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Clinical Features and Determinants of Pulmonary Hypertension amongst End Stage Kidney Disease Patients in a Sub-Saharan Country

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Abstract

Background: Pulmonary hypertension (PH) is an unrecognized and common cardiovascular complication of End Stage Kidney Disease (ESKD). Data on its burden in sub-Saharan Africa are rare. We aimed to determine the characteristic and determinants of ESKD patients with PH on maintenance hemodialysis in a tertiary care hospital in Cameroon.

Methods: A cross-sectional study from January to July 2017 at the Douala general hospital. We included consenting ESKD under hemodialysis for more than 3 months. Relevant clinical data were recorded from patient's files and interviews including baseline nephropathy, medications, blood pressure, inter dialytic weight gain, haemoglobin level. All patients underwent a standard echocardiography study (2D, M-mode, Doppler) within 3hours from the end of the dialysis session by the same cardiologist. PH was defined as pulmonary artery systolic pressure (PASP) > 35 mmHg and classified as: mild (PASP: 35-45 mmHg), moderate (PASP: 45-60 mmHg) and severe (PASP>60 mmHg).

Results: We included 98 patients with mean age of 49 ± 15.1 years. There was 59.2% men and 40.8% women. Left ventricular diastolic dysfunction (83.7%) and left atrium dilation (58.2%) were the frequent cardiac abnormalities. A total of 32/98 (32.7%) patients had PH with 8/98 (8.2%) mild, 13/98 (13.3%) moderate and11/98 (11.2%) severe. Diastolic blood pressure (OR=0.92, CI=0.85-0.99, p=0.011), hemoglobin level (OR=0.49, CI=0.27-0.90, p=0.006), duration on hemodialysis > 4 years (OR=42.71, CI=2.81-648.60, p=0.007) and inter dialytic weight gain (OR=2.36, CI=1.18-4.16, p=0.006) were significantly associated with PH.

Conclusion: PH seem to be frequent amongst patients on hemodialysis in our setting, with various patients related factors associated.

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Keywords: Hemodialysis; Pulmonary hypertension; Determinant; Cameroon

Abbreviations: CKD: Chronic kidney disease; WHO: World Health Organisation**;** CKD: Chronic Kidney Disease; ESKD: End Stage Kidney Disease; ESRD: End-stage renal disease; AVF: Arteriovenous Fistula; LVH: Left ventricular hypertrophy; SSA: Social Security Administration; TRV: Tricuspid Regurgitation Velocity; RAP: Right Atrium Pressure; PASP: Pulmonary Arterial Systolic Pressure; LA: Left Atrial; LV: Left Ventricular; RV: Right ventricular; LVH: Left Ventricular Hypertrophy ; SD: Standard Deviation; Or: Odds Ratio; RHC: Respirations Have Ceased.

Introduction

Chronic kidney disease (CKD) is a worldwide public health problem that carried a high morbidity and mortality especially at end stage, mainly due to cardiovascular diseases [1-4]. Pulmonary hypertension (PH) is defined as an increase in mean pulmonary arterial pressure (mPAP) at or above 25 mmHg at rest [5,6]. PH is currently classified by the World Health Organisation (WHO) into five different groups, which include pulmonary arterial hypertension, PH due to left heart disease (PHLHD), PH due to lung disease or hypoxia, chronic thromboembolic PH and PH due to unclear or multifactorial mechanisms. PH is an unrecognized cardiovascular complication of CKD [7-9]. It is more frequent in CKD patients compared to the general population and the prevalence increased with the stage of CKD [7,8,10–16]. Reported prevalence of PH in patients with end stage kidney disease (ESKD) on haemodialysis ranged from 18.8% to 68.8% depending on methods and definition used [10]. Potential factors predisposing to PH in ESRD are numerous including CKD specific risk factors like volume overload, arterio-venous fistula (AVF), exposure to dialysis membranes, endothelial dysfunction, vascular calcification and stiffening, left ventricular hypertrophy (LVH), anaemia, increase dialysis time and parahormone level (PTH), interdialytic weight gain and sleep-disorders [10,11,13,14,17,18].

Little information exists on the epidemiology of PH in sub-Saharan Africa (SSA) but the prevalence and mortality rate of PH may be higher than in Western countries [19,20]. In South Africa, PH has been identified as one of the commonest causes of death, accounting for 31% of total cardiovascular deaths [21]. In Cameroon, Dzudie *et al.* reported a prevalence of 15.6% amongst patients without CKD [22]. Studies have shown that the presence of PH is independently associated with high mortality and cardiovascular events in CKD patients [11,13,17,23,24]. CKD is a major public health problem in SSA with prevalence estimated at 13% [1], and carries a high morbidity and mortality amongst patients on maintenance haemodialysis, the main modality of renal replacement therapy in that setting [25-29]. Despite the reported high prevalence and poor outcome of PH in ESKD patients in developed world, data on the burden of PH amongst CKD patients in SSA are inexistent. We therefore aimed to assess the characteristics and determinants of PH in ESKD patients on maintenance haemodialysis in Cameroon, in order to contribute to a better knowledge of this condition in our setting.

Methods

Study setting and participants

We conducted a cross sectional study in the haemodialysis and cardiology units of the Douala General Hospital (DGH) during 7 months from 1^{srt} January to 31th July 2017. DGH is a tertiary referral hospital for patients with kidney disease in the littoral region of Cameroon. The center is equipped with 20 Fresenius® generators 4008 S (Fresenius Medical Care, Hamburg, Germany). Each dialysis session was done with a synthetic polysulfone dialysis membrane and a dialysate with bicarbonate buffer having the following composition: Na^+ =138mmol/L, Ca^{2+}=1.75mmol/L, Cl^-=109.5mmol/L, K^+= 2mmol/L, $Mg^{2=}$=0.5 mmol/L, carbohydrate=1 g/L, CH_3COO^-=3mmol/L, HCO_3^-=32mmol/L. In the center patients underwent 2 dialysis sessions of 4 hours per week.

Inclusion criteria

Patients aged 18 years and above on maintenance haemodialysis for more than 3 months were included in the study after a written consent was obtained.

Exclusion criteria

Patients with conditions that could alter the measurement of pulmonary arterial pressure such as atrial fibrillation or pulmonary artery stenosis were excluded.
Ethical clearance was obtained from the Cameroon National Ethics Committee with the number 2017/029/UDM/PR/CIE.

Data collection

Data were collected from patient's medical records and by interviews using a structured questionnaire. Relevant

data were: socio demographic (age, sex), co-morbidities (history of diabetes, arterial hypertension, Stroke, HIV, Hepatitis B or C), baseline nephropathy and clinical data (blood pressure, weight, residual diuresis, vascular access, dry weight, inters dialytic weight gain, duration on dialysis). Blood pressure and weight were measured after the dialysis session using an automatic blood pressure machine (OMRON® M2, HEM-7121-E), and a manual weighing scale respectively. Biological data of less than one month (haemoglobin, calcium, phosphorus) were collected. Biological abnormalities were defined as follows: Anemia: hemoglobin < 13,5 g/dl in men and < 12 g/dl in women, hypocalcemia: calcium < 85 mg/L, hyperphosphoremia: phosphorus > 45 mg/L and hypophosphoremia: phosphorus < 25 mg/L.

All patients underwent a standard Doppler echocardiography study (2D, M-mode) within 3 hours from the end of dialysis session while they were as close as possible to their dry weight. The echocardiography was performed by the same qualified cardiologist using a VIVID 3 machine from General Electric®. The following measurements were obtained: aortic root diameter, pulmonary artery trunk size, left and right atrium dimension, left ventricle (dimension, systolic and diastolic function) right ventricle (dimension, systolic function). The following procedure was used for the assessment of the pulmonary pressure: tricuspid regurgitation velocity (TRV) is the maximum tricuspid regurgitation jet speed, right atrium pressure (RAP) was estimated by visual inspection of the inferior vena cava diameter according to the recommendations of the American Society of Echocardiography. The estimation of pulmonary arterial systolic pressure (PASP) was based on the modified Bernoulli equation as follows: $PASP=4 \times (TRV)^2 + RAP$. PH was defined as a PASP > 35 mmHg. Patients were classified into 3 groups: mild PH (PASP 35-45 mmHg), moderate PH (PASP: 45-60 mmHg) and severe PH (PASP>60 mmHg) [30-33].

Cardiac abnormalities were defined as follows: Left atrial (LA) dilation: left atrium area > 20cm2; Right atrium (RA) dilation: right atrium area > 18 cm^2; Left ventricular (LV) dilation: end-diastolic diameter of the left ventricle > 56mm in men and > 53mm in women; Right ventricular (RV) dilation: end-diastolic diameter of the right ventricle > 42mm; Left ventricular hypertrophy (LVH): end-diastolic inter-ventricular septal thickness and end-diastolic thickness of the left ventricular posterior wall > 12mm; Left ventricular (LV) systolic dysfunction: ejection fraction < 50%; Right ventricular (RV) systolic dysfunction: Tricuspid Annular Plane Systolic Excursio (TAPSE) < 16mm; Left ventricular (LV) diastolic dysfunction was defined according to Appleton's classification [34].

Statistical analysis

Data were analysed using R Studio[R] Version 1.0.143 Software (R Development Core Team, Vienna, Austria). The general characteristics of the patients were described using standard descriptive statistics. Continuous variables were presented as mean and standard deviation (SD) or median and 25^{th}-75^{th} percentiles whereas categorical variables were presented as frequencies and percentages. Association between the presence of pulmonary hypertension and certain socio-demographic, clinical and paraclinical variables were studied. First, univariate logistic regression models were used to identify factors associated with pulmonary hypertension. Odds ratio (OR) were calculated to measure these association and p-values were estimated using Wald's tests. Then a manual backward elimination procedure was realized in a multi-varied logistic regression model. Variables with p-value inferior to 0.2 in univariate analysis were included in the model and factors a priori deemed to be important predictive factors of PH (Serum calcium level, serum phosphorus level, LA dilation, LV dilation, LVH, LV systolic dysfunction, LV diastolic dysfunction) were forced in the model. Adjusted OR and p-values were estimated. $p< 0.05$ was considered statistically significant.

Results

A total of 98 participants were included in the study. Their mean age was 49 ± 15,1years and 59.2% (58/98) were men and 40.8% women (40/98) male. Main etiologies of ESKD were hypertension (26.5%), chronic glomerulonephritis (19.4%) diabetes (18.4%). The etiology was unknown in 15.3% of patients. Prevalence of hypertension was 91.8% (90/98) and the main classes of antihypertensive drugs used were calcium channel blockers (70.4%), RAAS blockers (46.9%) and Alfa and beta blockers (22.4%). The general characteristics of the study population are shown in (Table 1).

Variables	N=98
Female, n (%)	40 (40.8)
Mean age, years (SD)	49 (15.1)
Co-morbidities	
Hypertension, n (%)	90 (91.8)

Diabetes, n (%)	22 (22.4)
HIV, n (%)	7 (7.1)
Hepatitis B and C, n (%)	9 (9.2)
Stroke, n (%)	5 (5.1)
Smoking, n (%)	10 (10.2)
Etiology of ESKD	
Hypertension, n (%)	26 (26.5)
Diabetes mellitus, n (%)	18 (18.4)
Chronic glomerulonephritis, n (%)	19 (19.4)
HIV, n (%)	6 (6.1)
Polycystic kidney disease, n (%)	4 (4.1)
Chronic interstitial nephritis, n (%)	10 (10.2)
Unknown, n (%)	15 (15.3)
Medications	
Calcium channel blockers, n (%)	69 (70.4)
RAAS blockers, n (%)	46 (46.9)
Alfa and beta blockers, n (%)	22 (22.4)
Central antihypertensives, n (%)	14 (14.3)
Diuretics, n (%)	7 (7.1)
Erythropoietin, n (%)	24 (24.5)
Iron, n(%)	3 (3.1)

Table 1: General characteristics of the study population.

SD: Standard Deviation; Q1-Q3; 25^{th}-75^{th} percentiles, HIV, human immunodeficiency virus; ESKD: End Stage Kidney Disease; RAAS: Renin Angiotensin Aldosterone System; BP: Blood Pressure; BMI: Body Mass Index.

Median duration in dialysis was 29 (14-64) months. Arteriovenous fistula (AVF) was the most common vascular access used in 85/98 (86.7%) of patients, and 90/98 (91.8%) patients received two dialysis sessions per week with a mean inter dialytic weight gain of 3.2 ± 1.3 kg. The mean inter dialytic interval was 3.6 ± 1.2 days. The main biological abnormalities found were anemia (94.9%), hypocalcemia (42.9%) and hyperphosphoremia (40.8%) Table 2.

Variables	N=98
Median dialysis duration, month (Q1-Q2)	29 (14-64)
Dialyses Vascular Access	
Arteriovenous fistula, n (%)	85 (86.7)
Permanent catheter, n(%)	9 (9.2)
Temporary catheter, n(%)	4 (4.1)
Number of weekly hemodialysis session	
1	4 (4.1)
2	90 (91.8)
3	4 (4.1)
Mean interdialytic interval, days (SD)	3.6 (1.2)
Interdialytic weight gain, Kg	
Mean (SD)	3.2 (1.3)
< 4	45 (45.9)
≥ 4	53 (54.1)
Mean systolic BP, mmHg (SD)	153.9 (25.2)
Mean diastolic BP, mmHg (SD)	81.0 (16.0)
Mean arterial pressure, mmHg (SD)	105.3 (17.1)
Mean BMI, Kg/m² (SD)	23.6 (4.1)
Calcium	

Mean, mg/L (SD)	89.1 (14.3)
Hypercalcemia, n (%)	7 (7.1)
Hypocalcemia, n (%)	42 (42.9)
Phosporus	
Mean, mg/L (SD)	44.6 (17.1)
Hyperphosphoremia, n(%)	40 (40.8)
Hypophosphoremia, n (%)	11 (11.2)
Haemoglobin	
Mean, g/dl (SD)	8.6 (2.1)
Anemia, n (%)	93 (94.9)

Table 2: Clinical and Dialysis Characteristics of the study participants.
SD: Standard Deviation; BMI: Body Mass Index.

Based on ultrasound, 96/98 (98%) of patients had at least one cardiac abnormality and the most common were left ventricular diastolic dysfunction (83.7%), left atrium dilation (58.2%), left ventricle dilation (39.6%) and left ventricular hypertrophy (33.3%). In total 32/98 (32.7%) patients had PH; 8/98 (8.2%) mild, 13/98 (13.3%) moderate and 11/98 (11.2%) severe (Table 3).

Variables, N= 98	n (%)
PH-	66 (67.3)
PH+	32 (32.7)
Mild	8 (8.2)
Moderate	13 (13.3)
Severe	11 (11.2)
LV diastolic dysfunction	82 (83.7)
LA dilatation	57 (58.2)
LV dilatation	38 (38.8)
LVH	32 (32.7)
RA dilatation	23 (23.5)
LV systolic dysfunction	6 (6.1)
RV systolic dysfunction	5 (5.1)
RV dilatation	2 (2.0)

Table 3: Frequency of pulmonary hypertension and echocardiographic characteristics of participants.
PH: Pulmonary Hypertension; RA: Right Atrial; LA: Left Atrial; RV: Right Ventricular; LV: Left Ventricular
LVH: Left Ventricular Hypertrophy.

Patients with PH compared to those without PH, had lower hemoglobin level, higher interdialytic weight gain, more cardiac abnormalities, higher systolic and diastolic blood pressure and used calcium channel blockers more frequently. HIV patients and women were also more affected by PH (Table 4). In multivariate analysis, diastolic blood pressure (OR=0.92, CI=0.85-0.99, p=0.011), hemoglobin level (OR= 0.49, CI= 0.27-0.90, p=0.006), duration on hemodialysis > 4 years (OR=42.71, CI=2.81-648.60, p=0.007) and inter dialytic weight gain (OR=2.36, CI=1.18-4.16, p <0.006) were factors significantly associated with PH (Table 5).

Variables	PH +	PH -	OR (95% CI)	P-value
Masculin, n (%)	14 (43.8)	44 (66.7)	2.6 (1.1 – 6.1)	0.04*
Age, years (SD)	45.5 (14.6)	50.6 (15.1)	0.98 (0.95 – 1.01)	0.11
Hypertension, n (%)	31 (96.9)	59 (89.4)	3.7 (0.4 – 31.3)	0.17
Diabetes, n (%)	4 (12.5)	18 (28.6)	0.4 (0.1 – 1.2)	0.07
HIV, n (%)	5 (15.6)	2 (3.0)	5.9 (1.1 – 32.4)	0.03*
Systolic BP, mmHg (SD)	165.2 (48,4)	148.6 (26.2)	1.03 (1.01 – 1.05)	0.002*
Diastolic BP, mmHg (SD)	86.0 (17.1)	78.6 (15.0)	2.45 (1.01 – 5.96)	0.05*
Calcium channel blockers, n (%)	26 (81.2)	43 (65.2)	2.32 (0.83 – 6.44)	0.09

RAAS blockers, n (%)	15 (46.9)	31 (47)	1.5 (0.6 – 3.4)	0.40
Aetiology of kidney disease, n (%)				0.28
Diabetes	4 (12.5)	14 (21.2)	1 (ref cat)	
Chronic glomerulonephritis	7 (21.9)	12 (18.2)	2.0 (0.5- 8.7)	
Hypertension	6 (18.8)	20 (30.3)	1.1 (0.3 – 4.4)	
Others	15 (46.9)	20 (30.3)	2.6 (0.7 – 9.6)	
Haemoglobin, g/dl (SD)	7.5 (1.6)	9.2 (2.0)	0.56 (0.41 – 0.77)	< 0.001*
Calcium, mg/L (SD)	93.2 (20.1)	87.1 (9.9)	1.03 (1.00 – 1.06)	0.052
Phosphorus, mg/L (SD)	48.2 (18.7)	42.7 (16.0)	1.02 (0.99 – 1.05)	0.144
Duration in dialysis, years				0.087
< 1	11 (32.3)	12 (18.7)	1 (ref cat)	
[1 - 4]	9 (26.5)	32 (50.0)	0.4 (0.1-1.3)	
> 4	14 (41.2)	20 (31.3)	1.1 (0.4-3.6)	
Inter dialytic interval, days (SD)	3,8 (1.4)	3.6 (1.1)	1.17 (0.83 – 1.67)	0.37
Inter dialytic weight gain, Kg (SD)	4,6 (0.8)	3.3 (1.3)	3.14 (1.80 – 5.47)	< 0.001*
Arteriousvenous fistula, n (%)	30 (93.8)	55 (83.3)	3.0 (0.6-14.4)	0.13
LA dilation, n (%)	28 (87.5)	29 (43.9)	8.9 (2.8 – 28.3)	< 0.001*
LV dilation, n (%)	20 (62.5)	18 (28.1)	4.3 (1.7 – 10.5)	0.001*
LVH, n (%)	16 (50.0)	16 (25.0)	3.0 (1.2 – 7.3)	0.01*
LV systolic dysfunction, n (%)	5 (15.6)	1 (1.6)	11.7 (1.3-104.6)	0.009*
LV diastolic dysfunction, n (%)	23 (71.9)	59 (89.4)	0.3 (0.1 – 0.9)	0.03*

Table 4: Associated factors to pulmonary hypertension in bivariate analysis.
OR: Odds Ratio; CI: Confidence interval; SD: Standard Deviation; ref cat, reference category; * p-value <0,05. PH, pulmonary hypertension; HIV, human immunodeficiency virus; BP: Blood Pressure; LVH: Left Ventricle Hypertrophy; RAAS: Renin Angiotensin Aldosterone System; RA: Right Atrial; LA: Left Atrial; RV: Right Ventricular; LV: Left Ventricular Others: End Stage Kidney Disease due to human immunodeficiency virus, Polycystic Kidney Disease, unknown, chronic interstitial nephritis, toxic and gout.

Variables	OR adjusted# (95% CI)	P-value
Female	2.58 (0.49–13.62)	0.252
HIV	33.98 (0,01–94164.08)	0.254
Systolic blood pressure	1.04 (1.00–1.09)	0.055
Diastolic blood pressure	0.92 (0.85–0.99)	0.011
Haemoglobin	0.49 (0.27-0.90)	0.006
Calcium	1.00 (0.95-1.06)	
Phosphorus	1.04 (0.98-1.09)	0.165
Calcium channel blockers	0.25 (0.04-1.59)	0.122
Years on haemodialysis		0.004
< 1	1.00 (ref cat)	
1-4	3.42 (0.42-27.66)	0.248
> 4	42.71 (2.81-648.60)	0.007
Inter dialytic weight gain	2.36 (1.18-4.16)	0.006*
LA dilation	4.29 (0.53–34.42)	0.158
LV dilation	3.41 (0.50–23.47)	0.204
LVH	1.68 (0.27-10.28)	0.575
LV systolic dysfunction	10.25 (0.29-358.02)	0.174
LV diastolic dysfunction	0.42 (0.05-3.28)	0.792

Table 5: Factors associated to PH in multivariate analysis.
HIV: Human Immunodeficiency Virus; LA: Left Atrial; RV: Right Ventricle; LVH: Left Ventricular Hypertrophy.

Discussion

The aim of this study was to determine the clinical phenotype and determinants of PH amongst patients on maintenance hemodialysis in Cameroon. Our findings showed that in our hemodialysis service, PH affects young male patients, most of whom are hypertensives (9 of 10), have left ventricular diastolic dysfunction (83.7%) and markers elevated of left ventricular filling pressure (58.2% with left atrium dilation) on echocardiography. Compared to those without PH, patients with PH exhibited lower hemoglobin level, higher interdialytic weight gain, more left atrial and ventricular abnormalities, higher systolic and diastolic blood pressure. Hemoglobin, duration on hemodialysis > 4 years, diastolic blood pressure and inter dialytic weight gain were independently associated with PH. All through we cannot rule out the possibility of other mechanisms of PH, these findings are suggestive of predominant PHLHD in our population of hemodialysed patients.

Reported studies in the literature have shown that PH occurs frequently in patients with CKD and its prevalence increases with the stage of CKD [8,9,35,7,8,10-16]. A recent review reported that the prevalence of PH in ESKD patients on haemodialysis is variable, ranging from 18.8% to 68.8% and is frequently associated with left heart disease [10]. This variability is mainly due to method and cut off used for definition of PH. In the present study we found that PH affect 32.7% of our study population. Sankar et al. in USA and Zhilian Li et al. in China also reported echocardiographic prevalence rates of 32.8% and 37.5% respectively amongst patients with CKD stage 5 on maintenance haemodialysis [17,36] Quian Zhang et al in China. Reported a higher prevalence rate (64.47%) with dominance of PHLHD[18].. In Cameroon, in a study carried out in a rural cardiology center amongst patients without CKD, Dzudie et al. Reported an echocardiographic PH prevalence of 15.6% with a dominance (64.5%) of PHLHD [22].

PH is determined by a complex of factors in CKD patients, the mechanism being multifactorial with CKD specific risk factors such as volume overload, presence of AVF, vascular calcification and stiffening, anaemia and inter dialytic weight gain [10,11,13]. Associated determinants of PH reported in the literature are: older age, anaemia, lower LVEF, presence of LVH, used of cardiovascular medication including statins, β-blockers, and diuretics, higher calcium × phosphate product, higher interdialytic weight gain, increase dialysis time, increase parathormone level [14,17,18,37,38]. In the present study factors associated to PH were diastolic blood pressure, hemoglobin level, longer duration on hemodialysis, and inter dialytic weight gain. This is consistent with previous reports. Interdialytic weight gain is consistently reported to be higher among patients with PH, compared to those without PH [14,39], suggesting that fluid retention is a contributing factor for the development of heart failure and PH. Due to economic constraints and government policy, majority of patients in our setting received only twice-weekly hemodialysis instead of thrice-weekly. Improving the frequency and quality of dialysis may be an option to reduce the rate of PH in our patients, but H. Suresh et al. reported that there was no significant difference in PH prevalence between those who had thrice-weekly and twice-weekly HD[14], suggesting that more studies are needed to answer the issue whether improving the frequency and quality of HD improves heart failure and hence PH. Secondary hyperparathyroidism is a severe complication in CKD patients and has been reported to be a risk factor for PH [18,40]. Unfortunately due to the high cost and out of pocket payment, majority of our patients did not have the test done and consequently we could not analysed this major factor in our study.

Our study has potential limitations. The diagnosis of PH was based on echocardiography and not RHC which remains the gold standard diagnostic tool for PH. Echocardiography is a non-invasive, available and less expensive screening tool compared to RHC which is invasive and still yet to be available in our milieu. In expert hands, echocardiography yields reliable and reproducible results. Indeed, studies carried out to evaluate the diagnostic accuracy of echocardiography compared to RHC have demonstrated a sensitivity of 83% and a specificity of 72% [41]. We increased our chances reliable diagnosis of PH with rigorous clinical studies and followed a rigorous diagnostic algorithm as suggested by Dzudie et al. [42]. Also this was a single centre and small sample study, which limits generalization of our findings to the entire Cameroon population of patients on hemodialysis. Despite this limitations, this study describe for the first time the frequency of PH amongst patients on maintenance haemodialysis in a setting where ESKD carries a high morbidity and mortality [28,29]. Giving the reported poor outcome of patients with PH elsewhere, this baseline data could serve to take specify measures to improve the care of these patients group.

Conclusion

PH is a frequent finding in ESKD patients on maintenance haemodialysis in Cameroon, generally affecting the young male with arterial hypertension as risk factor and likely to have abnormal left cardiac structure and function on echocardiography. Diastolic blood pressure, hemoglobin

level, longer duration on hemodialysis and inter dialytic weight gain were independently associated to PH. A nation study of the current cohort of all patients on hemodialysis with a follow up component to assess the true burden and outcomes of PH in these patients in our setting is urgently warranted.

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Conflict of Interests

The authors declare that they have no competing interests

Author's contribution

HMP: Study conception and design, drafting of the manuscript; KDM: data collection, drafting of the manuscript; MS: providing of data, supervision of data analysis, critical revision of the manuscript; TYB Data analysis and interpretation, critical revision of the manuscript**;** FH: Supervision of data collection, critical revision of the manuscript; KF: providing of data and revision of manuscript; DA: data interpretation, critical revision of manuscript; KS: study conception and critical revision of manuscript. All authors read and approved the final manuscript.

Availability of Data and Material

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval was obtained from University of Mountains with the number 2017/029/UDM/PR/CIE and consent for participated was obtained from each patient.

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