

Pre-and post-dialysis hematological indices of patients with chronic kidney diseases attending dialysis center of a tertiary hospital in Yola, Nigeria

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ABSTRACT

Background: Hemodialysis (HD) is the most common modality for renal replacement treatment in Sub-Saharan Africa where near normal kidney function is achieved in most patients with chronic kidney disease (CKD).

Objective: This case-control study sought to determine hematological changes and to compare the level of these changes in pre-dialysis and post-dialysis stages in patients with CKD attending the dialysis unit of federal medical center, Yola, Nigeria.

Materials and methods: A total of 100 kidney disease patients were used as study subject while 50 individuals without kidney disease were used as control group. All hematological parameters comprising packed cell volume (PCV), hemoglobin concentration (Hb), platelets count, red cell indices (mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular Hb concentration), and differential leukocyte count were analyzed using standard methods as provided by five parts Beckman Coulter hematology auto analyzer.

Results: The highest proportion (29%) was observed at age group, 51–55 years and least (1%) in those 76–80 years. The mean age of male HD patients was 56.9 ± 2.7 years while that of female was 42.5 ± 6.2 years and the male to female ratio in HD patients was 2.6:1. The patients at pre-dialysis have significantly reduced mean \pm standard deviation of Hb concentration (6.3 ± 1.8 g/dl), red blood cell (RBC) count ($2.1 \pm 1.3 \times 10^6$ /ul), and platelet count ($186 \pm 28.2 \times 10^3$ /ul) compared to control group which had 12.2 ± 1.4 g/dl, $4.4 \pm 0.2 \times 10^6$ /ul, and $350.5 \pm 82.2 \times 10^3$ /ul, respectively; while in contrast had higher lymphocyte count ($39.7 \pm 3.0\%$) when compared with the control group ($37.0 \pm 4.2\%$). At post-dialysis stage, PCV ($27.1 \pm 5.0\%$), Hb concentration (7.8 ± 1.2 g/dl), RBC count ($2.9 \pm 0.5 \times 10^6$ /ul), and neutrophil ($58.3 \pm 3.8\%$); significantly increased compared with pre-dialysis stage with PCV ($24.1 \pm 2.0\%$), Hb concentration (6.3 ± 1.8 g/dl), RBC count ($2.1 \pm 1.3 \times 10^6$ /ul), and neutrophil ($54.7 \pm 3.2\%$).

Conclusion: There is a remarkable improvement in hematological indices in CKD patients undergoing maintenance HD.

Key words: Hemodialysis, hematological indices, kidney disease

INTRODUCTION

Chronic kidney disease (CKD) is emerging as a major global health problem with huge economic burden both on the affected families of patients and health-care delivery systems. CKD continue to increase in low-income to middle-income countries (LMICs) due to the significant increase in non-infectious diseases and infectious conditions, juxtaposed with under-equipped health-care systems.^[1] Previous studies in Nigeria have put the prevalence of CKD between 1.6% and 12.4% with a high prevalence of risk factors observed in various studies among different groups.^[2] An epidemiological study by Arogundade *et al.*^[3] reported major causes of CKD in Nigeria; hypertension (29.8%), chronic glomerulonephritis (27.8%), diabetes mellitus (3.1%), obstructive uropathy (5%), unknown (30%), and

others (3.9%).^[3] Morbidity and mortality are high because most affected individuals cannot access renal replacement therapy and hemodialysis (HD). Other contributory factors for this exacerbated state include but not limited to late presentation, limited renal replacement therapy and its unaffordability, the absence of kidney disease prevention programs, and the poor literacy level.^[3]

CKD has been defined by the Kidney Disease Outcome Initiative as kidney damage or glomerular filtration rate (GFR) of <60 mL/min/1.73 m² for 3 months or more, due to any cause.^[4] CKD is a disease of multiple etiology characterized by progressive and irreversible deterioration of renal function due to the slow destruction of renal parenchyma, eventually terminating in death when sufficient numbers of nephrons have been damaged.

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Chronic glomerulonephritis and interstitial nephritis remain among the principal causes of CKD, reflecting the high prevalence of infections that affect the kidneys. Several parasitic infections cause CKD through ureteric obstruction (schistosomiasis), interstitial nephritis (kala-azar), and glomerulonephritis (malaria).^[5]

Hematological derangements are common in CKD due to relative deficiency/reduction in erythropoietin (EPO) production and other factors such as increased hemolysis, suppression of bone marrow erythropoiesis, and hematuria and gastrointestinal blood loss.^[6] The prevalence of anemia correlates with the severity (stages) of kidney impairment. It ranges from about 1% in Stage 2 of CKD to almost 100% in end-stage renal disease.^[7] The deficiencies of iron, Vitamin B12, and folate as a result of nutritional insufficiency or due to increased blood loss, aside EPO production, are contributory factors to abnormal hematological indices in CKD. EPO potentiates the effect of megakaryocyte colony stimulating factors, acetylhydrolase (PAF-AH), and paraoxonase (PON1); thus, in chronic renal disease, the impaired EPO secretion leads to a decrease in platelet count.^[6,8] The detection of receptors for EPO in megakaryocytes is comprehensible because EPO levels can affect platelet level and because of extensive homology between EPO and thrombopoietin, EPO act as the major humoral regulator of platelet mass.^[6,8] As high as 20% of HD patients may experience a fall in total leukocyte count. This is due to exposure of blood to artificial membranes in the dialyzer during dialysis. This exposure may result into *in vivo* complement activation (C3a or C5a) which in turn induces neutrophil aggregation and adherence to the endothelial surface with resultant fall in total leukocyte count.^[9]

HD is the most common modality for renal replacement treatment in Sub-Sahara Africa where accumulated toxic solutes (mainly urea and creatinine) and fluids are removed from a patient who has total or near total loss of kidney function using HD machine. The patient blood is passed through an extracorporeal circuit and pumped across an artificial semi-permeable membrane to bring the blood into contact with the dialysate (dialysis fluid). The principle of HD depends on utilization of dialysis solution, HD dilution, and ultra-filtration. Nigeria is the third with the highest number (6.3 per million population) of patients on hemodialysis in South Africa and Kenya.^[10] Whether or not HD impacts on the average life expectancy of CKD patients has been debated Stokes^[11] reported that the <3 years average life expectancy has not changed in 20 years. This may not be unconnected with the short- and long-term side effects and complications associated with the HD. Recently, studies illuminating under-reported hematological and biochemical indices at pre- and post-dialysis stages, as well as comorbidities are emerging.^[12] There is a paucity of such data in Yola, Nigeria. Hence, this study sought to determine hematological changes and to compare the levels of the changes in pre-dialysis and post-dialysis stages in patients with CKD attending Dialysis Centre in a Tertiary Hospital in Yola, Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out at the Dialysis Centre of Federal Medical Center, Yola, Adamawa state, Nigeria. Yola is in North Eastern Nigeria. The hospital serves as a referral site for the other health

institutions especially from the 21 Local Government Areas of the state and the neighboring communities. The study area is defined by longitude 13.5° E and latitude 11° N. The characteristic vegetation is that of Sub-Sudan and Guinea savannah with an average annual rainfall of 79 mm and 197mm in the northern and southern part of the state and temperature range of 15°C–39.7°C. There are two distinct seasons: The wet and the dry seasons and the former takes place between April and October, while the latter occurs from November to March. The state is multiethnic with a population of about 3.2 million; Christianity and Islam are the major religions.

Study Participants

A total of 100 kidney disease patients attending dialysis treatment at the hospital were used as research subject while fifty 50 individuals without kidney disease were used as control group. Ethical approval was obtained from the Ethics and Research Committee of the Hospital.

Sample Collection and Processing

5 ml of blood specimen was aseptically collected into a lavender-top vacutainer tube containing K2-Ethylenediaminetetraacetic acid. The blood was gently mixed with EDTA anticoagulant to avoid blood clot formation. Alternatively, a mechanical mixer was used for at least 5 min. All the venous blood samples were analyzed within 24 h of collection.

Laboratory Analytical Method

All hematological parameters comprising PCV, hemoglobin concentration (Hb), platelets count, red cell indices (Mean corpuscular volume, mean corpuscular Hb, and mean corpuscular Hb concentration), and differential leukocyte count were analyzed using standard methods as provided by five parts Beckman Coulter hematology auto analyzer.

Statistical Analysis

All values were expressed as mean ± standard deviation (SD). Data obtained were subjected to one-way ANOVA and t-test using Statistical Package for the Social Sciences (SPSS) version 22. $P \leq 0.05$ ($P \leq 0.05$) was considered statistically significant.

RESULTS

The hematological profile of 100 HD patients and 50 control subjects was analyzed. The pre- and post-dialysis samples were analyzed, and comparison was made between the pre-dialysis and control group, then between the pre- and the post-dialysis. Table 1 showed the prevalence of kidney disease patients in different age groups attending dialysis center of the Federal Medical Centre, Yola, Nigeria where the highest proportion (29%) was observed at age group 51–55 years while the lowest proportion (1%) was recorded at 76–80 years of age. Table 2 showed the mean age and gender distribution of the HD patients, the mean age of males was 56.9 ± 2.7 years while that of female was at 42.5 ± 6.2 and the gender ratio in male to female HD patients was 2.6:1. Table 3 showed the hematological profile of the HD patients at pre-dialysis and post-dialysis stages compared with control subjects. The patients at pre-dialysis have significantly reduced mean ± SD of Hb concentration (6.3 ± 1.8 g/dl), red blood cell (RBC) count ($2.1 \pm 1.3 \times 10^6$ /ul), and platelet count ($186 \pm 28.2 \times 10^3$ /ul) compared to control group which had 12.2 ± 1.4 g/dl, $4.4 \pm 0.2 \times 10^6$ /ul, and

Table 1: Age distribution of HD patients attending the dialysis center of the hospital

Age group	Number of patients (%)
16-20	2 (2)
21-25	4 (4)
26-30	3 (3)
31-35	6 (6)
36-40	5 (5)
41-45	16 (16)
46-50	12 (12)
51-55	29 (29)
56-60	8 (8)
61-65	2 (2)
66-70	7 (7)
71-75	3 (3)
76-80	1 (1)
≥81	2 (2)
Total	100 (100)

HD: Hemodialysis

Table 2: Age and gender distribution of the HD patients and control subjects

Parameter	Control subjects	HD patients
Age (years)		
M	47.4±5.3	56.9±2.7
F	39.1±6.2	42.5±6.2
Gender (n)		
M	30	72
F	20	28

HD: Hemodialysis

Table 3: Hematological indices of control subjects and HD patients at the dialysis center of the hospital

Parameter	Mean±SD		
	Control subjects	Pre-dialysis	Post-dialysis
PCV (%)	40.0±3.2	24.1±2.0	27.1±5.0 ^d
Hb Concentration (g/dl)	12.2±1.4	6.3 ^a ±1.8	7.8±1.2 ^d
WBC count (×10 ³ /ul)	6.9±3.7	6.8±2.7	7.1±0.3
RBC count (×10 ⁶ /ul)	4.4±0.2	2.1 ^a ±1.3	2.9±0.5 ^d
Platelet count (×10 ³ /ul)	350.5±82.2	186.4 ^a ±28.2	185.2±56.8
Neutrophil (%)	57.8±5.2	54.7±3.2	58.3±3.8 ^d
Basophil (%)	1.0±1.0	1.3±1.0	1.0±0.3
Eosinophil (%)	2.0±1.4	2.0±1.0	2.0±0.3
Lymphocyte (%)	37.0±4.2	39.7 ^b ±3.0	40.4±4.2
Monocyte (%)	2.0±0.5	1.0±1.0	2.0±1.0
MCV (fl)	102.8±0.6	101.3±2.2	99.8±0.8
MCH (pg)	31.5±0.3	30.7±0.9	31.2±0.2
MCHC (g/dl)	30.6±1.1	29.1±0.7	30.3±0.5

P<0.05 is considered statistically significant, ^asignificantly decreased (P<0.05) compared to the control, ^bsignificantly increased (P<0.05) compared to the control, ^csignificantly decreased (P<0.05) compared to the pre-dialysis, ^dsignificantly increased (P<0.05) compared to the pre-dialysis. PCV: Packed cell volume, MCV: Mean corpuscular volume, MCH: Mean cell hemoglobin, MCHC: Mean cell hemoglobin concentration, WBC: White blood cell, Hb: Hemoglobin, RBC: Red blood cell, SD: Standard deviation, HD: Hemodialysis

350.5 ± 82.2 × 10³/ul, respectively; while in contrast had higher lymphocyte count (39.7 ± 3.0%) when compared with the control group (37.0 ± 4.2%). At post-dialysis stage, PCV (27.1 ± 5.0%), Hb concentration (7.8 ± 1.2 g/dl), RBC count (2.9 ± 0.5 × 10⁶/ul), and neutrophil (58.3 ± 3.8%); significantly increased compared with pre-dialysis stage with PCV (24.1 ± 2.0%), Hb concentration (6.3 ± 1.8 g/dl), RBC count (2.1 ± 1.3 × 10⁶/ul), and neutrophil (54.7 ± 3.2%).

DISCUSSION

HD is the most common modality for renal replacement treatment in Sub-Sahara Africa where near normal kidney function is achieved in CKD patients with the use HD machine.^[13] There is a reluctant improvement in the life expectancy of CKD patients on HD over a long period of time and thus the need to elucidate hematological comorbidity associated with CKD. Previous studies depicted hematological alterations in the HD patients and emerging corrective modalities may help improve life expectancies and ameliorate costs and other burdens associated with CKD. This study was carried out to determine the pre- and post-dialysis hematological indices of CKD patients attending dialysis center in a tertiary hospital in Yola, Nigeria.

This study found out that most (29%) of HD patients in Yola are within the age of 51-55 years. This is similar to what obtained in previous studies in Sudan^[14] and Southern Nigeria.^[15] However, studies in India^[16] and Democratic Republic of Congo^[17] reported younger adults. However, due to the high cost of maintenance HD and prevailing poverty, greater proportion of CKD patients may not have been captured as they may not afford the dialysis fees.^[18] Nevertheless, young adults within the age of 20-50 years in Sub-Saharan Africa mostly develop CKD due to hypertension and glomerulonephritis.^[19] The male HD patients were found to be more than their female counterparts with the male to female ratio of 2.6:1. A large meta-analysis performed on a global consortium of over 2 million participants showed that the risks of all-cause mortality and cardiovascular-related mortality were higher among mean for all levels of GFR.^[20] Sex hormones are thought to play a major role in the biological mechanisms associated with variability in CKD prevalence and characteristics between men and women; even though, further research is needed to unravel additional gender-related characteristics in CKD and to identify the mechanisms of sexual dimorphism in CKD.^[21]

Hematological derangements are common in CKD patients, and these become most apparent as the disease progresses due to diminished EPO production, increased hemolysis, bone marrow suppression, and hematuria and gastrointestinal blood loss. Maintenance HD is the most common renal replacement treatment modality in Sub-Sahara Africa where near normal kidney function is temporarily restored. Pre- and post-dialysis hematological indices were analyzed and compared with control group in this study. The patients at pre-dialysis have significantly reduced mean ± SD of Hb concentration (6.3 ± 1.8 g/dl), RBC count (2.1 ± 1.3 × 10⁶/ul), and platelet count (186 ± 28.2 × 10³/ul) compared to control group which had 12.2 ± 1.4 g/dl, 4.4 ± 0.2 × 10⁶/ul, and 350.5 ± 82.2 × 10³/ul, respectively; while in contrast had higher lymphocyte count (39.7 ± 3.0%) when compared with the control group (37.0 ± 4.2%). Hematological indices obtained in this study are in agreement with previous studies.^[22-24] At post-dialysis stage,

PCV ($27.1 \pm 5.0\%$), Hb concentration (7.8 ± 1.2 g/dl), RBC count ($2.9 \pm 0.5 \times 10^6$ /ul), and neutrophil ($58.3 \pm 3.8\%$); significantly increased compared with pre-dialysis stage with PCV ($24.1 \pm 2.0\%$), Hb concentration (6.3 ± 1.8 g/dl), RBC count ($2.1 \pm 1.3 \times 10^6$ /ul), and ($54.7 \pm 3.2\%$). Improvement in the form of increased hematological indices at post-dialysis has also been reported by previous studies.^[14,25] This is, however, in contrast with the report by Dara^[26] where there was no significant change in the hematological indices at the post-dialysis stage.

CONCLUSION

There are remarkable changes in some hematological indices in chronic renal disease patients undergoing maintenance HD. A more detailed analysis of their hematological indices will provide data that will be used for the formulation of evidenced-based treatment modalities to improve the life expectancy of chronic renal disease patients.

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