Original Article

Blood Pressure Changes among Patients Undergoing Hemodialysis in Yenagoa, Nigeria

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Abstract

Introduction: Hemodialysis (HD) is a common modality of renal replacement therapy in Nigeria. Despite its usefulness, it may have complications such as intra-dialytic hypotension (IDH) and intra-dialytic hypertension (IDHTN), both of which may impact negatively on the patient. The aim of the study was to examine blood pressure (BP) changes during HD, to determine the frequency of IDH and IDHTN in patients undergoing HD, and to possibly identify associated factors. **Materials and Methods:** The study design was a retrospective review of records of patients who had HD in the Rainbow Dialysis Center, a foremost private dialysis center in Bayelsa State. The records of all adults who had HD in the center from June 2014 to June 2018 were reviewed. Data retrieved include sociodemographics, type and cause of renal disease, and clinical and laboratory parameters such as BPs, packed cell volume, urea, and creatinine. **Statistical Analysis Used:** Data were analyzed with SPSS version 20.0. Data were presented in tabular forms. Variables were expressed as mean with standard deviation, frequencies, and percentages. The means were compared using Student's *t*-test or analysis of variance where appropriate. Chi-square test was used to compare proportions. Statistical significance was set at $P < 0.05$. **Results:** One hundred and thirty-six cases were recruited for the study. IDH and IDHTN were found in 16.9% and 16.2% of the patients, respectively. There was no significant difference between the mean predialysis and postdialysis systolic, diastolic, mean arterial BP, or pulse pressure ($P > 0.05$). Older age was positively and significantly associated with IDHTN ($P = 0.047$). **Conclusions:** IDH and IDHTN were prevalent among the patients studied, with the latter being slightly more likely to occur with advancing age. There is a need for adequate BP monitoring and management during HD.

Keywords: Blood pressure, hemodialysis, intradialytic hypertension, intradialytic hypotension

Introduction

Hypertension is related to kidney failure in several ways. It is both a cause and a consequence of kidney disease.[1] The relationship between high blood pressure (BP) and the kidneys could be related to that between "the chicken and the egg."[2] Hypertension is among the leading causes of end-stage renal disease (ESRD) in Nigeria.[3,4] Hypertension also commonly complicates chronic kidney disease (CKD). It may be present in up to 80%–85% of patients with CKD.[5] Hypertension is more common among the patients who are just initiating dialysis because almost all such patients are volume overloaded.[6] Hypotension, on the other hand, frequently leads to decreased renal perfusion and may result in acute kidney injury (AKI).

Hemodialysis (HD) is the most common form of renal replacement therapy (RRT) in Nigeria today.[7] Due to hemodynamic changes, the HD procedure itself is associated with fluctuations in BP which may manifest as hypotension or hypertension. Intradialytic hypotension (IDH) is often defined as a decrease in systolic BP (SBP) by >20 mmHg or a decrease in the mean arterial blood pressure (MABP) by 10 mmHg, associated with symptoms that may include abdominal discomfort, yawning, sighing, nausea, vomiting, muscle cramps, restlessness, dizziness, fainting, and anxiety.[8] The European Best Practice Guidelines definition is slightly

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modified to include the presence of symptoms and need for nurses' intervention.[9] The prevalence of IDH in some parts of Nigeria has been reported to be about 8.5% though this depends on the criteria used for the diagnosis.[10,11]

Although intradialysis BP rise is also a recognized complication in these patients, there is as yet no universally accepted definition. Intradialytic hypertension (IDHTN) has been reported as a rise in the mean arterial pressure >15 mmHg within or immediately postdialysis or as a >10 mmHg increase in SBP, or in some cases, BP rise of any degree during the second or third intradialytic hour.[12-14] The underlying mechanism of IDHTN is multifactorial and may include activation of renin–angiotensin–aldosterone system and endothelial dysfunction.[15] IDHTN has been reported in about 13.2% of patients on maintenance HD.[13]

Controversies exist concerning acceptable BP levels in ESRD patients. However, higher cardiovascular mortality rates have been observed in patients with postdialytic SBP >140 mmHg and those with posttreatment SBP <110 mmHg in some series.[14] Reports have linked IDHTN to poor clinical outcomes with higher rates of hospitalization and death.[13,16] IDH, on the other hand, impacts negatively on patients' quality of life and can induce cardiovascular events including cardiac arrhythmia, coronary, or cerebral ischemic disease.[17,18]

Against this background, the objective of the study was to examine BP variability during dialysis, to determine the frequency of IDH and IDHTN in the patients undergoing HD, and to possibly identify associated factors. There is a paucity of data on this subject in this part of the world. The information derived from the study will not only help in cultivating a high index of suspicion and quick identification of these conditions in this vulnerable population but also place the physician on alert for prompt intervention and management.

Materials and Methods

This study was a retrospective one involving patients admitted to the HD unit over a 4-year period from June 2014 to June 2018 in the Rainbow Dialysis Center, a private dialysis center in Yenagoa, Nigeria. The Center serves as a referral center for several hospitals in Bayelsa State and neighboring states.

The case files of the patients dialyzed in the unit during this period were retrieved. The second session of HD was used for the study. Data from the first session were not used because they lasted for only 2 h according to the hospital dialysis protocol. Patients who failed to complete the expected 4 h of dialysis during the second session were also excluded from the study. Patients were dialyzed with bicarbonate dialysis, with a hollow-fiber F6 or F8 NIPRO dialyzer. Blood flow rates ranged between 150 and 350 ml/min. The dialysate flow rate ranged between 500 and 650 ml/min. The ultrafiltration goal varied and was determined after the physician had subjectively assessed the quantity of fluid retained in the patient. The dialysate temperature ranged from 36.5°C to 36.9°C. Anticoagulation was with heparin given at a dose of 2000 IU at the start of the dialysis and 1000 IU/h subsequently.

Variables obtained from the case files were age; gender; type of kidney disease; cause of kidney disease; SBP at the onset of the dialysis, middle, and at the end of the dialysis; and diastolic BP (DBP) at the onset, middle of, and at the end of the dialysis. The BP recording on each occasion was the arithmetic mean of two values done at an interval of 3 min. Laboratory data obtained were the hematocrit, serum urea, and serum creatinine.

BP variation during the dialysis was determined by finding the difference between pre-HD and post-HD BPs. Pulse pressure (PP) pre- and post-HD was calculated as the difference between pre-HD SBP and pre-HD DBP as well as between post-HD SBP and post-HD DBP, respectively. MABP pre- and post-dialysis was calculated as follows: MABP = 1/3 (PP) + DBP for their respective pressures.

IDH was defined as a negative difference >10 mmHg between the pre-HD MABP and the post-HD MABP.[9] IDHTN, on the other hand, was defined as a positive difference of ≥15 mmHg between the pre-HD SBP and the post-HD SBP.[14] Patients with negative or positive differences less than these values were considered as not having significant changes in BP intradialysis.

Data obtained were analyzed using IBM SPSS software version 20.0 (IBM Inc., Chicago, USA). Data were presented as tables. Continuous variables were expressed as mean, standard deviation, and range, while categorical variables were expressed as frequencies and percentages. Means were compared using Student's *t*-test or analysis of variance where appropriate. Chi-square test was used to compare proportions. $P < 0.05$ was considered statistically significant.

Ethical consideration

Ethical approval for the study was obtained from the Bayelsa State Ministry of Health.

Results

One hundred and forty-nine patients were dialyzed over the study period, of which 136 (91.3%) cases met the inclusion criteria and were recruited for the study. There were 66 males and 70 females. The mean age of patients was 48.1 ± 17.1 years. Only a quarter of the population was above 60 years old. Up to 73.5% of patients were of Bayelsa State origin, while others were from neighboring states of Nigeria. The baseline characteristics of the patients are shown in Table 1.

The mean predialysis SBP for males and females was 146.9 mmHg and 147.9 mmHg, respectively, while the mean predialysis DBP for males and females was 87.1 mmHg and 88.4 mmHg, respectively. Furthermore, the mean MABP was 107.7 mmHg, while the mean MABP postdialysis was 109.4 mmHg. There was no statistically significant difference in the MABP variation between males and females ($P = 0.462$), as shown in Table 2. Patients with

CKD also had higher mean predialysis SBP, DBP, and MABP compared with those with AKI. Similarly, the mean postdialysis SBP, PP, and MABP were also higher among the CKD groups [Table 2].

The postdialysis SBP, DBP, PP, and MABP were generally higher than the predialysis values [Table 3].

IDH was observed in 23 (16.9%) patients, while IDHTN was found in 22 (16.2%) patients. Similarly, there was no significant intra-dialysis BP variation in 81 (66.9%) patients.

Factors associated with IDH and IDHTN in the patients are shown in the regression analysis in Table 4. Age was positively associated with IDH. The older individuals were slightly more likely to develop IDH (odds ratio 1.04, 95% confidence interval = 1.00–1.09). IDH had no relationship with gender, nature of kidney disease, the level of predialysis SBP or DBP, and hematocrit, urea, or creatinine level. None of these variables also had any significant association with IDHTN.

Table 1: Baseline parameters of the study population (*n*=136)

Parameter	Frequency (%)
Mean age (years)	48.1±17.1
Age groups	
≤40	48 (35.3)
41-60	54 (39.7)
>60	34 (25.0)
Gender	
Male	66 (48.5)
Female	70 (51.5)
Type of kidney disease (*n*=136)	
AKI	24 (17.6)
CKD	107 (78.7)
Not specified	5 (3.7)
Etiology of CKD (*n*=107)	
Hypertension	42 (39.3)
Chronic glomerulonephritis	25 (23.4)
HIV associated	15 (14.0)
Diabetes mellitus	12 (11.2)
Obstructive nephropathy	8 (7.5)
Others	5 (4.6)

CKD – Chronic kidney disease; AKI – Acute kidney injury; HIV – Human immunodeficiency virus

Discussion

This finding of this study is in keeping with the current realities in Nigeria and sub-Saharan Africa where CKD affects predominantly the young- and middle-aged individuals with this age bracket also constituting the bulk of the dialysis population.[17] The male-to-female ratio in this small center study was almost unity though the prevalence of RRT has generally been reported to be higher among men.[19]

CKD patients made a large bulk of the study population. Although AKI may also progress directly to ESRD, especially if left untreated, the usual course of CKD is relentless progress to ESRD over time. A major challenge of CKD patients in developing countries like ours is a late presentation, with most patients doing so in an advanced stage.[20]

Hypertension was prevalent in this population. The mean BP s pre- and postdialysis were high. There was no significant difference in BP between males and females even though the latter had slightly higher BPs. In a similar study in Benin City, a nearby town, Okaka and Okwuonu reported higher mean BPs among women compared with males in their series of dialysis patients with only the difference in DBP reaching statistical significance.[21]

BP variability was common in our study as observed in up to one-third of our patients. IDH was reported to be present in up to 17.2% of all treatments in a large dialysis population study involving 1137 patients and over 44,800 treatments.[22] We found a similar rate in this study. However, adequate comparison between studies is constrained by the lack of uniformity and the use of different criteria. Some of these require only a minimum drop in BP, while others include clinical manifestations. In this study, we used a drop in MABP in the absence of clinical

Table 2: Pre- and post-dialysis blood pressure parameters across gender and kidney disease type

Parameters	Variables							
	Gender				Type of kidney disease			
	All	Male	Female	*P*	AKI	CKD	Unspecified	*P*
Pre-dialysis								
SBP	147.39±31.68	146.89±31.89	147.86±31.71	0.860	131.67±26.65	152.01±31.76	124.00±18.17	0.004*
DBP	87.79±19.27	87.12±17.95	88.43±20.55	0.693	80.42±18.53	90.37±18.80	68.00±14.83	0.004*
PP	59.60±23.99	59.77±25.88	59.43±22.26	0.934	51.25±21.12	61.64±24.41	59.60±24.00	0.151
MABP	107.66±21.31	107.05±20.13	108.24±22.51	0.745	97.50±19.14	107.92±20.95	86.67±11.79	0.001*
Post-dialysis								
SBP	151.67±33.90	150.30±34.55	152.96±33.47	0.650	135.00±32.84	156.45±33.29	129.40±17.94	0.006
DBP	88.30±20.06	88.03±21.43	88.56±18.83	0.879	82.50±19.62	90.09±20.16	77.80±12.81	0.120
PP	63.37±23.70	62.27±24.92	64.40±22.63	0.604	63.50±23.70	66.36±23.08	51.60±16.21	0.017
MABP	109.42±22.94	108.79±23.79	110.02±22.27	0.581	100.02±21.96	112.21±22.85	95.00±12.58	0.021

*Statistically significant. BP – Blood pressure; SBP – Systolic BP; DBP – Diastolic BP; PP – Pulse pressure; MABP – Mean arterial BP; AKI – Acute kidney injury; CKD – Chronic kidney disease

Table 3: Comparison of pre- and post-dialysis blood pressure parameters

Parameter	Predialysis	Postdialysis	*P*
SBP	147.39±31.7	151.67±33.90	<0.001
DBP	87.79±19.3	88.30±20.06	<0.001
PP	59.60±23.99	63.37±23.71	<0.001
MABP	107.66±21.31	109.42±22.94	<0.001

BP – Blood pressure; SBP – Systolic BP; DBP – Diastolic BP; PP – Pulse pressure; MABP – Mean arterial BP

Table 4: Regression analysis of factors associated with IDH and IDHTN

Variable	*P*	
	IDH	IDHTN
Age	0.047*	0.911
Gender	0.258	0.686
Predialysis SBP	0.999	0.989
Predialysis DBP	0.080	0.985
Type of kidney disease	0.275	0.954
Haematocrit	0.308	0.308
Serum urea	0.324	0.608
Serum creatinine	0.501	0.246

*Statistical significance. BP – Blood pressure; SBP – Systolic BP; DPB – Diastolic BP; IDH – Intradialysis hypotension; IDHTN – Intradialysis hypertension

manifestations. Since the study was a retrospective one, we could only rely on documented data. The findings are slightly less than those of Okaka and Okwuonu who reported a prevalence of 19.8%.[21] However, the criteria for diagnosis in that study differed from the one we employed. Similarly, Okoye *et al*. in Delta State, Nigeria, reported a prevalence of 8.8%.[11] The criteria for diagnosis used in this case incorporated both SBP drop and clinical manifestations. This may explain why they had a markedly lower rate. We did not find any association between IDH and most of the variables tested in this study. Older age was however only weakly associated with it. IDH has been reported to be more common in the elderly, diabetics, and those with cardiovascular compromise and low predialysis SBP due to the contraction in blood volume that could occur in these patients, especially after significant ultrafiltration.[23] IDH was not related to the predialysis BP levels or the level of serum electrolytes. Pakfetrat *et al*. reported no significant correlation between predialysis SBP, DBP, or serum electrolytes apart from serum magnesium level, which decrease was observed to correlate with IDH.[24] However, we did not test for serum magnesium in this study.

Intradialytic hypertension was similarly prevalent in the population studied. There is a paucity of data on the prevalence of IDHTN in Nigeria, thus placing a limit on the adequate comparison. Okaka and Okwuonu reported a higher rate of 30% in their population,[21] but here again, the criterion used was different from ours. While we used a drop in MABP >10 mmHg for our patients, a SBP drop of >20 mmHg was used in theirs. Another South African study reported a prevalence of 28%,[25] while Nilrohit *et al*. reported an even higher prevalence of 34.5% in India.[26] IDHTN was defined in the latter study as an increase in SBP >10 mmHg during HD for more than two HD sessions, while in the former, it was defined as a >10 mmHg increase in SBP in at least four of six prior consecutive HD sessions. Ours is one of the few studies that have used MABP as criteria for the diagnosis. Furthermore, only a solitary session of dialysis was used in our study. In the study done by Okaka and Okwuonu, the average values of three dialysis sessions were used, giving a prevalence of 30%.[21] Factors that have been reported to contribute to IDHTN in our environment include fluid overload, infrequent dialysis, inadequate antihypertensive therapy due to financial constraints and poor funding as well as the use of dialyzable antihypertensives during the procedure.[21]

This study had some limitations. Certain variables which have shown some association with IDH/IDHTN in previous reports such as serum albumin, diabetes, presence of edema, use of antihypertensive medications, and erythropoietin were not tested in our study.[26] The effect of HD treatment-related variables such as ultrafiltration rate, dry weight, blood, or dialysate flow was not assessed. The study is underpowered to significantly demonstrate association between variables, considering the relative small number of patients. Furthermore, being retrospective in nature, it does not establish causation for any of the risk factors of IDH or IDHTN. There is a need for large-scale prospective studies to evaluate risk factors for IDH and DHTN to ultimately reduce cardiovascular complications of ESRD.

Conclusions

HD-related hemodynamic instability is a major issue. IDH and IDHTN were prevalent in both AKI and CKD patients undergoing HD in this study. IDH was weakly associated with older age. There is, therefore, a need for greater caution during HD, especially for older patients to prevent the associated risks of the procedure. Thorough preassessment and monitoring of all the patients undergoing HD is necessary for the effective prevention and treatment of IDH and IDHTN to reduce dialysis-related morbidity and mortality while ensuring optimal treatment.

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Conflicts of interest

There are no conflicts of interest.

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