Research Article

Dialysis Termination and Dialysis Dose in Severe Intra-Dialytic Hypotension Managed with Inotropic Support in a Low Income Setting

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Abstract: Background: Intradialytic Hypotension (IDH) still remains a major complication and burden, and is associated with inadequate dose, poor quality of life, increased morbidity and mortality. Inotropic support could minimize dialysis termination and improve the dialysis dose.

Objective: To determine the impact of inotropic support on the incidence of dialysis termination (a common finding in resource limited settings), and the dialysis dose.

Materials and Methods: This retrospective, observational study compared the dialysis outcome in severe IDH with, and without dopamine treatment.

Results: The 36 participants had 518 sessions with IDH, of this, 405 (78.19%) were without dopamine while 113 (21.81%), with severe IDH, were managed with dopamine. The mean ages of participants in the two groups were not significantly different, P=0.05. The risk of severe IDH was negatively related to the predialysis systolic blood pressure (SBP) P=0.03 while the postdialysis. Blood pressure was higher in dopamine treated sessions (DTSs). The blood flow rate (BFR) and dialysis dose were higher in the DTSs (P=0.05) and (P=0.04), but the dialysis dose was lower with anemia (P<0.001), metabolic acidosis (P<0.001), heart failure (0.04) and diabetes (P=0.04). In DTSs, females were more likely to have lower dialysis doses, (P=0.02). Independent associates of inadequate dialysis dose were infrequent dialysis sessions, infrequent erythropoietin doses, metabolic acidosis and anemia.

Conclusion: Managing severe intradialytic hypotension with low dose dopamine is associated with reduced frequency of dialysis termination and augmentation of the dialysis dose. Reductions in the intradialytic BP gradients could minimize the complications associated with wide intradialytic BP variations.

Keywords: Inotropic support, Dopamine, Severe intradialytic hypotension, Dialysis dose, Dialysis termination, Tachycardia, Heart failure, Blood flow rate.

INTRODUCTION

Intradialytic Hypotension (IDH) still remains a major complication and burden arising from hemodialysis treatment despite advances made in dialysis delivery [1]. Sometimes referred to as the most common intradialytic complication with a wide prevalence range of 10-35% (depending on diagnostic criteria), it is associated with low quality of life (QOL), higher morbidity and could present with life-threatening features that may require some interventions to prevent mortality [1,2]. IDH could induce ischemic injury to vital organs like the heart, brain, intestines and further worsen kidney function, just as intradialytic blood pressure (BP) fall that didn't meet the BP diagnostic criteria for IDH have been reported to cause some ischemic organ injury, particularly in critically ill patients [3].

The BP and volume status are major determinants of outcome in maintenance hemodialysis (MHD), hypervolemia worsens hypertension, and increases the risk of left ventricular hypertrophy (LVH), heart failure and death [4]. Managing hypervolemia in MHD commonly entails dialysis delivery with higher ultrafiltration rates (UFRs), and this could precipitate IDH (particularly with compromised plasma refilling from poor cardiac systolic function) which can be complicated by myocardial stunning and ischemia and increased mortality [4, 5].

Studies assessing cardiovascular status in patients on MHD have found U-shaped, J-shaped, or no-relationship between the

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BP and mortality [6]. While large-volume ultrafiltration, low predialysis BP, fever, autonomic dysfunction and poor cardiac reserve could increase the risk of IDH, severe IDH could also involve poor sympathetic drive, imbalance between endothelin and nitric oxide and sub-optimal response of the antidiuretic hormone (ADH) to ultrafiltration and low plasma volume [6-8]. Supranormal dialysis dose (DD) heightens the risk of IDH, and IDH can negatively impacts the DD, increasing the risk of poor BP control, malnutrition, dialysis termination and intradialysis death [9]. Inotropic support in low doses (which do not commonly trigger tachycardia), can lead to higher intradialytic BP, allowing higher BFR and longer dialysis duration, both, major contributors to higher dialysis doses [10]. It may therefore be necessary to prevent or promptly manage severe IDH with inotropic support to minimize the delivery of an inadequate dose.

Inotropic support with dopamine in dialysis is scarcely reported worldwide. We hypothesize that low dose dopamine improves the dialysis dose in severe IDH, maintain better hemodynamic stability and reduces dialysis termination. The study compared the dialysis dose and dialysis termination in sessions treated with, and without dopamine.

MATERIALS AND METHODS

This was a retrospective cohort study. The dialysis sessions were grouped into two: with, and without dopamine, were given between August 2018 and July 2021 at Babcock University Teaching Hospital, Ilishan-Remo, Nigeria. Five hundred and eighteen MHD sessions given to 128 participants aged 18-81 years, who had CKD using the KDOQI diagnostic criteria were studied [11]. The minimum sample size for this study was determined from the formula $n=Z^2 pq/d^2$, using 21.4% prevalence rate got by the European Best Practices Guidelines (EBPG) definitions [95% CI-2.004 (1.137-3.586)] with margin of error 4% calculated sample size came out to be 404 [7]. But we studied five hundred and eighteen sessions (for 128 participants). Participants' biodata, etiology and type of CKD, hospitalizations, comorbidities, blood pressure (BP) and results of renal biochemistry (electrolytes, urea, creatinine and albumin), urea reduction ratio (URR), Kt/V and hematocrit were retrieved.

Predialysis dopamine was administered to participants who had ≥3 consecutive episodes of severe IDH defined as intradialytic systolic BP <90mmHg with symptoms that were not successfully resolved by nursing intervention, hence dialysis termination (after ruling out risk factors such as fever, drug effect or food intake) [10].

Dopamine was given intradialysis to participants who had ≥3 consecutive episodes of severe IDH defined as a systolic BP fall of ≥20 mmHg down to <100 mmHg with symptoms that were not successfully resolved by nursing intervention, hence dialysis termination (after ruling out and/or correcting modifiable factors causing IDH) [10].

PDD was commenced 30 minutes before dialysis at 2-5ug/kg/min in 200ml of 0.9% saline at 10-15 drops/minute (depending on the BP). IDD was commenced 2-5ug/kg/min in 200ml of 0.9% saline at 10-15 drops/minute (depending on the extent of BP fall).

Sessions with no IDH, and in which sodium profiling were carried out were excluded.

Unfractionated heparin 5000 IU was used for anticoagulation in all sessions and the dialysate flow rate (DFR) was 500ml/min. The dialysate fluid had sodium (140.0 mmol/L), potassium (2.0 mmol/L), calcium (2.0 mmol/L) and bicarbonate (34.0 mmol/L). The study was approved by the Babcock University Human Research Ethics (BUHREC/723/19, NHREC/24/01/2018).

DEFINITION OF TERMS

- Tachycardia was defined as mild (PR-101-119/min), moderate (PR-120-139/min), severe (PR-140-149/min) or life threatening (PR ≥ 150/min) [12].
- Hypoxemia was defined as SPO2 < 95% [13].
- Dopamine doses was defined as low (<5.0 ug/kg/min), medium (5.01-9.99 ug/kg/min) [14].
- Post dialysis weight (PDW) was defined as predialysis weight plus administered fluid minus UFV [15].
- IDH was defined as intra-dialytic fall in SBP ≥ 20 mmHg [16].
- Severe IDH was defined as ≥3 consecutive episodes of intradialytic SBP <90mmHg with symptoms that were not successfully resolved by nursing intervention, hence dialysis termination 10 or ≥3 consecutive episodes of intradialytic SBP fall ≥ 20mmHg down to <100 mmHg with symptom that were not successfully resolved by nursing intervention, hence dialysis termination [17].
- Anemia: Hematocrit < 33% [18].
- Hypoalbuminemia: Serum albumin <35mg/Dl [19].
- Dialysis dose (kt/V): adequate (≥ 1.2), low (0.9-1.1), very low (< 0.9) [20].
- Hypertension-associated CKD: Kidney disease complicating long standing hypertension, common in elderlies and in late middle age [20].
- Chronic glomerulonephritis: Hypertension complicating kidney disease, common in the young and in early middle age, with or without antecedent history of pharyngitis or skin sepsis [20].

STATISTICAL ANALYSIS

Data analysis was with SPSS version 22.0 (IBM, CA, USA). Continuous variables, presented as means were compared using t-test while categorical variables, presented as proportions were compared using Chi square test or fisher's exact test for variables less than 5. From the univariate model, variables with a p-value of <0.025 were entered into the multivariate model, with back-

ward elimination to adjust for confounders, and to determine independent predictors of the dialysis dose [21]. P-values <0.05 were considered statistically significant.

RESULTS

Five hundred and eighteen dialysis sessions for 36 participants were conducted during the study duration. Four hundred and five (78.89%) of this were managed without dopamine while 113 (21.81%) were managed with dopamine (Table **1**).

Table 1. Participants' Socio-Demographics and Predialysis Blood Pressure.

Variables	All participants	IDH without Dopamine	IDH with Dopamine	P-value
	N=36 (%)	N=405 (%)	N=113 (%)	
Sex				
Mean Males Females	64.60 ± 9.5 23 (63.89) 13 (36.11)	64.48 ± 8.22 238 (58.76) 167 (41.24)	64.64 ± 10.31 60 (53.10) 53 (46.90)	 0.05 0.01
Age, Years				
16-39 40-64 ≥65	6 (16.67) 21 (58.33) 9 (25.00)	52 (12.84) 241 (59.51) 112 (27.65)	9 (7.97) 57 (50.44) 47 (41.59)	 0.01
Causes of CKD				
CGN Hypertension Diabetes Others	9 (25.00) 16 (44.44) 6(16.67) 5 (13.89)	119 (29.38) 136 (33.58) 81 (20.00) 69 (17.04)	16 (14.16) 33 (29.20) 43 (38.05) 21 (18.59)	 0.02
Hemodialysis Sessions				
1 2 3	18 (50.00) 16 (44.44) 2 (5.56)	93 (22.96) 263 (64.94) 49 (12.10)	42 (37.17) 60 (53.10) 11 (9.73)	 0.03
BP Lowering Drugs				
1 2 3	10 (27.78) 17 (47.22) 9 (25.00)	54 (13.33) 172 (42.47) 179 (44.20)	75 (66.37) 33 (29.20) 5 (4.43)	 0.001
Erythropoietin 4000 IU/week				
1 2 3	14 (38.89) 20 (55.56) 2 (5.55)	125 (30.87) 239 (59.01) 41 (10.12)	47 (41.59) 56 (49.56) 10 (8.85)	 0.04
Predialysis SBP, mmHg				
<120 120-139.9 ≥140		49 (12.09) 111 (27.42) 245 (60.49)	39 (34.51) 41 (36.29) 33 (29.20)	 0.03
Postdialysis SBP, mmHg				
<120 120-139.9 ≥140		185 (45.68) 67 (16.54) 153 (37.78)	28 (24.78) 37 (32.74) 48 (42.48)	 <0.001
Predialysis DBP, mmHg				
<80 80-89.0. ≥90		32 (7.90) 75 (18.52) 298 (73.58)	33 (29.20) 31 (27.44) 49 (43.36)	 0.02
Postdialysis DBP, mmHg				
<80 80-89.0. ≥90		183 (45.19) 89 (21.97) 133 (32.84)	22 (19.47) 35 (30.97) 56 (49.56)	 <0.001

BP: Blood pressure, IDH: Intradialytic hypotension, CKD: Chronic kidney disease, IU: International unit.

The mean age of all participants was 64.6 ± 9.5 years, majority (57.03%) were middle aged. Only 3.91% of the participants received thrice weekly sessions while 6.25% received erythropoietin thrice weekly.

The risk of severe IDH was negatively correlated with the predialysis systolic, and diastolic BP, P=0.03 and P=0.02 respectively. The postdialysis systolic and diastolic BP were more likely to be higher in DTS. The BFR was more likely to be higher in sessions with dopamine, P<0.001. The DD was higher in DTSs, P=0.04 (Table **2**).

Table 2. Relationship between Prescribed Dialysis and Dialysis Outcome.

Variables	IDH without Dopamine	IDH with Dopamine	P-value
	N=405 (%)	N=113 (%)	
Blood Flow Rate, ml/min			
250-299 300-349 ≥350	13 (3.21) 112 (27.65) 280 (69.14)	3 (2.66) 29 (25.66) 81 (71.68)	 0.05
Dialysis Duration, Hours			
<4 4	15 (3.70) 390 (96.30)	6 (5.31) 107 (94.69)	0.04
Ultrafiltration Volume, mL			
<1000 1000-1999 ≥2000	35 (8.64) 52 (12.84) 318 (78.52)	10 (8.85) 39 (34.51) 64 (56.64)	 0.02
Vascular Access			
Arteriovenous fistula CVC (Jugular) Femoral	50 (12.35) 217 (53.58) 138 (34.07)	13 (11.51) 59 (52.21) 41 (36.28)	 0.08
Dialysis Dose, Kt/V			
<1.2 ≥1.2	388 (95.80) 17 (4.20)	104 (92.04) 9 (7.96)	0.04
Dialysis Termination			
Yes No	15 (3.70) 390 (96.30)	6 (4.31) 107 (94.69)	0.04

Continued Table 2

Intradialytic Death			
Yes No	0 (0.00) 405 (100-00)	1 (0.89) 112 (99.11)	<0.001

IDH: Intradialytic hypotension, Kt/V: Urea clearance.

The DD was higher in males, P=0.8 (Table **3**).

Inadequate dialysis was likely in the elderly (P=0.04) and diabetics (P=0.04), without dopamine (P=0.03), predialysis systolic HTN (P=0.002), metabolic acidosis (P=0.001), anemia (P<0.001), and in terminated sessions (P=0.004) (Table **4**).

Table 3. Gender Associations with Dopamine (inotropic) Support and Dialysis Dose.

Variables	**IDH without Dopamine**	**IDH with Dopamine**	**P-value**	**IDH without Dopamine**	**IDH with Dopamine**	**P-value**
	Males	Females		Males	Females	
	N=238 (%)	N=167 (%)		N=60 (%)	N=33 (%)	
Age, Years						
<65	178 (74.79)	115 (68.86)	0.02	34 (56.67)	28(52.83)	0.01
≥65	60 (25.21)	52 (31.14)		26 (43.33)	25 (47.17)	
Erythropoietin, 4000 IU						
<3	210 (88.23)	154 (92.21)	0.03	54 (90.00)	49 (92.45)	0.04
3	28 (11.77)	13 (7.79)		6 (10.00)	4 (7.55)	
Dialysis Sessions/week						
<3	206 (86.55)	150 (89.82)	0.03	53 (88.33)	49 (92.45)	0.02
3	32 (13.45)	17 (10.18)		7 (11.67)	4 (7.55)	
Predialysis SBP, mmHg						
<140	39 (16.39)	121 (72.46)	<0.001	37 (61.67)	43(81.13)	<0.001
≥140	199 (83.61)	46 (27.54)		23 (38.33)	10 (18.87)	
Predialysis DBP, mmHg						
<90	19 (7.98)	98 (58.68)	<0.001	26 (43.33)	35(66.04)	<0.001
≥90	219 (92.02)	69 (41.32)		34 (56.67)	18 (33.96)	
Mean Predialysis GFR, ml/min						
<5	209 (87.81)	151 (90.42)	0.03	56 (93.33)	50 (94.34)	0.06
≥5	29 (12.19)	16 (9.58)		4 (6.67)	3 (5.66)	
Mean Predialysis Hematocrit, %						
<33	218 (91.59)	158 (94.61)	0.03	57 (95.00)	51 (96.22)	0.03
≥33	20 (8.41)	9 (5.39)		3 (5.00)	2 (3.78)	
Serum Albumin, mg/dL						
<35	197 (82.77)	147 (88.02)	0.02	55 (91.67)	51(96.22)	0.03
≥35	41 (17 23)	20 (11.98)		5 (8.33)	2 (3.78)	
Heart Failure						
Yes	51 (21.43)	38 (22.75)	0.05	31 (51.67)	26(49.05)	0.04
No	187 (78.57)	29 (77.25)		29 (48.33)	27 (50.95)	
Hospitalization						
Yes	113 (47.48)	99 (59.28)	<0.001	30(50.00)	28(52.83)	0.04
No	125 (52.52)	68 (40.72)		30 (50.00)	25 (47.17)	
Vascular Access						
AVF	41 (17.23)	9 (5.39)	<0.001	10 (16.67)	3 (5.66)	<0.001
Internal Jugular	144 (60.50)	73 (43.71)		38 (63.33)	21 (39.62)	
Femoral	53 (22.27)	85 (50.90)		12 (20.00)	29 (54.72)	

Continued Table 3

Blood Flow Rate, mL/min						
<300	236 (99.16)	166 (99.40)	0.09	51 (85.00)	44(83.02)	0.05
≥300	2 (0.84)	1 (0.60)		9 (15.00)	9 (16.98)	
Dialysis Duration, Hours						
<4	10 (4.20)	5 (3.00)	0.001	2 (3.33)	2 (3.77)	0.06
4	228 (95.80)	162 (97.00)		58 (96.67)	51 (96.23)	
Ultrafiltration Volume, L						
<2	42 (17.65)	45 (26.95)	0.001	23 (38.33)	50(94.34)	0.001
≥2	196 (82.35)	122 (73.05)		37 (61.67)	27 (50.94)	
Kt/V						
<1.2	227 (95.38)	161 (96.41)	0.06	54 (90.00)	50 (94.34)	0.02
≥1.2	11 (4.62)	6 (3.59)		6 (10.00)	3 (5.66)	

IDH: Intradialytic hypotension, IU: International unit, GFR: Glomerular filtration rate, BFR: Blood flow rate, AVF: Arteriovenous fistula, CVC: Central venous catheter, Kt/V: Dialysis dose.

Table 4. Correlation between the Dialysis Dose and Participants' Variables.

Variables	**Kt/V <1.2**	**Kt/V ≥1.2**	**OR**	**95% CI**	**P-value**
	N=492 (%)	N=26 (%)			
Sex					
Males	303(94.10)	19 (5.90)	0.73	0.05-0.92	0.08
Females	189(96.43)	7 (3.57)			
Age, Years					
<65	337(93.87)	22 (6.13)	1.87	0.99-2.86	0.04
≥65	155(97.48)	4 (2.52)			
CKD Etiology					
Diabetes	120(97.56)	3 (2.44)	1.58	1.14-2.97	0.04
No Diabetes	374(94.20)	23 (5.80)			
Dopamine					
Yes	104 (92.03)	9 (7.97)	2.01	1.03-4.01	0.03
No	390 (95.82)	17(4.18)			
Dialysis/week					
<3	455(99.13)	4 (0.87)	6.26	1.77-8.41	<0.001
3	38 (63.33)	22 (36.67)			
Erythropoietin, 4000 IU/week					
<3	447(97.60)	11 (2.40)	5.18	2.84-8.04	<0.001
>3	45 (75.00)	15 (25.00)			
Predialysis Systolic HTN					
Yes	245(91.42)	23(8.58)	4.15	4.07-8.62	0.002
No	247(98.80)	3 (1.20)			
Predialysis Diastolic HTN					
Yes	326(93.96)	21(6.04)	1.36	1.18-2.25	0.05
No	166(97.08)	5 (2.92)			
Predialysis Creatinine, µmol/L					
<500	80 (90.90)	8 (9.10)	2.11	1.05-4.26	0.03
≥500	412 (95.81)	18 (4.19)			
Predialysis SBC, mmol/L					
<22	436 (96.46)	18 (3.73)	4.76	3.29-8.53	0.001
≥22	56 (84.85)	10 (15.15)			
Predialysis Hematocrit, %					
<33	465 (96.27)	18 (3.73)	5.38	1.42-8.03	<0.001
≥33	27 (77.14)	8 (22.86)			

Continued Table 4

Blood Flow Rate, mL/min					
<300	72 (97.30)	2 (2.70)	1.81	0.82-2.76	0.04
≥300	420 (94.59)	24 (5.41)			
Dialysis Duration, Hours					
<4	12 (92.31)	1 (7.69)	1.81	0.82-2.76	0.04
≥4	480 (95.50)	25 (4.50)			
Ultrafiltration Volume, L					
<2	130 (97.01)	4 (2.99)	1.48	1.19-2.70	0.05
≥2	362 (94.27)	22 (5.73)			
Intradialytic Death					
Yes	3 (100.00)	0 (0.00)	11.37	3.65-17.29	<0.001
No	489 (94.95)	26 (5.05)			

Kt/V: Dialysis dose, OR: Odds ratio, CI: Confidence interval, CKD: chronic kidney disease, HTN: Hypertension, SBC: Serum bicarbonate concentration.

Inadequate dialysis was associated with infrequent dialysis (OR-8.36, 95% CI-3.06-12.94, P<0.001), infrequent erythropoietin (OR-7.18, 95% CI-1.52-9.42, P<0.001) and predialysis systolic HTN (OR-4.53, 95% CI-0.87-5.63, P=0.001), metabolic acidosis (OR-5.17, 95%-CI-4.82-10.33, P<0.001), anemia (OR-6.05, 95% CI-3.02-10.95, P<0.001).and intradialytic death (OR-13.28, 95% CI-2.74-18.01, P<0.001).

DISCUSSION

Within the IDH population we found a prevalence of 21.81% of severe IDH. There was a positive relationship between inotropic support with dopamine and the dialysis dose, a synergy that was aided by the positive association between dopamine inotropic support and the dialysis duration, the intradialytic blood pressure, frequency of dialysis, and of erythropoietin use [10, 22]. Severe IDH and the requirement for inotropic support was more common in females, the elderly, diabetics, infrequent dialysis and fewer anti-hypertensives, as previously reported [23].

The positive relationship between inotropic support and the dialysis dose is in agreement with previous findings that reported a positive association between the BP (particularly from the hypotensive to the normal range) and the dialysis dose [23]. The relative advantage of low dose dopamine in augmenting residual kidney function (RKF) through increased renal blood flow would also contribute to the higher dialysis dose [10]. Dopamine in doses of 0.5-2.0mg/kg/min acting on the D1 and D2 receptors causes vasodilatation and lower blood pressure while higher doses but less than 5mg/kg/min) acting on D1 and D2, and alpha and beta adrenergic stimulation cause vasodilatation, increased cardiac output and blood pressure, without inducing tachycardia, a precipitant of many of the adverse effects of dopamine, like cardiac failure and cardiac arrest [24]. Major determinants of dialysis dose like the blood flow rate and dialysis duration, are best optimized with relatively higher intra-dialytic BP as the risk of IDH and its complication of dialysis termination, is minimized [25]. Higher intradialytic BP correlate with better systolic cardiac function, a feature that tends to play a significant role in the plasma refilling process that follows ultrafiltration [26]. Moreover, the impact of the systolic contractile waveform is transmitted through the vessel wall to the dialyzer membrane thereby creating higher transmembrane gradient which facilitates higher solute clearance [27].

The extent to which each of the contributing factors impacts the dialysis dose can be approximated through inotropic support. Despite the fact that the dopamine-treated participants had more of the known dose-limiting factors such as advancing age (frequency of dopamine use increased with age), fewer dialysis and erythropoietin treatment, lower UFVs, and higher frequencies of diabetes (and therefore autonomic neuropathy) and heart failure, their mean dialysis dose was still higher than those without dopamine treatment. This highlights the greater contributing role played by higher blood flow rates and "optimal intra-dialysis BP" (and the resultant longer dialysis duration) on the dialysis dose [28]. The avoidance of tachycardia, (which increases myocardial oxygen demand) through the use of low dose dopamine in this study, further buttresses the usefulness of inotropic support (dopamine) in augmenting the dialysis dose [23].

The higher dialysis dose in males (despite receiving lesser dopamine treatment) tends to contradict the higher dialysis dose associated with dopamine use in this study. This paradox we infer, results from the combined effects of factors that contributed to the higher doses in males such as: being younger, more frequent dialysis, and erythropoietin treatment, higher predialysis GFR, longer dialysis sessions, fewer hospitalization and higher concentrations of serum albumin [29]. These factors, in synergy, overwhelm the synergistic effect of higher dopamine use and higher BFR (in dopamine treated sessions) that were commoner with females. The higher frequency of hospitalization in females' mirrors findings by Lee *et al*. [30], and this is expected to be more prevalent in resource-poor settings due to socioeconomic and cultural biases against women [31-33]. The fact that the women were older, with heightened risk of cardiovascular dysfunction in their elderlies, coupled with lesser financial capacity to afford the prescribed regimen, in resource-poor settings, could explain the higher hospitalization rates in females on MHD [30, 33, 34].

The higher BFR in women in this study could be due to the lesser hemodialysis-associated BP reductions that resulted from the inotropic support [25]. The strong association between severe IDH and diabetes is seen more in participants with DTSs as diabetes was the most frequent cause of CKD in participants with DTSs, but only third commonest cause of CKD in those with mild-moderate IDH. The combination of autonomic neuropa-

thy and LVH in diabetics makes them less likely to achieve an adequate dialysis dose [35].

The positive correlation between the dialysis dose and serum bicarbonate concentration (SBC) mirrors previous findings, hypobicarbonatemia metabolic acidosis (MA) induces cutaneous vasodilatation thereby reducing the effective blood (plasma) volume and this could worsen the IDH, although very severe form of MA, particularly with concurrent severe anemia could cause vasoconstriction, severe intradialytic hypertension and myocardial ischemia that may be severe enough to precipitate cardiac events [36, 37]. This positive relationship was also present between the dialysis dose and the hematocrit. Anemia increases the plasma volume and in combination with hypoalbuminemia can induce the up regulation of the antidiuretic hormone (ADH) further diluting the plasma and worsening the fluid overload which can precipitate pulmonary edema and increase the risk of IDH as the nephrologist attempt to prescribe a high volume ultra-filtrate to maintain fluid balance and prevents consequences of fluid overload in these patients [38, 39].

LIMITATION

Limitations encountered in this study included the study's retrospective design, the small sample size, our inability to determine the blood PH (a better tool to assess metabolic), the non-availability of hematocrit and online blood volume monitoring devices, including bioimpedance, and biofeedback ultrafiltration assessment. Participants dry weight, interdialytic weight and residual kidney function were not determined moreover, only the weight of patients that were fit to stand were measured hence the non-consideration of the body mass index. The temperature, a determinant of the dialysis dose was not centrally regulated as there were no central cooling systems. The strength of the study is the rarity of its kind and the likely positive impact it makes in managing severe IDH. Despite dopamine use in low doses, without significant tachycardia, further studies would be needed to ascertain the long-term safety profile of its use.

CONCLUSION

Severe forms of IDH are common in resource poor nations. Without increasing the risk of tachycardia and intra-dialytic death, low dose dopamine in severe IDH allowed for higher BFR, dialysis duration and dialysis doses, and reductions in intradialytic BP variations and dialysis termination. Hospitalization during MHD was common in females while males had higher dialysis doses. Severe IDH requiring low dose dopamine was common in the elderly, females and diabetics. Independent associates of inadequate dialysis were advancing age, anemia, MA, frequent hospitalization and intra-dialytic death. Low dose dopamine in severe IDH could be a useful regimen that improves dialysis outcome without undermining the safety profile of patients.

AUTHORS' CONTRIBUTION

- **Peter K. Uduagbamen**: Conception.
- **Peter K. Uduagbamen, Folasade O. Soyinka, Titilope A. Bamikefa, Boladale A. Alalade**: Design of the work.
- **Peter K. Uduagbamen, Folasade O. Soyinka, Titilope A. Bamikefa, Boladale A. Alalade, Marion I. Ogunmola, Chukwuyerem I. Nwogbe, Tolulope E. Falana**: Data acquisition and analysis, Interpretation of data and Manuscript revision.

CONFLICT OF INTEREST

Declared none.

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