; MCHC = Mean Corpuscular Haemoglobin Concentration; Na^+Conc = Serum Sodium Concentration; K^+Conc = Serum Potassium Concentration.

The mean age of the study population was 48.6 ± 6.7years (range 13 – 88 years). Figure 2 shows the age range distribution of the study population.Overall, as well as among patients with CKD, the peak age range of the study population was 40 – 49 years. Among patients with AKI however, the age range distribution was bimodal with an initial peak at 30 – 39 years and a second peak at 70 years and above.

Table 1 shows the baseline clinical and laboratory parameters of the study population stratified by gender. Other than a higher mean age among males, there were no significant differences between male and female study participants.

Table 2 shows the Table 1 shows the baseline clinical and laboratory parameters of the study population stratified according to type of kidney disease. Compared to patients with AKI, patients with CKD had significantly higher mean systolic and diastolic blood pressures as well as mean serum potassium and creatinine concentrations. They also had a significantly lower mean haemoglobin concentration.

Table 3 shows the baseline characteristics of the study population stratified according to whether or not the patients had previously received dialysis. Other than a lower mean haemoglobin concentration and a higher mean platelet count, there were no significant differences between patient who had previously received dialysis and those who had not.

Vascular access for the first session of dialysis was via femoral vein cannulation in all but two patients who had tunneled internal jugular vein catheters in place. Twelve (10.3%) of the patients who had CKD subsequently went on to have tunneled internal jugular catheters with a further five (4.3%) having a non-tunneled catheter inserted as vascular access for HD. Figure 3 shows the frequency of co-morbid conditions as well as abnormalities in clinical and laboratory parameters of the patients at the time of initial presentation for dialysis. Overall, and among patients with CKD, anaemia was the commonest

Table 2. Baseline characteristics of the study population stratified according to type of kidney disease.

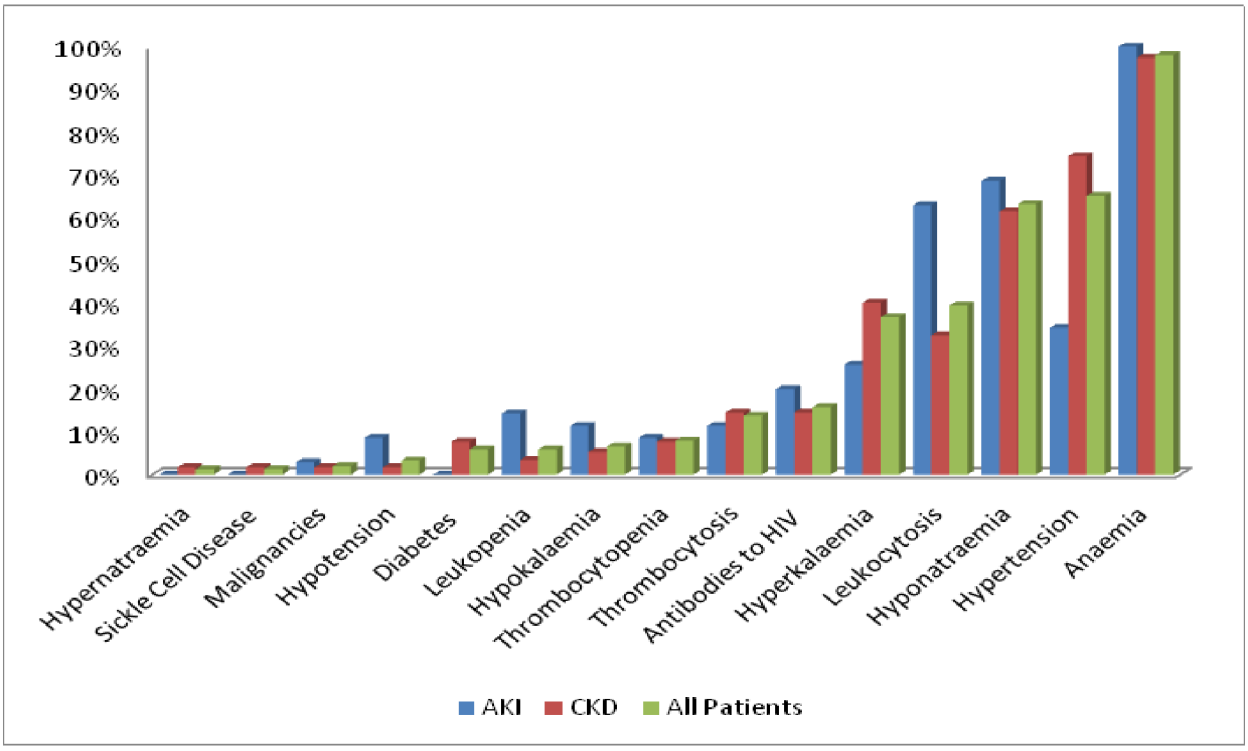
Characteristics	All Patients	AKI	CKD	P-value
	152	35 (23.0%)	117 (77.0%)	
Prior Dialysis	54 (35.5%)	10 (28.6%)	44 (37.6%)	0.33
Antibodies to HIV	24 (15.8%)	7 (20.0%)	17 (14.5%)	0.44
Mean age (years)	48.6 ± 6.7	45.6 ± 20.1	49.5 ± 15.6	0.22
SBP (mmHg)	154.9 ± 36.8	136.3 ± 31.9	160.4 ± 36.5	< 0.001[m]
DBP (mmHg)	93.0 ± 23.2	81.7 ± 21.3	96.4 ± 22.7	< 0.001[m]
HbConc (g/dL)	8.2 ± 1.9	8.8 ± 1.6	8.0 ± 1.9	0.02[m]
MCV (fL)	70.1 ± 11.3	71.8 ± 13.4	69.5 ± 10.6	0.31
MCH	24.8 ± 4.8	24.4 ± 4.5	24.9 ± 4.9	0.55
MCHC	34.1 ± 5.6	34.2 ± 8.6	34.1 ± 4.4	0.97
WBC (X 10^9)	14.7 ± 16.3	19.0 ± 15.5	13.4 ± 16.3	0.07
Platelets (X 10^9)	268.0 ± 139.5	249.4 ± 121.9	273.5 ± 144.4	0.37
Na^+Conc (mmol/L)	130.6 ± 8.4	129.6 ± 8.8	130.9 ± 8.3	0.41
K^+Conc (mmol/L)	5.2 ± 1.1	4.8 ± 1.0	5.2 ± 1.2	0.04[m]
Urea (mg/dL)	239.0± 147.2	217.6 ± 150.6	245.4 ± 146.2	0.33
Creatinine (mg/dL)	11.7 ± 7.8	8.9 ± 6.3	12.6 ± 8.1	0.01[m]

AKI = Acute Kidney Disease; CKD = Chronic Kidney Disease; HIV = Human Immunodeficiency Virus; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; HbConc = Haemoglobin Concentration; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin; MCHC = Mean Corpuscular Haemoglobin Concentration; Na+ Conc = Serum Sodium Concentration; K+ Conc = Serum Potassium Concentration.

Table 3. Baseline characteristics of the study population stratified according to whether or not the patients had previously received dialysis

Characteristics	All Patients	Prior Dialysis	No Prior Dialysis	P-Value
	152	54 (35.5%)	98 (64.5)%	
Mean age (years)	48.6 ± 6.7	45.0 ± 16.0	55.6 ± 16.9	0.05
SBP (mmHg)	154.9 ± 36.8	154.8 ± 36.4	154.9 ± 37.2	0.98
DBP (mmHg)	93.0 ± 23.2	89.1 ± 20.5	95.1 ± 24.4	0.13
HbConc (g/dL)	8.2 ± 1.9	7.6 ± 1.7	8.5 ± 1.9	< 0.01[m]
MCV (fL)	70.1 ± 11.3	69.6 ± 10.8	70.3 ± 11.7	0.73
MCH	24.8 ± 4.8	24.9 ± 5.0	24.7 ± 4.8	0.82
MCHC	34.1 ± 5.6	34.4 ± 5.7	34.0 ± 5.9	0.71
WBC (X 10^9)	14.7 ± 16.3	17.2 ± 21.8	13.3 ± 12.2	0.16
Platelets (X 10^9)	268.0 ± 139.5	306.7 ± 154.4	246.6 ± 126.4	0.01[m]
Na^+Conc (mmol/L)	130.6 ± 8.4	130.5 ± 7.7	130.7 ± 8.8	0.92
K^+Conc (mmol/L)	5.2 ± 1.1	5.4 ± 1.2	5.0 ± 1.1	0.05
Urea (mg/dL)	239.0 ± 147.2	242.1 ± 142.6	237.3 ± 150.4	0.85
Creatinine (mg/dL)	11.7 ± 7.8	12.9 ± 8.2	11.0 ± 7.5	0.16

SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; HbConc = Haemoglobin Concentration; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin; MCHC = Mean Corpuscular Haemoglobin Concentration; Na+ Conc = Serum Sodium Concentration; K+ Conc = Serum Potassium Concentration.



abnormality with 42(%) of all patients requiring transfusion with at least one unit of blood. This followed by hypertension and hyponatraemia. In patients with AKI however, leukocytosis was more commonly seen than hypertension.

The 152 patients received a total of 1,278 sessions of dialysis during the period under review. Intradialytic complications requiring intervention occurred during28(2.2%) of the sessions with hypotension (60.7%), hypertension (28.6%) and hypoglycaemia(10.7%) responsible for all 28 episodes. In six of the cases, the session of dialysis had to be terminated early due to failure of hypotension to respond to fluid resuscitation and/orinotropic support during dialysis.In all six cases, the patients' blood pressures stabilized following discontinuation of dialysis.

As at the time of this review, of the 152 patients, 31(20.4%)[29(24.8%) of patients with CKD and 2(5.7%) of patients with AKI] remained ondialysis; 4(2.6%)all of whom had a diagnosis of AKI, were known to have recovered kidney function sufficiently to be independent of dialysis; 3 (1.97%), had received a kidney transplant; 16(10.5%) were known to have died while 98 (64.5%) had been lost to follow-up.Overall, the median duration on dialysis was 15.5 days (range: 1 – 365), however it differed between patients with CKD [20days (range: 1 – 365)] and AKI [7 days (range: 1 – 47)].

DISCUSSION

The majority of patients who were dialyzed at the unit during the study period were referred from hospitals ranging from private hospitals to government-run secondary healthcare facilities and even government-run tertiary hospitals reinforcing the widely held view among nephrologists that private dialysis units provide dialysis for a large proportion of patients requiring dialysis in Lagos. Of note is the group of walk-in patients, presenting for dialysis without referral,who made up about 10% of the study population. Walk-in dialysis patients are symptomatic of the wider problem of both poor healthcare seeking behaviour and poor access to care;and present perculiar challenges to dialysis unit including; what level of care the patient had received prior to presentation, a higher possibility of non-adherence to care as well as whom, when and how the decision to initiate/continue dialysis was taken. The practice of ordering a full electrolytes, urea and creatinine panel prior initiating dialysis in incident dialysis patients ensured that the need for dialysis was established beforehand in this unit. A similar approach is required across all units to prevent patients from being dialyzed unnecessarily especially since regulatory oversight of healthcare facilities is still in its infancy in our practice setting.

The study findings also highlight noteworthy differences between AKI and CKD patients receiving dialysis. We found well established differences such as higher; mean blood pressures (both systolic and diastolic), and mean serum creatinine concentrations, as well as lower mean haemoglobin concentration among CKD patients compare with AKI patients. [16,17] There were also glaring differences in age distribution between the two groups of patients. While theage range distribution peaked at 40 – 49 years for patients with CKD, the age range distribution of patients with AKI was bimodal with an initial peak at age 30 – 30 years and a second peak after 70 years of age. It is possible that the bimodal nature of the age distribution of the AKI patients is a reflection of an evolution aetiology of AKI in the general population, with conditions such as gastroenteritis and pregnancy-related conditions traditionally causing AKI in the younger age group and emergence of sepsis as an aetiology in the older population.[18] The peak age range of patients with CKD provides further evidence for the "shift to the right" in the age of patients with CKD in Nigeria that is being increasingly documented by researchers.[19 -21]

The study findings also bring to question the blanket practice of prescribing longer durations of dialysis for patients who had previously been dialyzed while shorter durations are offered to those who had not previously received dialysis. This practice which is common in dialysis centers across the country, aims at reducing the incidence of dialysis disequilibrium syndrome, by limiting urea clearance and thereby limiting osmotic changes in incident dialysis patients whom are generally presumed to have higher serum urea levels.[23] We however found no significant difference in serum urea levels between patients who had previously been dialyzed and those who had never received dialysis. This finding likely reflects the infrequency of dialysis among patients with renal failure in our practice setting that is brought about by

their inability to afford the cost of dialysis. Are we then over dialyzing some of our returning dialysis patients while at the same time missing subtle symptoms and signs of dialysis disequilibrium? There is a need for further studies to provide answers to these. Meanwhile, physicians referring patients for dialysis should endeavour to provide individualized dialysis prescriptions. In addition, there is a need for adequate supervision of privately-rundialysis units by nephrologist to ensure that dialysis appropriately prescribed in those situations where patients present without a dialysis prescription.

A high rate of pre-dialysis clinical and laboratory abnormalities was noted in the study population. Despite these however, intradialytic complications necessitating termination of the procedure were relatively few. Anaemia was the most common abnormality being almost universally prevalent. In just over 40% of the patients, anaemia was severe enough to require blood transfusion prior to commencement of dialysis. Transfusion with blood and blood products is in general not without attendant risks such as transfusion reactions and transmission of blood-borne infections. These risks are much higher in resource-limited settings such as ours. In patients with CKD there is the additional problem of sensitization which reduces the chances of finding compatible donor kidneys in the future. Hypertension was the next most common abnormality noted, particularly among patients with CKD. While higher blood pressures have been suggested by some to enable delivery of higher doses of dialysis and ultrafiltration, intradialytic hypertension has been reported to be the commonest intradialytic complication requiring intervention and it has been associated with higher pre-dialysis blood pressures.[24] Leukocytosis was mainly seen in patients with AKI and is likely due to sepsis in this population while the high rates and hyperkalaemia seen were not unexpected and may indeed be partly responsible for the decision to institute dialysis.

Another major finding in the study population was the high rate of pre-dialysishyponatraemia. The reason for this high rate of hyponatraemia is unclear, but may be iatrogenic, from the combined effects of low dietary salt restriction and high dose loop diuretic use. Hyponatraemia has been associated with poor outcomes in several disease conditions, [25] including pre-dialysis CKD.[26] Its effect on dialysis patients is less clearhowever, although there is evidenc to suggest a similar effect on outcomes.[27,28] Rapid correction of severe hyponatraemia as may occur during dialysis has been associated with the osmotic demyelination syndrome, although, this complicationhas not been widely reported in haemodialysis patients. One possible explanation that has been put forward for this is that uremia may be protective against demyelinationduring rapid sodium correctionbecause the sudden decrease in blood urea levels duringhemodialysis offsets the rapid rise in extracellularserum sodium thereby preventing brain cellulardehydration.[29] Despite this explanation however, central pontine and extra pontinemyelinolysishas been reported after rapid correction of hyponatremia by hemodialysis in a uremic patient.[30]

The percentage of the study population who remained on dialysis is not significantly different from those reported in other studies from Nigeria.[31,32] A large proportion of the patients who received dialysis in the unit during the period under review had been lost to follow-up by the time of the study. This is again similar to previous reports.[31,32] What actually happened to these patients is difficult to determine. There is a possibility that some had recovered kidney function sufficiently to be independent of dialysis, it is also possible that some had died. However, as was the case with some of the patients in the study, they may simply have "walked-on" to another dialysis facility and continued their treatment.

Our study has several limitations which should be taken into consideration. Firstly it is a retrospective review. Secondly, due to the out-of-pocket nature of payment for care and consequent irregularity of session, we did not assess markers of dialysis adequacy. Also, due to the large proportion of the patient population who were lost to follow-up, comparisons of data on patient outcomes should be made with caution.

In conclusion, privately-run dialysis centers provide services to a wide range of patients with renal failure. These patients have wide ranging co-morbid conditions and high rates of pre-dialysis clinical and laboratory abnormalities. While intradialytic complications leading to termination of dialysis sessions appear to be relatively infrequent, there is an urgent need for review of practices and re-orientation of physicians attending to patients requiring dialysis to ensure individualization of dialysis

prescriptions. As the number of patients requiring dialysis in the country, especially those with CKD, is projected to increase further, there is a need for increased professional and regulatory oversight of privately-run dialysis units.

REFERENCES

1. Katz IJ, Gerntholtz T and Naicker S. Africa and Nephrology: The Forgotten Continent Nephron ClinPract. 2011;117:c320–c327.
2. Grassman AS, Gioberge S, Moeller S and Brown G. ESRD patients in 2004: global overview of patient numbers, treatment modalities and associated trends. Nephrol Dial Transplant. 2005; 20: 2587–2593.
3. Okunola Y, Ayodele O, Akinwusi P, Gbadegesin B and Oluyombo R. Haemodialysis practice in a resource-limited setting in the tropics. Ghana Med J. 2013; 47(1): 4 – 9.
4. Pozo ME, Leow JJ, Groen RS, Kamara TB, Hardy MA and Kushner AL. An overview of renal replacement therapy and health care personnel deficiencies in sub-Saharan Africa. Transpl Int. 2012;25(6): 652 – 657.
5. Kilonzo KG, Jones ESW, Okpechi IG, Wearne N, Barday Z, *et al.* Disparities in dialysis allocation: An audit from the new South Africa. PLoS One. 2017; 12(4): e0176041.
6. Isola WA and Alani RA.Human capital development and economic growth: Empirical evidence from Nigeria.Asian Economic and Financial Review. 2012; 2(7): 813 – 827.
7. Oluyombo R,Okunola OO, Olanrewaju TO, Soje MO, Obajolowo OO, *et al.* Challenges of hemodialysis in a new renal care center: call for sustainability and improved outcome.Int J NephrolRenovasc Dis. 2014; 7: 347–352.
8. Navaneethan SD, Aloudat S and Singh S. A systematic review of patient and health system characteristics associated with late referral in chronic kidney disease. BMC Nephrol. 2008; 25: 9-3
9. Pozo ME, Leow JJ, Groen RS, Kamara TB, Hardy MA, *et al.* An overview of renal replacement therapy and health care personnel deûciencies in sub-Saharan Africa.Transpl Int. 2012; 25(6): 652 – 657.
10. Hoenich NA, Levin R and Ronco C. Water for haemodialysis and related therapies: recent standards and emerging issues. Blood Purif. 2010; 29(2): 81 – 85.
11. Coulliette AD and Arduino MJ. Hemodialysis and water quality.Semin Dial. 2013;26(4): 427 – 438.
12. Braimoh RW, Mabayoje MO, Amira CO and Coker H. Quality of hemodialysis water in a resource-poor country: the Nigerian example. Hemodial Int. 2012;16(4): 532 – 538.
13. Prabhakar, Singh RG, Singh S, Rathore SS and Choudhary TA. Spectrum of intradialytic complications during hemodialysis and its management: a single-center experience. Saudi J Kidney Dis Transpl. 2015; 26(1): 168 – 172.
14. Elamin S and Abu-Aisha H. Prevention of hepatitis B virus and hepatitis C virus transmission in hemodialysis centers: review of current international recommendations. Arab J Nephrol Transplant. 2011;4(1): 35 – 47.
15. United State Centers for Disease Control. And Prevention. Recommendations for preventing transmission of infections among chronic hemodialysis patients.MMWR Recomm Rep. 2001;50(RR-5): 1– 43.
16. Naicker S, Aboud O and Gharbi MB. Epidemiology of acute kidney injury in Africa. SeminNephrol. 2008; 28: 348 –353.
17. Prakash J, RathoreSS, Arora P, Ghosh B, Singh TB, *et al*. Comparison of clinical characteristics of acute kidney injury versus acute-on-chronic renal failure: Our experience in a developing country. Hong Kong J Nephrol. 2015; 17: 14–20.
18. Ozmen S, Akin D, OzmenCA. A Review to Differentiate Acute Kidney Injury from Chronic Kidney Disease.Br J Med Med Res. 2016; 18(9): 1 – 7.
19. Amira CO, Bello BT and Braimoh RW.Chronic Kidney Disease: A Ten-year Study of Aetiology and Epidemiological Trends in Lagos, Nigeria. Br JRenal Med. 2014/15; 19(4): 19 – 23.
20. Ulasi II and Ijoma CK. The enormity of chronic kidney disease in Nigeria: the

situation in a teaching hospital in South-East Nigeria. J Trop Med. 2010; 501957.

21. Alebiosu CO, Ayodele OO, Abbas A and Olutoyin AI. Chronic renal failure at the OlabisiOnabanjo University teaching hospital, Sagamu, Nigeria. Afr Health Sci 2006; 6: 132–138.

22. Akinsola W, Odesanmi WO, Ogunniyi JO and Ladipo GOA. Diseases causing chronic renal failure in Nigerians—a prospective study of 100 cases. Afr J Med MedSci 1989; 18:131–137.

23. Zepeda-Orozco D and Quigley R. Dialysis Disequilibrium Syndrome.PediatrNephrol. 2012; 27: 2205–2211.

24. Amira CO, Braimoh RW and Bello BT. Pattern of intradialytic complications at the Lagos University Teaching Hospital. Afr J Med Med Sci. 2012;41(4):411 –416.

25. Wald R, Jaber BL, Price LL,Upadhyay and Madias NE. Impact of hospital-associated hyponatraemiaon selected outcomes. Arch Intern Med 2010; 170: 294–302

26. Kovesdy CP, Lott EH, Lu JL,Malakauskas SM, Ma JZ, *et al*. Hyponatraemia, hypernatremia and mortality in patients with chronic kidney disease with and without congestive heart failure. Circulation 2012; 125: 677–684.

27. Pérez-García R, Palomares I, Merello JI, Ramos R, Maduell F, *et al.* Hyponatraemia, mortality and haemodialysis: An unexplained association. Nefrologia. 2016; 36(1): 42 – 50.

28. Chang TI, Kim YL, Kim H, Ryu GW, Kang EW, *et al.* Hyponatraemia as a predictor of mortality in peritoneal dialysis patients. PLoS One. 2014;9(10):e111373.

29. Oo TN, Smith CL and Swan SK.Does uremia protect against the demyelination associated with correction of hyponatraemia during hemodialysis? A case report and literature review.Semin Dial. 2003; 16(1): 68-71.

30. Huang WY, Weng WC, Peng TI, Ro LS, Yang CW *et al*. Central pontine and extrapontinemyelinolysis after rapid correction of hyponatraemia by hemodialysis in a uremic patient.Ren Fail. 2007;29(5):635-638.

31. Arogundade FA, Sanusi AA, Hassan MO and Akinsola A. The pattern, clinical characteristics and outcome of ESRD in Ile-Ife, Nigeria: Is there a change in trend? Afr Health Sci. 2011; 11:594–601.

32. Alasia DD, Emem-Chioma P and Wokoma FS. A singlecenter 7-year experience with end-stage renal disease careinNigeria-asurrogateforthepoorstateofESRDcare in Nigeria and other sub-Saharan African countries: Advocacy for a global fund for ESRD care program in sub-Saharan African countries. Int J Nephrol. 2012; 639653.